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Collaboration objectives and the location of the university partner:
Evidence from the Piedmont region in Italy

Bodas Freitas Isabel Maria*
Grenoble Ecole de Management

Federica Rossi **
School of Business, Economics and Informatics, Birkbeck College, University of London

Aldo Geuna ***
Department of Economics and Statistics Cognetti De Martiis, University of Torino
BRICK, Collegio Carlo Alberto

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Running title: Collaboration objectives and the location of the university partner

*: Grenoble Ecole de Management, 12 rue Pierre Sémard-BP 127, 38003 Grenoble cedex 01; email: Isabel-Maria.BODAS-FREITAS@grenoble-em.com
**: School of Business Economics and Informatics, Birkbeck, University of London, Malet Street, London WC1E 7HX, UK; Tel. +44 2070790685; email: f.rossi@bbk.ac.uk
***: Department of Economics and Statistics Cognetti De Martiis, University of Torino, Lungo Dora 100A, 10153 Torino, Italy; Tel: +39 0116703891, Fax: 0039 011 6703895; email: aldo.geuna@unito.it

Abstract

This study examines firms' decisions to collaborate with universities in their region as opposed to non-regional universities, focusing on the role of collaboration objectives. Through a survey of a representative sample of manufacturing firms in the Piedmont region (Italy), we find that firms seeking business advice are more likely to collaborate with regional universities while firms seeking R&D support and testing and analysis services are more likely to collaborate with both regional and non-regional universities. The partner university's location is endogenous to the level of investment in the collaboration; and the collaboration objectives provide good instruments. Some implications for regional policy are discussed.

Keywords: University-industry collaboration, knowledge transfer, proximity, regional economy.

JEL: O31; O32; L25; R12

1. Introduction

Interactions between firms and universities in the same region, for the exchange of knowledge and its integration into firms' innovation activities, are thought to stimulate local collective learning processes (Camagni, 1995; Lawton-Smith, 2007) leading to the development of "regional capabilities" (Foss, 1996; Lawson, 1999; Lawson and Lorenz, 1999). Regional capabilities are a source of competitive advantage for regional actors and foster economic development in the region. Investigating what factors stimulate interaction between firms and universities located in the same region is important for understanding the determinants of the capabilities that might enhance a region's competitiveness.

While there is a large literature on the role of geographical distance in university-industry knowledge interaction and the development and transfer of knowledge spillovers from academic to industrial research, most work focuses on research and development (R&D) collaborations, ignoring business consulting or services provided by the university. Also most studies that compare the decision to collaborate with a university in the firm's own region with a decision to collaborate with a university in another region, show that larger, more R&D intensive firms, and firms that belong to a group, are more likely to collaborate with universities outside their home region (e.g. Fritsch and Lukas, 1995; Fritsch, 2001; Laursen, Reichstein and Salter, 2011; Bouba-Olga, Ferru and Pepin, 2012). However, little is known about the extent to which the knowledge objectives of the collaboration affect the likelihood to collaborate intra-regionally as opposed to extra-regional university cooperation.

This study aims to fill this gap by investigating how the firm's decision to collaborate either with a university within the region or with a university outside the region is associated with different knowledge objectives. In particular, we distinguish among

collaborations aimed at R&D, at the provision of services mainly to support the firm's production activities (e.g. safety and quality testing and analysis), and at supporting the firm's business development via organizational, management, logistics, marketing and legal consultancy arrangements. We propose a basic theoretical framework that addresses the role of different collaboration objectives for explaining the location of the partner university. We examine these issues empirically based on an original survey of a representative sample of manufacturing firms with 10 or more employees, in the Italian region of Piedmont (UIPIE survey). While the empirical analysis focuses on a specific regional setting, Piedmont provides a case, which it is argued, has broad relevance since it has similarities in several key dimensions to other industrial regions in Europe. Section 3 presents the main features of Piedmont's regional economy and provides some comments on the generalizability of our findings.

