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Delocalisation patterns in University-Industry interaction: Evidence from the 6th R&D Framework Programme

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ABSTRACT *Increasing university-industry interaction and university contribution to the local economy are compatible –conventional wisdom would say. However, as other university activities, interaction with industry may be limited due to a lack of absorptive*

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capacity in local firms. The data of those participating in the European Union's 6th R&D Framework Programme (FP6) was used to obtain values for the number and, notably, the budgets of UII projects at regional level for the EU27. Two types of interactions were considered: inside and outside the region. Our analysis indicates that universities from regions whose firms have low absorptive capacity participate more often in FP6 projects with firms outside the region. Our results highlight the value of policies that facilitate firm R&D to enhance collaboration with regional universities.

1. Introduction

University-industry interaction (UII) has increased in most developed countries over the last 30 years or so, due to changes in societal demands and institutional changes that have redefined the needs of universities for funding. However, we can rarely find explicit targets in policy rhetoric or documents about how much UII should take place inside and outside the region. Both types of UII are important, but explicit attention on the balance between the two has been lacking so far. Therefore, as a first step, our paper aims to map both types of UII in the regions of the European Union (EU) 27, motivated by a desire to stimulate policy awareness – and perhaps policy action – regarding territorially imbalanced UII. To do so, we examine UII as captured the EU's 6th Framework Programme for Research (henceforth FP). FP participations present a unique data source in terms of scale – it accounts for a substantial proportion of publicly-funded R&D activity in the EU, by some accounts up to 5% (EC, 2009: 105) – and scope, covering all of the EU as well as a near-comprehensive cross-section of R&D stakeholders. Although the FP's transnational nature means that it is biased toward interregional UII, this bias does not seem to be important if one wants to compare the characteristics of regions with more or less inter and intraregional links.

Indeed, a most striking pattern emerges from the data: There is a wide variation across regions according to the degree of intraregional UII. Therefore, as a second step, we aim to combine insights from literature and our own reasoning in an attempt to offer some preliminary explanations about observable patterns in the data, with a view of articulating them into a testable hypothesis.

What could the reasons behind differences in the regionalisation of UII be? Absorptive capacity is a very powerful explanatory variable of innovative success at firm level. Applying this insight at a regional level, it is worth asking whether differences in aggregated firms' absorptive capacity may condition the localisation of UII.

Hence, in this paper, we attempt to give a theoretical explanation of localised (intraregional) and delocalised (interregional) UII by analysing the UII literature in relation to another literature stream: the absorptive capacity of firms, with a regional perspective (section 2). This paper also includes an assessment of the phenomenon by looking at the quantity and value of interactions (section 3), a breakdown at regional level (section 4) and an empirical explanation of observed variation (section 5). We rely on these fundamental elements to advocate greater policy awareness of territorial imbalance in UII (section 6).

2. Building a hypothesis about the relationship between localisation of university-industry interaction and absorptive capacity of firms in the region

2.1. Higher absorptive capacity increases university-industry interaction

Cohen & Levinthal (1990: 128) label a firm's absorptive capacity as "the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends". The concept of the absorptive capacity of firms attempted to explain how firms are able to benefit, first, from R&D spillovers (Cohen & Levinthal, 1989; 1990) and, more recently, from openness (Barge-Gil, 2010). UII is different from R&D spillovers because the former involves engaging in partnerships, increasingly through contractual arrangements. Openness can encompass both spillovers and interaction (Perkmann & Walsh, 2007) and many sources of information other than universities (Amara & Landry, 2005) so UII is part of openness. The theoretical relationship between firms' interaction with universities and absorptive capacity is not obvious.[3]

However, high absorptive capacity is an explanation of, for example, why German firms maintain long-standing links with universities and vice-versa: the knowledge flows are bi-directional so universities also obtain relevant knowledge from firms (Meyer-Krahmer & Schmoch, 1998). On the opposite side, the lack of technical structure and graduate staff may hinder absorptive capacity and impede SMEs, like the Italian ones, to interact with research bodies (Rolfo & Calabrese, 2003).

Some statistical and econometric works support this idea. Mangematin & Nesta (1999) found some empirical evidence that supported that firms involved in projects with the French National Centre for Scientific Research (CNRS) benefited from greater cooperation and a wider range of modalities of research (not only applied and tacit but also fundamental and codified) if their absorptive capacity was higher. Fontana *et al*. (2006) corroborated, in the case of seven EU countries, that R&D intensity, a proxy for firm absorptive capacity, had a significant influence on the number of R&D projects

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[3] The management literature has nevertheless focused on how firms can increase the success of interaction with universities, with recommendations that are perfectly compatible with concept of raising absorptive capacity, like the creation of hybrid organisations (Andrisano *et al*., 2006; Rohrbeck & Arnold, 2006) or managing the different available instruments for interaction (Romero, 2007).

with PROs (including universities). Laursen & Salter (2004) found a similar positive relationship between R&D intensity and the ordinal value of the use of knowledge created in universities by firms in the UK sample of the Eurostat Community Innovation Survey (CIS)[4]. Alegre & Chiva (2008) found that firm interaction with the external environment, including universities, positively correlated with the degree of organisational learning capability (OLC) in the Spanish and Italian ceramic tile industry –OLC being a concept concomitant with that of absorptive capacity. Absorptive capacity is also important for increasing the impact of research and technology organizations (including universities) on firm competitiveness (Barge-Gil & Modrego, 2011).

2.2. University-industry interaction can take place inside or outside the region

Regional authorities try to create hybrid organisations to establish a Triple Helix between university, industry and government. The reason is that sometimes the model of 'best science' is not accepted as the sole basis for distribution of public research funds to regions. Some propose university contribution to regional development as a new source of legitimation (Etzkowitz & Leydesdorff, 1999), especially if it assumes a leading role in less favoured regions that goes beyond technology commercialisation (Rodrigues, 2011).

Many regional initiatives to foster the use of knowledge from universities assume that this use will take place within the region. In terms of spillovers, studies directly investigating the geography of knowledge transfers support this assumption as they

[4] These authors sometimes refer to the 'use of knowledge created in universities' as a proxy for university-industry interaction with the same meaning that we give it here: partnerships, not spillovers. However, it is not clear from the nature of their dependent variable whether this excludes spillovers.

report that knowledge from universities tends to spill over locally with a definite distance decay (Jaffe *et al*., 1993; Audretsch & Feldman, 1996; Varga, 1998; Fritsch & Slavtchev, 2007).

However, in terms of UII (i.e. engaging in partnerships, especially through contractual arrangements), this is not so straightforward. Unless there is a deliberate involvement of city authorities (Benneworth *et al*., 2010; Papaioannou, 2011) some universities are more successful than others in being a motor of regional development – sometimes irrespective of age, even if younger universities have been created with that explicit target (Braunerhjelm, 2008). Moreover, there is some evidence that geographical proximity is not likely to promote formal, regional links between universities and industry in the form of science parks (Vedovello, 1997).

Econometric literature has also found some evidence to support the finding that geographic proximity might not always be important. Beise & Stahl (1999) found that the proportion of scientists employed by universities in municipalities less than 100 kilometres away from the municipality of the firm did not have any significant effect on the innovation that could not have been developed without public research by universities. Mora-Valentin *et al*. (2004) did not find that the perception of the distance in kilometres and the perception of time wasted travelling to the partner's address had a significant impact on the success of the participation in cooperative agreements, both for firms and for public research organisations. Levy *et al*. (2009) showed that proximity matters only for bilateral relations but not for multilateral ones. According to Wetering & Ponds (2009), regional knowledge flows require more face-to-face contacts and are less valuable than non-regional knowledge flows, so the role of spatial proximity for knowledge transfer should not be exaggerated. However, other studies find that proximity is important, e.g. Arundel and Geuna (2004) who found, when comparing five information sources, that proximity effects are greatest for public research organisations.

2.3. Absorptive capacity of firms in the region and university-industry interaction

The literature review suggests that (i) the absorptive capacity of firms increases UII, and (ii) increasing regional UII may have an effect both inside and outside the region. By combining i and ii, we can deduce that absorptive capacity of firms in the region may have an effect on UII both inside and outside the region[5]. In order to predict the direction of the effect, we can only rely on indirect evidence.

Azagra *et al*. (2006), through the case study of the autonomous region of the Valencian Community in Spain, speculated on the role of absorptive capacity in the context of UII. They found that UII in this region was characterised by some distinctive features. Firstly, faculty members who cooperated with firms in the region exchanged less relevant knowledge than if they collaborated with firms outside the region. Secondly, it was easier for faculty members to transfer existing knowledge than to engage in the interactive generation of new knowledge. The authors interpreted these findings as an idiosyncrasy of a region with low absorptive capacity, in contrast with the importance given to bidirectional flows in UII in more research-intensive contexts (e.g. Meyer-Krahmer & Schmoch, 1998). On the contrary, when analysing a region characterised as having high absorptive capacity, such as the Basque Country, Castro *et*

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[5] Actually, when talking about the localisation of knowledge spillovers, Agrawal (2001) conducted a bibliographic review, according to which such localisation occurs and indirectly implies that the degree of localisation varies across regions. The author finds in the concept of ‘regional absorptive capacity’ an interesting opportunity for future research to explain this variation. Still, the relationship is between R&D spillovers –not UII and absorptive capacity of firms in the region.

al. (2008) found that UII was geographically concentrated. Applying the same principles to a country instead of a region, Schiller (2006) and Vega *et al*. (2008) found that the low absorptive capacity in the productive sector was a barrier for strengthening local UII, in Thailand and Bolivia, respectively.[6]

What this evidence suggests is that, for a given quantity of university research in a country, if the absorptive capacity of firms in the region rises, these firms will be more able to perform joint research with local universities[7]; whereas if such absorptive capacity decreases, universities in the region will look for partners in other regions. Hence, we formulate the following hypothesis:

Hypothesis. The lower the absorptive capacity of firms in the region, the more often university-industry interaction will take place outside the region.

3. Methodology and data

The context of our research is the European Union (EU). We will try to test our hypothesis at the regional level. At the possible expense of eloquence but in the interest of precision, we will use the term intraregional UII to refer to UII within regional

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[6] The relation between absorptive capacity and industry interaction with other partners in general (not only universities) has also been explored. Boschma & ter Wai (2007), using a sample from one Italian Industrial District and 33 firms, stated that there was no influence of absorptive capacity on local networking, but a positive one on non-local networking. For Belussi *et al.* (2008), number of patents (which is related to absorptive capacity) was related to research collaboration with partners abroad and not with regional or national partners, based on one Italian regions and 78 life science firms.

[7] Sometimes absorptive capacity of firms in the region may increase if multinationals locate their subsidiaries next to relevant university research (Abramovsky *et al*, 2007).

borders, and the term interregional UII to refer to UII outside those borders.

The EU R&D Framework Programmes (FP) are a well known source of data for the analysis of regional R&D (Vence *et al.*, 2000) and cooperation in R&D activities covering a large number of countries. University participation in particular is traceable through this data.

For example, Geuna (1998) showed that the FP can be a useful source of information about university interaction with other partners, although the author does not focus on industry. Using universities as a unit of observation, the econometric estimations suggest that scientific research productivity determines whether universities engage at least once in FP projects and then scientific research productivity, size and some country and scientific area fixed effects, determine the number of times that universities participate in these projects.

Taking another unit of observation, FP projects themselves, Caloghirou *et al*. (2001) found that projects involving at least one firm would be more likely to include at least one university over time, and also the larger the total number of partners, the longer the duration of the project. They also found some country-coordinator fixed effects, but did not conclude that any regional patterns existed.

In order to test our hypothesis, we obtained a unique database detailing participations to the 6th EU R&D Framework Programme (FP6) in September 2007. This is a 'live' database constructed by the European Commission, recording 8,861 distinct projects and 69,260 participations involving universities, private firms, public or private research centres and other organisations. In contrast with other studies, our analysis here is not confined to the number of participations but also includes information on the amount of funding per participant, and the unit of observation is the region-year, not the university or the project.

Given our focus on UII, we narrowed down the database to a subset of projects with at least one university and one firm. Additionally, in line with the primary focus of the FP, we confined our analysis to the EU27 members.

To assess the extent of interregionalisation, we identified whether universities and firms belonged to the same region by attributing to each project the region of the university (duplicating projects in the case of universities that belonged to more than one region[8]), and checking whether firms participating in the same project were from the same region as the university. If the firm was from a region other than that of the university then the participation was designated 'interregional'; otherwise it was designated 'intraregional' (a participation with joint university-industry participation where both the university and the company were from the same region).

We therefore constructed the following variables:

- INTERREG_C: number of interregional UIIs in projects from the FP6
- INTERREG_M: value of interregional UIIs in projects from the FP6

We took logs for the econometric estimations, calling the variables lnINTERREG_C and lnINTERREG_M, respectively.

These variables express absolute measures of interregional UII. We opted for the share of interregionalisation of UII, that is the ratio of interregional to all UII projects, as an indicator of relative measures. We defined the next variables in the following way:

- sINTERREG_C: number of interregional UIIs in FP6 projects over total number of UIIs in FP6 projects

[8] For projects with more than one university, we duplicated observations, attributing a distinct nationality in each duplicate project. We then added as many duplicate project observations as the discrete nationalities of participating universities.

- sINTERREG_M: value of interregional UIIs in FP6 projects over total value of UIIs in FP6 projects

As our database contains information on the number and value of intraregional UII, we repeated the above procedure creating similar variables as those for interregional UII:

- INTRAREG_C: number of intraregional UIIs in projects from the FP6 (lnINTRAREG_C if in logs)
- INTRAREG_M: value of intraregional UII in projects from the FP6 (lnINTRAREG_M if in logs)
- sINTRAREG_C: number of intraregional UIIs in FP6 projects over total number of UIIs in FP6 projects
- sINTRAREG_M: value of intraregional UIIs in FP6 projects over total value of UIIs in FP6 projects[9]

Focusing on a single project may clarify the interpretation of the variables. For example the project in Table 1 includes 6 universities and 2 firms, i.e. 12 UIIs. The project also includes other types of institutions but we do not count them. The regions of the six universities are DE71, ES51, FR43, ITC1, ITG2 and UKH2, which we include in the panel, i.e. the unit of observation is the region of the university. The regions of the firms are ES51 and PT16. Since there was a university from ES51, one out of the twelve UIIs has been intraregional. The remaining 11 UIIs have been interregional. Therefore, sINTERREG_C=0.5 in ES51 and 1 in the rest of regions.

{Table 1 around here}

[9] We have also used the percentage of less refined variables, the number and value of projects with UII (instead of number and value of UIIs), and the results do not change (available upon request).

For the aggregation by region, we sum the number of interactions in a given region and year (irrespective of the project) and then calculate the share of intraregional and interregional interactions. For example, there were 169 UIIs in region ES51 in 2005: 10 intraregional, 159 interregional. Hence, sINTERREG_C=0.94.

Given the non-standard regional coding used in the database (a mixture of NUTS1, NUTS2 and NUTS3 codes in addition to outdated national classifications)[10], this exercise required considerable harmonisation, much of which had to be done manually. In due course, we were also able to improve the completeness of the regional identifier using information from the participant's address field.