Our results shed light on firms' choices to collaborate with universities in their home region. We consider several firm characteristics that might affect their willingness to engage in university interaction and find that collaborations with universities in the home region are more likely to involve business consulting irrespective of whether the firms collaborate exclusively with home region universities or a combination of within and outside-region university partners. Firms that collaborate over both R&D and testing are more likely to collaborate with both types of university partners, than firms that collaborate only for R&D or only for the provision of testing services. Our results suggest also that the location of the university partner is endogenous in the level of investment in university collaboration, and that the knowledge objectives of the collaboration are good instruments. Thus, the knowledge objectives of the collaboration, rather than the location of the partner, matter for the amount of money that firms invest in the collaboration.

The paper is structured as follows. Section 2 reviews the literature on the firm's choice to collaborate with a university partner in the home region, and derives hypotheses about how the different knowledge objectives of the collaboration may influence the choice of (location of) the university partner. Section 3 presents a brief overview of Piedmont's economic system and Section 4 describes the data used for the empirical analysis and the methodology. Section 5 presents the empirical results, and Section 6 concludes with a summary of the main results and some policy-relevant remarks.

2. Regional university-industry collaboration: channels and objectives

2.1. University-industry relationships and regional innovation capabilities

Analytical concepts and frameworks, such as learning regions (Asheim, 1996), regional innovation systems (Cooke et al., 1997), and competence theory of the region (Lawson, 1999), emphasize the impact of the region's socioeconomic and institutional environment on the innovativeness and competitiveness of its firms. The theory and evidence suggest that geographic, cultural, and institutional proximity of the economic actors within a region supports frequent interactions (e.g. via career mobility and inter-organizational relationships) that promote collective learning (Camagni, 1995) and foster innovativeness (Capello and Faggian, 2005). Some authors suggest that, over time, these learning processes lead to the development of regional capabilities (Foss, 1996; Lawson, 1999; Lawson and Lorenz, 1999). Since these capabilities relate to knowledge that resides in the region, and "emerge in a historical process from the systemic interaction among firms" (Foss, 1996, p. 3), they are highly idiosyncratic and localized, and hence difficult to replicate elsewhere

(Lawson and Lorenz, 1999; Antonelli, 2000; Romijn and Albu, 2002). This renders them important sources of competitive advantage for regional firms. Understanding the interaction process that gives rise to higher-order regional capabilities is important for policymakers keen to strengthen potential sources of regional competitive advantage and increase the attractiveness of the region for firms.

Regional universities are one of the important actors involved in interactions that sustain regional capabilities: they can potentially support collective learning processes in numerous ways, including training (and retraining) of the local workforce, supporting technology development in firms, creating spin off firms, providing access to advanced equipment and other services, acting as a bridge with the wider scientific community, assuming the role of "knowledge gatekeeper" in the diffusion of external knowledge to the local territory. The presence of a public science infrastructure, consisting of universities and public research institutes, is considered a key feature of the regional innovation system, which contributes to competitive advantage in the home region vis-à-vis other locations (Lundvall, 1992; Nelson, 1993; Cooke et al., 1997).

There is a large literature confirming the importance of geographic proximity for promoting the transfer of knowledge between universities (or public research laboratories) and firms. Much of this work investigates and finds evidence for either the extent to which co-localization of firms and universities generates spatially-mediated knowledge spillovers from university research to industrial innovation (e.g. starting from Jaffe, 1989; Feldman, 1994; Feldman and Florida, 1994; Audretsch and Feldman, 1996; a recent review is presented in Autant-Bernard and Massard, 2009) or the extent to which distance matters for the likelihood of knowledge transfer between universities and firms (Mansfield and Lee, 1996; Hanel and St-Pierre, 2006). A small

group of studies investigates the specific characteristics of firms that collaborate with universities in their own region as opposed to universities outside their regional border (e.g. Fritsch and Schwirten, 1999; Fritsch, 2001; Laursen, Reichstein and Salter, 2011; Bouba-Olga, Ferru and Pepin, 2012). These studies show that larger, more R&D intensive firms, and firms that belong to a group, are more likely to collaborate with universities outside the region and to have a larger number of collaborations. However, most studies do not investigate the specific features of the collaboration.

The specific processes channeling knowledge between universities and industry whether through direct interactions or via spillovers from public research, are rarely considered directly (Capello and Faggian, 2005; D'Este and Iammarino, 2010). Contributions that specifically explore the relative importance of different channels for the transfer of university knowledge (which generally do not consider geographical distance) show consistently that most firms favor open science channels, employment relationships, and direct collaboration (Baldwin and Link, 1998; Link and Vonortas, 2002; Bekkers and Bodas Freitas, 2008).