In order to perform the econometric analysis we specify the following function:

$$\begin{aligned} &\text{INTERREG\_C}^{*}_{i,t} = \alpha + \beta_1 \text{BERD}_{i,t-1} + \beta_2 \text{HERD}_{i,t-1} + \beta_3 \text{GDP}_{i,t-1} + \beta_4 \text{NUMPRO}_{i,t-1} + \\ &+ \beta_5 \text{AVNUMPAR}_{i,t-1} + \beta_6 \text{sFIRMS}_{i,t-1} + \beta_7 \text{LEAD}_{i,t} + \beta_8 \text{sTHEPRI}_{i,t} + u_{i,t} \end{aligned} \quad (1)$$

Where INTERREG_C* is an unobserved random variable related to the original INTERREG_C through the following transformation:

$$\begin{aligned} &\text{INTERREG\_C}_{i,t} = 0 \text{ if } \text{INTERREG\_C}^{*}_{i,t} \leq 0, \\ &\text{INTERREG\_C}_{i,t} = \text{INTERREG\_C}^{*}_{i,t} \text{ if } \text{INTERREG\_C}^{*}_{i,t} > 0 \end{aligned} \quad (2)$$

We opted for a logarithmic functional form[11] for the usual reasons (i.e. scaling

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[10] For some countries there was a mismatch between the NUTS code reported in the database and contemporary NUTS classifications used for the same regions by Eurostat. This is probably due to comprehensive national coding revisions (as e.g. in the case of Bulgaria, Denmark, Romania, Sweden and Slovenia) and to smaller ad hoc changes (as e.g. in the German regions DEE2, DEE3 which have been merged into DEE0).

[11] The transformation introduces a complication, as the logarithm of zero is undefined. A common solution is to add a small positive number to all observations before taking logarithms. We added 0.0001,

variables expressed in different units of measurement, suitability to non-linear relationships and lessening of the influence of outliers), so the actual function to be estimated is:

$$\begin{aligned} \ln INTERREG\_C^{*}_{i,t} &= \alpha + \beta_1 \ln BERD_{i,t-1} + \beta_2 \ln HERD_{i,t-1} + \beta_3 \ln GDP_{i,t-1} + \beta_4 NUMPRO_{i,t-1} + \\ &+ \beta_5 AVNUMPAR_{i,t-1} + \beta_6 sFIRMS_{i,t-1} + \beta_7 LEAD_{i,t} + \beta_8 sTHEPRI_{i,t} + u_{i,t} \end{aligned} \quad (3)$$

We ran analogous regressions for lnINTERREG_M, sINTERREG_c and sINTERREG_c. So for each region *i* at year *t*, the degree of interregionalisation was a function of the following independent variables:

- (ln)BERD: (natural log of) business expenditure on R&D (BERD). This is a proxy for absorptive capacity. If our hypothesis were true, a negative sign would be expected for lnBERD[12]
- (ln)HERD: (natural log of) higher education expenditure on R&D (HERD). It is a control for the strength of universities in the region. A positive significant parameter estimate would provide stronger support to the hypothesis since it would

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so that when INTERREG_C or INTERREG_M are equal to 0, lnINTERREG_C and lnINTERREG_M are equal to -9.21.

[12] It is difficult to measure absorptive capacity of firms in the region and, to the best of our knowledge, few studies have put forward tangible results. Roper & Love (2006), test how the labour market characteristics of European regions shape regional absorptive capacity. To that end, they add to the usual innovation production function some explanatory variables of interaction effects between the labour market indicators and public and private technology investment. However, for the authors, these interaction effects capture 'regional absorptive capacity' effects rather than 'regional absorptive capacity' per se. All in all, there is no generally accepted method for quantifying regional absorptive capacity. For this reason, based on new economic geography, we prefer to talk about the absorptive capacity of firms in the region and in our empirical analysis we opt for a measure that is faithful to the origins of the concept within the firm whilst maintaining the regional focus: regional BERD.

suggest that big-sized universities in terms of research interact with firms outside the region

- (ln)GDP: (natural log of) GDP in millions of euros. It is a control for the size of the region

The size and the type of projects in which a region participates could affect the estimation of the coefficients of the former independent variables. To avoid this, we will also include some characteristics of the region's participation in UII projects[13]:

- NUMPRO: number of UII projects in which universities in the region participate
- AVNUMPAR: average number of partners in UII projects
- sFIRMS: number of firms over total number of partners in UII projects (firms and universities)
- LEAD: count of number of times a university (or universities) in the region appear as coordinators in FP projects. A similar control to lnHERD, it identifies when universities act as lead partners. The rationale behind including it is to identify relationships that are actively built by a university. We must take into account that in most cases there are 'core participants' in any FP project with some academic institutions who have a major influence on the selection of a particular set of partners including industrial partners. It might be possible that a leading university (part of the core of an FP) selects an industrial partner from its region. Without this variable, the results from the regression could be misleading. Our measure is the count of number of times a university (or universities) in the region appears as a coordinator in FP projects, from the FP6 database
- sTHEPRI: share of projects of the region in each FP thematic priority; we

[13] As these variables take integer, mostly low, values we retain them in their original form.

considered seven priorities –the first six in Table 7 plus a benchmark category including the rest of projects –see section 5.2 for the details.

We repeated the former regressions for the intraregional variables, where the expected sign of the coefficients should be the opposite of those just explained.

We obtained BERD, HERD and GDP from the Eurostat online public database, which we then matched to the FP6 panel. We lagged them by one period in order to lessen the possibility of endogeneity.

Using this method, we constructed a panel of five years (2003-2007) for the EU's 27 Member States, yielding around 800 observations after having dropped missing values (mainly of BERD and HERD).[14]

The dependent variables are censored. The absolute measures INTERREG_C and INTERREG_M have a lower limit of 0 because an observation equal to zero may be the outcome of two different distributions: for all regions, the discrete outcome of not participating in UII FP projects; for regions that did participate, the decision of participants to participate in interregional projects. In addition, the relative measures sINTER_C and sINTER_M have an upper limit of 1 because an observation equal to one may be the outcome of two different distributions: for all regions, the discrete outcome of participating in UII FP projects, interregional by default; for regions that did participate, the decision of participants to participate in interregional projects. The same logic applies to the intraregional variables. Therefore, since all the dependent variables

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[14] Our near-complete sample of UII across EU regions is somewhat marred by missing year-region observations for HERD, BERD and GDP. To counter this issue we have followed the common convention of filling single missing year-region observations with the average value of the preceding and following years. This made the recuperation of a small number of observations for BERD (150) and HERD (49), but not for GDP, that had no missing values meeting the above criterion, possible.

are censored, the Tobit model appears to be adequate for the econometric estimations. Empirically, the high proportion of censored observations reinforces having taken this option (see tables in section 5).

The panel structure of our data raises an additional issue, namely the choice between a random effects and fixed effects estimator. In that respect, the need for a Tobit model, constrains us to random effects, as the alternatives are not very appealing[15]. A random effects estimator is certainly attractive given our research question (our interest in explaining cross sectional variation) and the structure of our panel (limited time-series variation). Random effects procedures are appropriate where the sample can be safely assumed to be a random draw from the population and the within-panel error term uncorrelated with the explanatory variables (Dougherty, 2007: 419). In our case, we have no particular reason to expect that our sample is not random, but we are unable to evaluate the validity of the second assumption. This constraint need not be detrimental though, provided one keeps an open mind about the possibility of omitted variable bias while drawing inferences.

4. Descriptive results

Table 2 presents some descriptive statistics. Overall about two-thirds (70%) of the 1370 regions in our sample had interregional UII, with the average EU region being home to about 32 such contracts worth about 9 million euros. Intraregional UII was

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[15] Conditional fixed effects models are not common practice as there does not exist a sufficient statistic allowing the fixed effects to be conditioned out of the likelihood. Unconditional fixed effects with dummy variables for the members of the cross-section produce biased estimates (from http://www.stata.com/help.cgi?xttobit, last access: 19/01/2010.)

much less common, occurring in just under one third (30%) of regions, with the average EU region barely having one such contract, worth on average about 300,000 euros.

{Table 2 around here}

Fig. 1 and 2 are two maps of intraregional UII across EU27 regions –one showing aggregate budgets (INTRAREG_M) and the other, intraregional budget shares (sINTRAREG_M). Darker areas (denoting higher values) seem to largely coincide with highly industrialised regions (much of northern Italy, Catalonia and the Basque Country (ES), Rhône Alpes (FR), Hamburg (DE) etc.) and include the greater regions of major EU capitals. Table 3, a list of the top 25 EU regions with intraregional UIIs, reinforces this impression.

{Fig. 1 around here}

{Fig. 2 around here}

{Table 3 around here}

On the surface, this pattern appears to be in agreement with our hypothesis: in such centres, one would expect not only high business R&D expenditures, but also a history of cooperation and an associated familiarity (through personal contacts and local networks) that could permit intraregional UII.

There are also notable exceptions to the above pattern, including Andalusia (ES), Midi-Pyrénées (FR), Sud-Est (RO), Sicily (IT) and Severoiztochen (BG); regions that are not commonly associated with high-technology industry. While it is true that some of these regions are improving their industrial R&D capacities (as partly reflected in the recent regional innovation scoreboard (Hollanders *et al*., 2009)) and/or receiving considerable policy attention and funding as cohesion (‘Objective 1’) regions, it is highly likely that we are witnessing here the effects of a region's size, as larger regions can accommodate a larger number of companies and hence increase the likelihood of intraregional UII.

Let us restrict the sample to the 1020 observations that report BERD statistics. Table 4 shows how INTRAREG varies across EU regions according to their BERD. For ease of presentation, we have divided BERD into quartiles. Just above one-third of all regions has had intraregional UII in FP6. We can observe that a greater proportion of observation belong to the mid-upper and upper quartiles of INTRAREG (counts and money) as we move to upper BERD quartiles. This is in agreement with our hypothesis, although it will have to be confirmed in a multivariate context.

{Table 4 around here}

5. Econometric results

The price paid for using HERD in the following econometric estimations is high, as we renounce to more than one third of the population. We performed a t-test for differences to verify if the observations in the sample are representative (Table 2). According to the test, region-years that report full R&D data present higher values for all variables: they have more interregional and intraregional UII, business expenditure on R&D, economic size (GDP), number of FP6 UII projects, average number of partners and share of firms in those projects. Hence, our initial econometric results allow inferences only about what we could call medium-large regions (sections 5.1-5.2) However, as a robustness check, we will show than without HERD and a larger, more representative sample, the results can be extrapolated to all regions (section 5.3.)

5.1. Aggregate UII

The econometric analysis with Tobit models now follows. Regression estimates are presented in Table 5.[16]

{Table 5 around here}

The signs of the coefficients coincide with our expectations. All four models provide evidence of a negative relationship between our proxy for absorptive capacity, lnBERD, and the degree of interregionalisation, therefore we can confirm the central hypothesis of the paper. Increasing regional firms' R&D will decrease UII beyond regional borders.

Our control variable for university R&D reinforces this theory. Higher HERD values have a significant, positive, association with the degree of interregionalisation. Hence, increasing HERD will boost UII outside regional borders. This result is in line with Belussi *et al.* (2008). Notice that the coefficients of HERD are always higher in absolute values than those of BERD, so the net impact of an equal percentage increase of HERD and BERD will most likely reduce interregionalisation of UII. More precisely, the marginal effect of lnHERD is 3.5-4 times higher than that of lnBERD on the dependent variables in logs and 1.4-1.8 times higher on the dependent variables in shares. In other words, BERD needs to increase faster than HERD to compensate for the interregionalisation of UII.

Size of the region or its proxy GDP does not correlate significantly with interregionalisation. If there is a size effect, it is better captured by the number of UII projects, which increases interregional UII, but only for the variables in logs, not in shares.

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[16] We acknowledge here the convenience offered by the table-producing tool developed by Wada (2009).

Other characteristics of FP projects also matter: the larger the average number of partners and the share of firms in the project, the more likely it will be that UII is interregional. The fact that universities assume the leadership of UII in FP projects has no influence. The joint effect of the shares of projects by thematic priority is significant.

{Table 6 around here}

The impact of lnBERD on intraregional participation in UII FP projects is not significant in the first three columns. However, it is positive and significant in the fourth column (variable sINTRAREG_M), which is consistent with our central hypothesis: increasing BERD makes firms interact less intensely with universities outside the region and equally or more intensely with universities within the region.

University R&D has a positive impact on intraregional UII, as it has on interregional UII. Hence, it has the dual role of generating compatible interaction with firms inside and outside the region. However, it is worth highlighting that the marginal effects of lnHERD in Table 5 are higher than in Table 6 for the relative measures (columns 3-4). Specifically, the impact of lnHERD is around 4-5 times higher on the share of interregionalisation than on the share of intraregionalisation. Taken at face value, an improvement in university R&D will increase university interaction with firms outside the region more quickly than with firms within the region. However, the imposition of a random effects model and the possible noise in the data advocate caution, so a more tentative interpretation is that the dual role of university R&D appears to be asymmetric and in favour of interregional UII.[17]

[17] Certainly, the marginal effects of the absolute measures in Table 5 are the same (column 1) or slightly smaller (column 2) than in Table 6. One may wonder how it is possible that variables in relative measures behave differently than in absolute measures. One reason is that the ratio of the marginal effects in Table

The coefficients of lnGDP are positive and significant for one of the two measures of absolute intraregionalisation (columns 1-2), and for both measures of relative intraregionalisation (columns 3-4), despite not being significant for interregionalisation. We may interpret that while GDP controls for size, it captures parts of absorptive capacity that are not included in BERD and which are influential for the intraregional UII, not for interregional UII.

Some characteristics of the region's participation in UII have significant effects on intraregional links: the larger the number of projects and the share of firms in the project, the more likely it will be that UII is intraregional. Some other characteristics do not exert any significant effect: the average number of partners and regional leadership of UII FP projects. The joint effect of the shares of projects by thematic priority is not significant and individually, only the effect of the share of projects in "Aeronautics and space" is significantly positive.

5.2. A test for robustness with a more homogeneous measure of UII

UII counts and their value used so far, bring together a heterogeneous mixture of activities. FP6 classifies its activities into (i) specific programmes that are subdivided into (ii) thematic areas and/or (iii) instruments. Thematic areas and instruments overlap in most instances. EC (2002) provides a quick guide to these differences, and a brief overview is also provided here.

Breaking down the data is convenient for technical and substantive reasons.

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6 over those in Table 5 is equal to 1, so the difference is not remarkable. More technical reasons are that: a) the Tobit estimation is not linear; b) the absolute measures are nevertheless taken in logs, which introduce additional non-linearity; c) one has to take into account the effect of the rest of the parameters in the model.

Technically, the construction of a more homogenous and meaningful measure of UII, should reduce the amount of noise contained in the dependent variables[18]. From a substantive perspective, reaching the level of thematic areas is especially interesting because they broadly correspond to scientific disciplines.