Most studies also do not consider the knowledge objectives of the interactions and investigate all forms of knowledge transfer without distinguishing among them, or restrict the analysis to R&D collaboration ignoring interactions with other objectives (such as provision of services related to production, or business consulting related to management, or legal, logistic or marketing issues). Studies that investigate the role of geographical distance for promoting collaborations between university and industry often measure co-publication or co-patenting activities, which capture only a small part of the outputs of knowledge transfer processes (Christ, 2009; Abramo et al., 2011; Gao et al., 2011; von Proff and Dettmann, 2013). Studies that use survey data to

capture the geographical determinants of university-industry collaboration, although they explore the characteristics of the interactions in more detail, do not investigate the objectives of collaboration (Goddard and Isabelle, 2002; D'Este and Patel, 2007; Garcia-Aracil and Fernandez De Lucio, 2008; Bruneel et al., 2010).

Several authors have argued that taking account of the knowledge objectives is important to analyze knowledge transfer patterns. First, there is evidence that universities and firms develop and transfer knowledge using several channels, only a few of which are based on the commercialization of patented outputs, and many of which do not involve R&D activity (D'Este and Patel, 2007; Bekkers and Bodas Freitas, 2008; Hughes et al., 2011). Collaboration with a university is often aimed at provision of services (such as safety and quality control testing of firm products) and organizational, management, logistic, marketing or legal consultancies (Cohen et al., 1998; Hughes, 2006; Perkmann et al., 2010). Thus, a focus only on R&D collaborations potentially misrepresents the extent to which knowledge is developed and transferred between universities and industry. It has been shown that different universities engage in different patterns of interactions with industry, according to both parties' objectives and disciplinary orientation. For example, mid-range universities typically have a different engagement profile from the top-ranked universities. The former focuses more on the creation of spinoff companies and consultancies involving local firms than on the development of intellectual property, and contract research (Wright et al., 2007). Research intensive universities tend to engage more in knowledge transfer activity involving firms compared to less research-intensive universities which tend to provide courses for the community and interact predominantly with organizations in their home region (Hewitt-Dundas,

2012) although they can engage in a wide variety of interactions (Molas-Gallart et al., 2002; D'Este and Patel, 2007).

Also, to identify the strengths of the local university system and the local industry base, it is important to understand the content and the patterns of interactions that drive the development of regional capabilities.

This paper contributes by examining how the firm's choice to collaborate with a university within the local region or one outside the region, is associated with the knowledge objectives of the collaboration. In the remainder of this paper we refer to regional university to describe a university in the same region of the firm, and non-regional university to describe a university from outside the firm's home region.

2.2. The determinants of collaboration with a regional university

There are several arguments suggesting that collaboration with regional universities is likely to involve lower transaction costs than collaborations with non-regional universities. Organizations co-localized within a region are more likely to have common social and cultural backgrounds, which facilitates communication and in turn makes it easier to initiate and organize the collaboration and negotiation and setting up of contracts (Gertler, 1995; Laursen, Reichstein and Salter, 2011). Ease of communication and possibility of frequent face-to-face contact make it easier for the firm to monitor engagement (thus reducing the agency costs involved in collaborating with agents such as academic researchers whose competences are sophisticated and hence difficult to assess), and to enforce rules and penalties. A common socio-cultural background may increase trust among the parties and lower the risk of opportunism, further reducing the costs of contract design, monitoring, and enforcement (Bouty, 2000; Inkpen and Currall, 2004; Muthusamy and White, 2005). Some authors argue

that modern information and communication technologies and stronger intellectual property rights are lowering the costs of communication and the transfer of knowledge, and increasing firms' abilities to acquire external knowledge, hence reducing the importance of a similar cultural and social context (Antonelli, 1999; Roberts, 2000). Others maintain that knowledge exchange using emerging and complex technologies will also need to be complemented by the development and sharing of tacit and sticky knowledge (Senker, 1995), with the result that a similar social and cultural background will be crucial for interactions designed to foster innovation. There is little evidence that firms in clusters are becoming more spatially disembedded (Isaksen, 2005). Thus, investigating the knowledge content of a collaboration as a determinant of the choice of a university partner based on its location adds a new and important dimension to the debate.