In order to get to the level of thematic areas, for the sake of clarity, we start by breaking the data down by specific programme. There are three (Table 7): (i) ‘Integrating and strengthening the ERA’, the bulk of the FP6 (92% of UIIs), and mostly concerned with research projects; (ii) ‘Structuring the ERA’, less numerous and more concerned with the mobility of human resources and the development of infrastructures (6%); (iii) Euratom, a small proportion of UIIs on nuclear research (2%).

{Table 7 around here}

The first one, ‘Integrating and strengthening the ERA’, is the most relevant for this study, because it is the largest and contains the thematic areas that can be attached to scientific disciplines. These are numbered from 1 to 7 (that is to say, numbered in the original dataset), while other thematic areas, not numbered and cannot be attached to scientific disciplines).

Out of the seven numbered thematic areas, 1-6 are closer to natural sciences, whether 7 is closer to social sciences. This is arguable, but not vital for our analysis. Areas 1-7 also encompass a narrower variety of instruments, which make it a more homogeneous subset. For the sake of building a less noisy variable, we will test whether our hypothesis holds true for an aggregate of the grey-shaded quadrant in Table 7.

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[18] This may not happen necessarily, as the exclusion of a large number of projects means that point estimates are produced from an overall lower number of observations – potentially exacerbating the impact of 'noise'.

The regression results (Table 8) are identical to those for the model with the aggregated data (Table 5) regarding the impact of BERD on interregionalisation. Hence, the central hypothesis is again supported. Differences in the marginal effects between BERD and HERD on interregionalisation are sustained (last rows of Tables 5 and 8).

{Table 8 around here}

In Table 9 the positive impact of lnBERD on intraregionalisation is more significant than it was in Table 6, favouring our hypothesis.

{Table 9 around here}

An important difference between Tables 6 and 9 is that the impact of lnHERD on sINTRAREG (both counts and money) becomes insignificant. This is further evidence than the impact HERD is larger for interaction beyond borders than within borders. Actually, differences between the marginal effects of HERD on interregionalisation and intraregionalisation remain similar for absolute interaction but are exacerbated for relative interaction (last rows of Tables 6 and 9).

For the rest of the coefficients in Tables 8 and 9, the findings are the same as with the aggregate measure of FP projects, with the exception of GDP in Table 9, column 1, which is no longer significant..

5.3. A second test for robustness with a larger sample

The variable with more missing values in the model is HERD. According to our theory, it made sense to control for it. Given that in the last two estimations of Table 9, HERD was not significant, we consider dropping it in this section. Doing so increases the number of observations included in the sample. Table 10 shows that the new sample is more similar to the population, since there are no significant differences with the observations excluded from the sample in the average value of any variable, with the exception of the variable LEAD.

Table 11 presents econometrics results for intraregionalisation. LnBERD is always significant and positive, as before, confirming our hypotheses. Hence, the hypothesis is validated for a larger, more representative, sample of EU27 regions.

The rest of the coefficients are like in previous estimations, except for lnGDP, which has a significant impact on the two sINTRAREG measures (same as before), but also on the two lnINTRAREG measures (not like before). This suggests that size of the region is more important for interaction to be local than in previous models.

6. Conclusions

The results so far highlight the importance of absorptive capacity of the region's firms in determining why UII is more delocalised in some EU regions than in others. As far as companies are concerned, our analysis has shown that controlling for proxies of the scientific efforts of universities in the region, the stronger the R&D capacities of firms the more likely they are to collaborate with universities in the region. Hence, regional policy makers may find that promoting firms' R&D in their region will not only boost local innovation directly but also through increased interaction with local universities.

On the contrary, as far as universities are concerned, our analysis has shown that, controlling for the region's absorptive capacity, promoting university research will push their collaboration activities outside the region rather than keep them inside the region. This means that universities establish cross-border links that may complement firms' preference for localisation. In short: all things being equal, improvements in the R&D

capacities of firms appear to strengthen centripetal forces in UII whereas improvements in the R&D capacities of universities strengthen centrifugal forces in UII.

As our sample draws data from FP, research networks are, almost by design, international. This international bias skews our sample, in that we are likely to witness more interregional UIIs than we would if we were observing 'natural' collaborations. While this is an important limitation that should be kept in mind when drawing inferences if the aim is to compare inter and intraregional links, it is not fatal if one wants to compare the characteristics of regions with more or less inter and intraregional links, as we do. In addition, the sample is valid for our approach for the following reasons: First, the remaining few intraregional UIIs are likely to represent important, high value ties (perhaps even indispensable), rather than casual collaboration patterns. Second, as we have shown, intraregional UIIs are not distributed randomly, but are in regions with high corporate absorptive capacity. Third, and crucially, there is no *a priori* reason to expect that an international bias should account for or even influence the observed correlations between the direction of UII and the absorptive capacity of firms in the region. In fact, if we accept the common intuition that partners from less developed regions are commonly sought after in FP projects then one should expect the opposite effect. While our findings may be specific to the FP and further research is needed to confirm that they hold more broadly, they are certainly compatible with the broad literature consensus on the importance of agglomeration effects (Feldman, 1994; Varga, 2000; Koo, 2005; Goldstein & Drucker, 2006).

Without calling for techno-regionalism (the regional analogue of techno-nationalism), our findings imply that policymakers should be aware that the objective of maximising UII is not necessarily compatible with the objective of maximising university contribution to local development.

This interpretation of the findings may have some policy implications. It may imply that policy makers should refine their objectives regarding UII by defining to what extent it should be localised. For established instruments such as the FP, the delocalisation of UII may not be successful if some regions perceive it as a threat to regional development, so compensating measures may be needed. Encouraging that the participation of universities as lead partners in projects with firms heads towards increased intraregional interaction could be a possible measure (right now, we have consistently found that such a leading role has no geographic impact). An alternative is to focus on regional links between firms and technology institutes, rather than universities (Barge-Gil *et al.*, 2011).

More generally, our findings highlight the need for a broader discussion on the normative assumptions surrounding UII in a regional context and, possibly, the distribution of UII-related policy competences in a multi-level governance system. A quixotic adherence to intraregional UII, despite its attractive appearance in the short-term, would be counter-productive in the long-term. This is not to say of course that more nuanced approaches could not be profitable in specific cases. For instance, the wide spectrum ranging from basic to applied research could benefit from geographically differentiated policies. As basic research is more likely to take place internationally (as well as interregionally), a supranational authority seems best suited to governing it. This may not be the case for applied research, which given the importance of proximity, might be best left to those authorities better able to contextualise policy.

Obviously, the immediate inferences one can draw from these findings apply to the FP and the jury is out on whether they could apply more generally. On the one hand, there are good reasons to expect that they do apply, given the FP's overall size and prominence in the European R&D landscape. On the other hand, the tilt of the FP towards internationalisation and the de facto artificiality of policy-induced networks may bias our findings. The topic could benefit from further research on alternative data sources.

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Figures

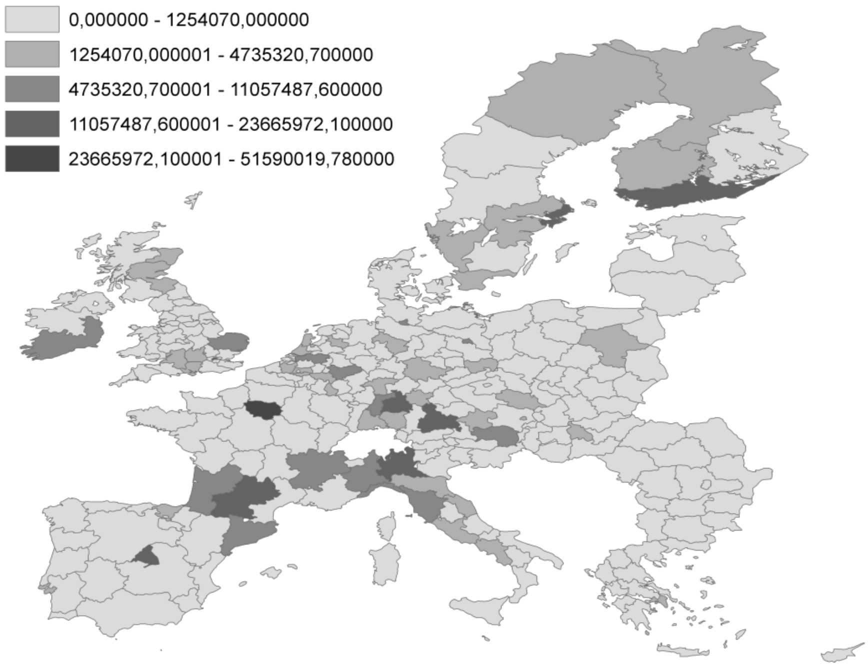

Figure 1. Intraregional UII across EU27 NUTS2 regions (INTRAREG_M: aggregate budgets of FP projects).

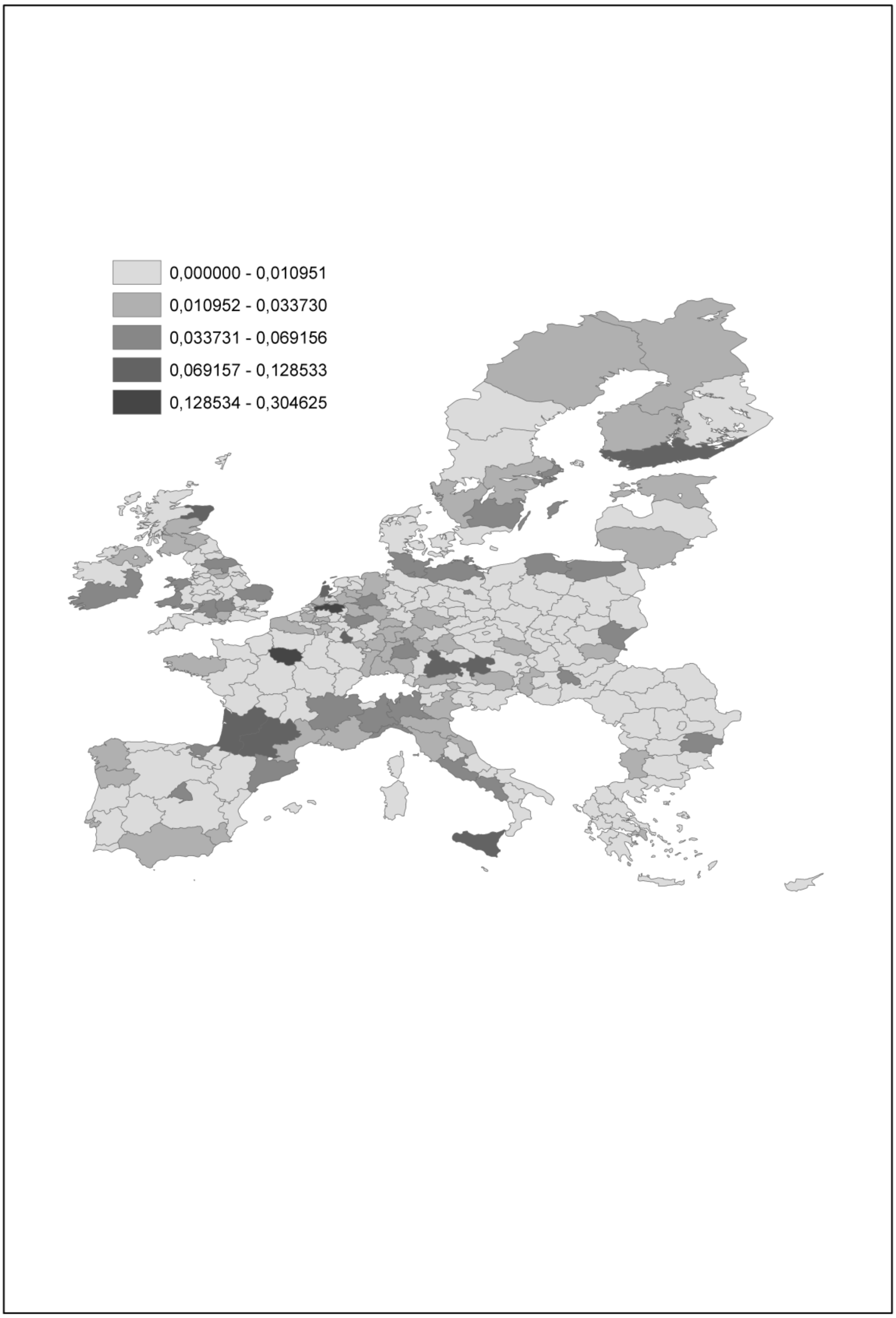

Figure 2. Intraregional UII across EU27 NUTS2 regions (sINTRAREG_M: shares of FP budgets).

Tables

Table 1. An example of the construction of the dependent variables

Region of university	INTRAREG_C (number of interactions with firms of the same region) (a)	INTERREG_C (number of interactions with firms from other regions) (b)	Total number of interactions (c=a+b)	sINTERREG_C (b/c)
DE71	0	2	2	1
ES51	1	1	2	0.5
FR43	0	2	2	1
ITC1	0	2	2	1
ITG2	0	2	2	1
UKH2	0	2	2	1

Table 2. Descriptive statistics

Variable	Population					Included in the sample (1)					Excluded from the sample (2)					Significance of t-test for mean differences (1 vs 2)
	Obs.	Mean	Std. Dev.	Min	Max	Obs.	Mean	Std. Dev.	Min	Max	Obs.	Mean	Std. Dev.	Min	Max	
INTERREG_C	1370	32.972	54.125	0	431	802	40.774	59.789	0	431	568	21.956	42.609	0	270	***
INTERREG_M	1370	9,020,739	16,800,000	0	151,000,000	802	11,400,000	19,000,000	0	151,000,000	568	5,677,712	12,500,000	0	88,300,000	***
sINTERREG_C	1370	0.685	0.448	0	1	802	0.774	0.396	0	1	568	0.559	0.487	0	1	***
sINTERREG_M	1370	0.683	0.451	0	1	802	0.773	0.400	0	1	568	0.557	0.486	0	1	***
INTRAREG_C	1370	1.144	3.215	0	46	802	1.555	3.837	0	46	568	0.563	1.894	0	29	***
INTRAREG_M	1370	321,760	1,213,793	0	21,700,000	802	422,183	1,450,340	0	21,700,000	568	179,966	742,439	0	7,818,962	***
sINTRAREG_C	1370	0.017	0.044	0	1	802	0.021	0.048	0	1	568	0.011	0.036	0	1	***
sINTRAREG_M	1370	0.016	0.047	0	1	802	0.018	0.044	0	1	568	0.013	0.051	0	1	*
BERD	1020	401.772	761.286	0	8,944	802	427.733	834.034	0	8,944	218	306.266	377.067	0	1,786	**
HERD	873	150.605	207.750	0	2,065	802	152.964	211.863	0	2,065	71	123.951	152.452	0	708	n.s.
GDP	1345	37,941	42,575	809	442,538	802	39,292	42,647	811	416,711	543	35,947	42,429	809	442,538	*
NUMPRO	1370	8.028	12.872	0	102	802	9.868	14.049	0	102	568	5.431	10.473	0	79	***
AVNUMPAR	1370	10.806	9.026	0	64	802	11.561	8.159	0	64	568	9.739	10.035	0	48	***
sFIRMS	1370	0.277	0.226	0	1	802	0.328	0.217	0	1	568	0.205	0.220	0	1	***
LEAD	1370	0.550	1.286	0	13	802	0.693	1.451	0	13	568	0.347	0.973	0	10	***