As argued above, since co-localization in the same region facilitates the transmission of tacit knowledge, we expect firms to prefer a regional university in the search for knowledge that either is mostly tacit or has a large tacit component. The knowledge objective of the collaboration affects the type of knowledge transferred. Business consulting activities are often tailored to specific firm's needs, which necessitate the sharing of firm-specific knowledge that is often tacit in nature. Hence this type of collaboration will benefit greatly from interaction between firms and university partners in the same region. Bouba-Olga, Ferru and Pepin (2012) show that collaborating with universities specialized in social sciences and the humanities significantly increases the probability of local collaboration. Since these universities are more likely to engage in business consulting activities and less likely to engage in R&D and testing services, this result is in line with our expectation that firms that

collaborate for business consulting activities will be more likely to collaborate with universities in the same region.

H1: Firms that collaborate for business consulting activities will be more likely to collaborate with universities in the same region.

At the same time, while location in the same region is an important facilitator of collaboration, there may be several reasons why firms want to collaborate with more distant universities. The importance of geographic proximity must be balanced in with other types of proximity such as industrial (D'Este et al, 2012), technological (Maggioni et al., 2007; Hoekman et al., 2010), social, organizational, and institutional proximity (Autant-Bernard et al., 2007). Firms will use non-regional universities if the knowledge and skills required are not available within the region (Asheim and Coenen, 2006; Fritsch and Schwirten, 1999). Hence, we would expect firms to be more likely to collaborate with distant universities if their knowledge needs are in areas not addressed by the regional universities. Additionally, since R&D activities involve more abstract knowledge, we expect co-localization allowing frequent personal interaction to be less important in the choice of university partners, while the access to specific knowledge, even at a distance, may be more important. Laursen, Reichstein and Salter (2011) find that especially firms with high absorptive capacity prefer collaboration with a more distant but higher-quality university than with a lower ranked local university: thus, distance is not a strong barrier to collaboration, rather it is the quality of the university partner that matters and particularly for R&D collaborations. D'Este and Iammarino (2010) find a positive (but curvilinear) relationship between distance and the research quality of the partner university.

H2: Firms that collaborate for R&D are more likely to collaborate with universities outside the region.

Very little academic research has focused on the determinants and characteristics of the provision of services such as safety and quality testing on the part of universities. Their actual importance is quite difficult to gauge from available large-scale quantitative data, as they usually fall under the headings of research and development, third-party contracts or consultancy contracts in universities' accounts and no separate information is provided about them. Some survey evidence from the UK suggests that testing services are provided by a non-negligible share of academics (about 6%) and that those engaged in engineering and technical disciplines have an above-average propensity to do so (PACEC/CBR, 2009). To our knowledge, no studies have attempted to investigate these activities in detail. Arguably, the provision of services such as safety and quality testing, is likely to involve a mix of customized and general knowledge since the service must be specific to the firm's products, but its performance must conform to standard procedures and methods. Moreover, performing appropriate testing and analyses services often requires the access to specialized knowledge, procedures and equipment that are available only in few universities. Because they rely upon a combination of standardized, abstract procedures and specialized assets we would expect geographic proximity to be less important than the possibility to access specific competences irrespective of the university's location. Hence, we would expect firms to be more likely to collaborate with universities outside of the region if the collaboration is directed at technical services.

H3: Firms that collaborate for provision of technical services are more likely to collaborate with universities outside of the region.

3. The regional economic context: Piedmont and its universities[1]

Piedmont is located in the north west of Italy. It has a population of about 4.4 million and accounts for 8.5% of Italian GDP. GDP per capita in PPP is €28,500 (Eurostat, 2011), 114% of the EU (27 countries) average. The region has a positive trade balance with about €36 billion of exports. About 66% of its exports are to other EU-27 countries, especially France and Germany (ISTAT, 2013).