*, ** and *** denote statistical significance at the 0.1, 0.05 and 0.01 levels respectively; n.s. not significant

Table 3. Top 25 Regions with intraregional UII

Region name	NUTS Code	Intraregional UIIs (INTRAREG_C)
Île de France	FR10	145
Lombardy	ITC4	62
Stockholm	SE11	62
Inner London	UKI1	50
Catalonia	ES51	49
Oberbayern	DE21	46
Madrid	ES30	46
Stuttgart	DE11	43
Etelä-Suomi	FI18	42
Köln	DEA2	36
Attiki	GR30	35
Toscana	ITE1	33
Southern and Eastern	IE02	32
Rhône-Alpes	FR71	29
Kozep-Magyarorszag	HU10	29
Emilia-Romagna	ITD5	24
Zuid-Holland	NL33	24
East Anglia	UKH1	24
Piemonte	ITC1	22
Wien	AT13	20
Midi-Pyrénées	FR62	20
Prov. Vlaams-Brabant	BE24	19
Karlsruhe	DE12	18
Berlin	DE30	18
Lisboa	PT17	18

Table 4. Intraregionalisation of UII in the 6th FP and BERD: Number of observations per quartiles

		Quartiles of BERD				
		Lower quartile	Mid-lower quartile	Mid-upper quartile	Upper quartile	Total
Quartiles of INTRAREG_C	Lower quartile	236	195	143	94	668
	Mid-upper quartile	14	30	46	36	126
	Upper quartile	5	30	66	125	226
	Total	255	255	255	255	1,020
Quartiles of INTRAREG_M	Lower quartile	237	196	144	95	672
	Mid-upper quartile	13	22	19	9	63
	Upper quartile	5	37	92	151	285
	Total	255	255	255	255	1,020

Table 5. Tobit models of the determinants of interregionalisation of UII in the FP6

	1 lnINTERREG_C	2 lnINTERREG_M	3 sINTERREG_C	4 sINTERREG_M
lnBERD	-0.193**	-0.452***	-0.024**	-0.033***
	(0.081)	(0.168)	(0.011)	(0.012)
lnHERD	0.786***	1.592***	0.043***	0.046***
	(0.105)	(0.22)	(0.014)	(0.016)
lnGDP	0.13	0.245	-0.029	-0.025
	(0.207)	(0.428)	(0.025)	(0.028)
NUMPRO	0.106***	0.155***	-0.001	-0.001
	(0.01)	(0.021)	(0.001)	(0.001)
AVNUMPAR	0.201***	0.391***	0.032***	0.032***
	(0.012)	(0.027)	(0.002)	(0.003)
sFIRMS	10.141***	21.378***	1.339***	1.379***
	(0.455)	(1.001)	(0.078)	(0.088)
LEAD	-0.072	-0.108	0.006	0.007
	(0.075)	(0.164)	(0.009)	(0.01)
sTHEPRI	Included (6)	Included (6)	Included (6)	Included (6)
Constant	-12.273***	-15.638***	0.032	-0.036
	(1.779)	(3.674)	(0.211)	(0.237)
Observations	802	802	802	802
Number of regions	234	234	234	234
Log likelihood	-1421.115	-1912.137	-197.456	-236.996
Prob > χ^2	0.000	0.000	0.000	0.000
Proportion of censored observations	20.449%	20.948%	62.344%	62.594%
	Relevant average marginal effects			
lnBERD (1)	-0.166	-0.387	-0.007	-0.009
lnHERD (2)	0.675	1.363	0.013	0.013
Times higher (2 over absolute value of 1)	4.064	3.520	1.795	1.400

Standard errors in parentheses. *, ** and *** denote statistical significance at the 0.1, 0.05 and 0.01 levels respectively

Table 6. Tobit models of the determinants of intraregionalisation of UII in the FP6

	1 lnINTRAREG_C	2 lnINTRAREG_M	3 sINTRAREG_C	4 sINTRAREG_M
lnBERD	0.316	0.787	0.005	0.007*
	(0.356)	(0.795)	(0.004)	(0.004)
lnHERD	1.877***	4.759***	0.009*	0.012**
	(0.506)	(1.165)	(0.006)	(0.005)
lnGDP	1.605**	2.923	0.022**	0.02**
	(0.81)	(1.804)	(0.009)	(0.009)
NUMPRO	0.21***	0.441***	0.001**	0.001**
	(0.037)	(0.082)	(0.000)	(0.000)
AVNUMPAR	0.041	0.088	0.000	0.001
	(0.061)	(0.136)	(0.001)	(0.001)
sFIRMS	8.753***	19.467***	0.111***	0.095***
	(2.269)	(5.075)	(0.028)	(0.025)
LEAD	0.022	-0.033	0.003	0.001
	(0.273)	(0.606)	(0.003)	(0.003)
sTHEPRI	Included (6)	Included (6)	Included (6)	Included (6)
Constant	-43.452***	-81.54***	-0.412***	-0.397***
	(7.145)	(15.868)	(0.084)	(0.075)
Observations	802	802	802	802
Number of regions	234	234	234	234
Log likelihood	-1215.011	-1445.851	145.577	198.354
Prob > χ^2	0.000	0.000	0.000	0.000
Proportion of censored observations	62.344%	62.594%	62.344%	62.594%
	Relevant average marginal effects			
lnHERD (3)	0.663	1.665	0.003	0.003
Times higher (3 over 2 from Table 5)	1.018	0.819	4.915	3.855

Standard errors in parentheses. *, ** and *** denote statistical significance at the 0.1, 0.05 and 0.01 levels respectively

Table 7. Number of UIIs in the FP6 by specific programme, thematic priority and instrument

	NoE	IP	STREP	CA	SSA	CRAFT	CLR	I3	II	MCA	Total
Integrating and strengthening the ERA	54427	99780	35877	13101	2832	3525	1713				211255
1. Life sciences, genomics and biotechnology for health	10722	15545	5279	1336	321						33203
2. Information society technologies	34852	26697	10148	2607	972						75276
3. Nanotechnologies and nanosciences, knowledge-based multifunctional materials and new production processes and devices	2146	11922	5774	2996	164						23002
4. Aeronautics and space	154	7560	5564	312	93						13683
5. Food quality and safety	1402	10886	1829	1367	540						16024
6. Sustainable development, global change and ecosystems	5151	26933	4821	2773	208						39886
7. Citizens and governance in a knowledge-based society		105	24	187							316
Horizontal research activities involving SMEs						3525	1713				5238
Policy support and anticipating scientific and technological needs			2246	1206	376						3828
Specific measures in support of international cooperation		132	192	298	158						780
Support for the coordination of activities				19							19
Structuring the ERA		96	170	462	1407	88		2721	2215	5855	13014
Human resources and mobility					12					5855	5867
Research and innovation				300	236	88					624
Research infrastructures		96	20	126	1071			2721	2215		6249
Science and society			150	36	88						274
Euratom	510	2573	377	1257	42						4759
Total	54937	102449	36424	14820	4281	3613	1713	2721	2215	5855	229028

NoE: Networks of Excellence; IP: Integrated Projects; STREP: Specific Targeted Research Projects; CA: Coordination Actions; SSA: Specific Support Actions; CRAFT: Co-operative research projects; CLR: Collective research projects; I3: Integrated Infrastructure Initiatives; II: Specific actions to promote research infrastructures –other than I3; MCA: Marie Curie Actions