Of the 420,000 companies active in the region, about 40,000 are manufacturing firms. Employment in manufacturing is relatively more important, representing about 33% of the total (compared with 23% nationally). Although micro-firms (less than 10 employees) are slightly less important than for the rest of Italy, they make up around 81% of all manufacturing companies in Piedmont (Vitali et al., 2011). High and medium-high technology manufacturing is particularly strong, representing some 12% of total employment. The good performance of the manufacturing sector is evident from the employment statistics; the unemployment rate was relatively low at 5% in 2008, significantly lower than the EU average, while participation for the 15-64 age cohort is 65%, only slightly lower than the 70% target set in the Lisbon strategy (ISTAT, 2013).

Piedmont has strong specialization in automotive components: the home base of Italy's main car producer FIAT is in Turin. Among the R&D intensive companies in the region, many belong to the FIAT group (Alfa Romeo, Lancia, Iveco), and some are well-known designers, specialized primarily but not exclusively in automobile design (e.g. Italdesign-Giugiaro, and Pininfarina). There are also companies producing trains (e.g. Alsthom Ferroviaria) and aeronautics and aerospace firms (including Fiat Avio, Alenia Aeronautica, Alenia Spazio, and Altec). In addition to

[1] For consistency with the implementation year of the UIPIE survey, the data discussed in this section refer to 2008.

the large R&D intensive firms, the regional industrial structure is characterized by a large number of small and medium-sized enterprises (SMEs) organized in traditional industry clusters. Regional specializations include wool, plumbing fittings and valves, textiles and apparel, mechanics, jewelry, kitchen utensils and appliances, food and wine. Piedmont's best known brands include Alessi, Ermenegildo Zegna, Fila, Ferrero, Lavazza, Martini-Bacardi, and Marchesi di Barolo.

While Italy as a whole suffers from structural weakness in R&D investment,[2] Piedmont has the highest value of R&D expenditure as a percentage of regional GDP among the Italian regions (1.88%) (ISTAT, 2010). The region is characterized by a high incidence of private R&D expenditure as a share of GDP (1.4%) (ISTAT, 2010) and as a share of total R&D expenditure: while the Italian average is about 53%, Piedmont's share of private R&D is about 75% (ISTAT, 2011). This is due mostly to the huge investment in R&D of a few large Piedmontese firms, particularly FIAT (through its research centre CRF) and Telecom Italia (through its research centre TILAB). Of the 27,310 Piedmontese workers employed in R&D roles in 2008, 15,606 were employed in private firms, 6,127 in universities, 4,746 in other public organizations, and 831 in private charities (ISTAT, 2013). The 3rd Community Innovation Survey indicates that some 33% of Piedmontese companies are innovative, which is a few percentage points higher than the Italian average.

Fondazione Rosselli has published a set of regional scoreboards that map the performance of Piedmont's science and technology system and compare it with other Italian regions, a sample of foreign regions, and with the averages for Italy and Europe (EU 15) (Fondazione Rosselli, 2007). Three aggregate performance indicators (total innovativeness; innovation performance; enabling factors) are computed as the

[2] In the period 2000-2008, Italy's R&D expenditure as a percentage of GDP was 1.1%-1.2% vs. an EU-25 average of around 1.9% (Eurostat, various years).

weighted average of several additional specific indicators, each normalized to take values between zero and 1.[3] The values of the three aggregate indicators, reported in Table 1, show that Piedmont is in a favorable position compared with other Italian regions, although a less favorable one compared with the top performing foreign regions and the EU-15 average. Piedmont's innovation performance is lower than the EU-15 average, while the value for its enabling factors is higher than the EU-15 average (but lower than the most innovative regions included in Table 1).

Table 1. Performance of Piedmont's science and technology system

	Total innovativeness	Innovation performance	Enabling factor
Baden-W.	0.77	0.71	0.66
Bayern	0.76	0.71	0.65
Catalunya	0.34	0.40	0.46
Lombardia	0.47	0.51	0.54
Piedmont	0.37	0.39	0.42
Rhone-Al.	0.52	0.57	0.62
Stockholm	0.90	0.83	0.75
Campania	0.17	0.23	0.30
Emilia Romagna	0.29	0.37	0.46
Lazio	0.34	0.40	0.46
Toscana	0.22	0.35	0.47
Veneto	0.22	0.27	0.31
Italian average	0.27	0.30	0.33
EU 15 average	0.52	0.44	0.36
sample average	0.45	0.48	0.51