Table 8. Tobit models of the determinants of interregionalisation of UII in the FP6, in the specific programme 'Integrating and strengthening the ERA' and the six thematic priorities corresponding to natural sciences

	1 lnINTERREG_C	2 lnINTERREG_M	3 sINTERREG_C	4 sINTERREG_M
lnBERD	-0.163*	-0.441**	-0.04***	-0.05***
	(0.083)	(0.177)	(0.014)	(0.016)
lnHERD	0.619***	1.352***	0.036*	0.045**
	(0.109)	(0.233)	(0.019)	(0.021)
lnGDP	0.156	0.337	-0.01	-0.003
	(0.21)	(0.444)	(0.034)	(0.037)
NUMPRO	0.102***	0.151***	-0.002	-0.003
	(0.01)	(0.023)	(0.002)	(0.002)
AVNUMPAR	0.093***	0.169***	0.017***	0.017***
	(0.013)	(0.03)	(0.003)	(0.003)
sFIRMS	4.654***	10.9***	0.629***	0.684***
	(0.498)	(1.104)	(0.095)	(0.104)
LEAD	-0.113	-0.206	0.001	0.001
	(0.079)	(0.176)	(0.012)	(0.013)
sTHEPRI	Included (6)	Included (6)	Included (6)	Included (6)
Constant	-13.142***	-17.807***	-0.234	-0.333
	(1.809)	(3.826)	(0.29)	(0.318)
Observations	802	802	802	802
Number of regions	234	234	234	234
Log likelihood	-1406.39	-1891.157	-265.304	-290.001
Prob > χ^2	0.000	0.000	0.000	0.000
Proportion of censored observations	23.192%	23.566%	67.207%	67.456%
	Relevant average marginal effects			
lnBERD (1)	-0.136	-0.367	-0.011	-0.013
lnHERD (2)	0.516	1.126	0.010	0.012
Times higher (2 over absolute value of 1)	3.799	3.066	0.910	0.900

Standard errors in parentheses. *, ** and *** denote statistical significance at the 0.1, 0.05 and 0.01 levels respectively

Table 9. Tobit models of the determinants of intraregionalisation of UII in the FP6, in the specific programme 'Integrating and strengthening the ERA' and the six thematic priorities corresponding to natural sciences

	1 lnINTRAREG_C	2 lnINTRAREG_M	3 sINTRAREG_C	4 sINTRAREG_M
lnBERD	0.79**	1.827**	0.01**	0.013***
	(0.38)	(0.862)	(0.005)	(0.004)
lnHERD	1.402***	3.749***	0.004	0.008
	(0.529)	(1.237)	(0.006)	(0.006)
lnGDP	1.193	2.123	0.02**	0.018*
	(0.827)	(1.87)	(0.01)	(0.009)
NUMPRO	0.234***	0.502***	0.001***	0.001***
	(0.039)	(0.088)	(0)	(0)
AVNUMPAR	-0.053	-0.114	-0.001	0
	(0.071)	(0.16)	(0.001)	(0.001)
sFIRMS	6.701**	15.562***	0.097***	0.092***
	(2.653)	(5.997)	(0.033)	(0.031)
LEAD	-0.03	-0.139	0.001	0
	(0.294)	(0.66)	(0.004)	(0.003)
sTHEPRI	Included (6)	Included (6)	Included (6)	Included (6)
Constant	-42.514***	-80.953***	-0.421***	-0.421***
	(7.381)	(16.648)	(0.09)	(0.084)
Observations	802	802	802	802
Number of regions	234	234	234	234
Log likelihood	-1089.507	-1292.237	89.586	126.472
Prob > χ^2	0.000	0.000	0.000	0.000
Proportion of censored observations	67.207%	67.456%	67.207%	67.456%
		Relevant average marginal effects		
lnHERD (3)	0.445	1.177	0.001	0.002
Times higher (3 over 2 from Table 8)	1.160	0.956	9.817	5.820

Standard errors in parentheses. *, ** and *** denote statistical significance at the 0.1, 0.05 and 0.01 levels respectively

Table 10. Descriptive statistics – excluding HERD from the model

Variable	Included in the sample (1)					Excluded from the sample (2)					Significance of t-test for mean differences (1 vs 2)
	Obs.	Mean	Std. Dev.	Min	Max	Obs.	Mean	Std. Dev.	Min	Max	
INTERREG_C	998	34.008	55.966	0	431	372	30.194	48.805	0	260	n.s.
INTERREG_M	998	9,352,360	17,600,000	0	151,000,000	372	8,131,067	14,700,000	0	87,200,000	n.s.
sINTERREG_C	998	0.690	0.446	0	1	372	0.671	0.454	0	1	n.s.
sINTERREG_M	998	0.690	0.448	0	1	372	0.665	0.458	0	1	n.s.
INTRAREG_C	998	1.168	2.943	0	27	372	1.078	3.855	0	46	n.s.
INTRAREG_M	998	324,471	1,090,519	0	11,300,000	372	314,489	1,496,850	0	21,700,000	n.s.
sINTRAREG_C	998	0.017	0.043	0	1	372	0.017	0.046	0	1	n.s.
sINTRAREG_M	998	0.015	0.042	0	1	372	0.018	0.060	0	1	n.s.
BERD	761	400.535	713.927	0	8,387	259	405.406	887.461	0	8,944	n.s.
HERD	672	152.975	195.826	0	2,065	201	142.680	243.801	0	2,049	n.s.
GDP	982	37,101	37,783	809	410,747	363	40,214	53,424	1140	442,538	n.s.
NUMPRO	998	8.306	13.268	0	102	372	7.285	11.728	0	79	n.s.
AVNUMPAR	998	10.854	9.077	0	64	372	10.677	8.899	0	44	n.s.
sFIRMS	998	0.281	0.228	0	1	372	0.268	0.221	0	1	n.s.
LEAD	998	0.592	1.374	0	13	372	0.435	1.006	0	7	**

*, ** and *** denote statistical significance at the 0.1, 0.05 and 0.01 levels respectively; n.s. not significant

Table 11. Tobit models of the determinants of intraregionalisation of UII in the FP6, in the specific programme 'Integrating and strengthening the ERA' and the six thematic priorities corresponding to natural sciences – excluding HERD from the model

	1 lnINTRAREG_C	2 lnINTRAREG_M	3 sINTRAREG_C	4 sINTRAREG_M
lnBERD	1.044***	2.428***	0.01**	0.013***
	(0.352)	(0.807)	(0.004)	(0.004)
lnGDP	2.173***	4.92***	0.025***	0.028***
	(0.776)	(1.78)	(0.009)	(0.009)
NUMPRO	0.268***	0.595***	0.001***	0.001***
	(0.037)	(0.084)	(0)	(0)
AVNUMPAR	-0.086	-0.208	-0.001	-0.001
	(0.065)	(0.149)	(0.001)	(0.001)
sFIRMS	6.086**	13.963**	0.102***	0.092***
	(2.463)	(5.586)	(0.029)	(0.028)
LEAD	0	-0.082	0.002	0.002
	(0.282)	(0.637)	(0.003)	(0.003)
sTHEPRI	Included (6)	Included (6)	Included (6)	Included (6)
Constant	-49.441***	-100.202***	-0.465***	-0.501***
	(7.142)	(16.359)	(0.083)	(0.082)
Observations	998	998	998	998
Number of regions	247	247	247	247
Log likelihood	-1285.543	-1515.766	101.943	127.908
Prob > χ^2	0	0	0	0
Proportion of censored observations	69.339%	69.739%	69.339%	69.739%

Standard errors in parentheses. *, ** and *** denote statistical significance at the 0.1, 0.05 and 0.01 levels respectively