Source: Fondazione Rosselli (2007); Data refer to 2004-2005

The universities and the many public research centers based in the region contribute hugely to local research and knowledge production. Piedmont has four universities, the private Università di Scienze Gastronomiche, and three public universities (Università degli Studi di Torino, Politecnico di Torino, Università degli Studi del

[3] Innovation performance includes: a) output indicators such as patents in hightech, weighted number of patents, share of innovative companies, leading innovative companies, and b) resources indicators such as R&D intensity, private R&D, number of Framework Program projects financed. Enabling factors include: a) financial indicators such as venture capital intensity, venture capital investment, high-tech offer on the new stock exchange, market capitalization; b) scientific system such as number of weighted citations, university-industry collaboration, scientific productivity; c) human resources such as employment in science and technology jobs, intensity of science and technology employment. The indicator total innovativeness is obtained by combining the previous two.

Piemonte Orientale "Amedeo Avogadro").[4] The Università di Torino was founded in 1404 and in 2007/08 (the year of the UIPIE survey) comprised 13 schools and 55 departments; its student enrolment is over 66,000 and it employs more than 2,000 permanent academic staff (plus another thousand or so non-permanent academic staff), and over 1,500 administrative and technical staff. The Politecnico di Torino was founded in 1859, and had 6 schools and 18 departments in 2007/08; student enrolment is almost 24,000. The institution employs over 800 permanent academic staff (2,000 if non-permanent academic staff are included) and around 600 administrative and technical staff. Politecnico di Torino is quite narrowly specialized in engineering and architecture, but Università di Torino offers undergraduate and postgraduate courses in a wide range of other disciplines (although compared with other large Italian universities, its course offering is relatively more oriented towards the social sciences, humanities, and medicine). Università del Piemonte Orientale was founded in 1998 and had 7 schools and 12 departments in the cities of Alessandria, Novara, and Vercelli. In 2007/08, it enrolled almost 10,000 students, employed almost 400 permanent academic staff (over 500 if non-permanent academic staff are included) and about 300 administrative and technical staff. Università di Scienze Gastronomiche is a small university specialized in food science. In 2007/08 it enrolled about 200 students and employed 6 permanent academic staff. Available data on students in Piedmont (MIUR, 2009) show that in 2008 almost 40% of bachelors and masters graduates in 2008 specialized in science (mainly at the Università di Torino) and technology (at the Politecnico di Torino), and about two-thirds of PhD students were enrolled in science and technology programs.

[4] There are numerous public research centres in the region, although they are not discussed here.

In sum, although Piedmont is a specific setting, its economy is quite diverse and in many respects similar to other industrial regions, allowing interesting parallels to be drawn with other contexts. While most employment is in the service sector, manufacturing employment is relatively high; Piedmont's industrial base is quite diverse in terms of high and low technology industries, and compared with the national average, it has a relatively high incidence of medium and large firms; science and technology indicators position the region near the EU-15 average. Piedmont also has a range of universities with different and complementary characteristics: a large, old, generalist university in the regional capital, an established and prestigious technical university also in Turin, and a recently founded university with campuses in peripheral towns. This diverse context provides an appropriate setting for an investigation of university-industry collaboration.

4. Data and methodology

4.1 University-industry interactions in Piedmont: the UIPIE survey

We use data from an original survey (UIPIE) administered a representative sample of 1,058 manufacturing firms in the Piedmont region with 10 or more employees.[5] The official representative sample has been developed, validated (with statistical treatment for outliers), and maintained by the local Chamber of the Commerce, which uses it for its quarterly manufacturing survey of regional economic trends. The UIPIE questionnaire was circulated in October-November 2008, together with the quarterly manufacturing survey. This ensured a very high response rate (99.4%, i.e. 1,052 valid

[5] It is a stratified sample of 10 industrial sectors and 3 dimensional classes based on the 2001 ISTAT census. In 2008 there were about 7,900 manufacturing firms with less than 10 employees active in Piedmont, accounting for around 80% of total employment.

responses). The advantages of an official representative sample and the associated high response rate were balanced by the Chamber of Commerce asking that we limit the number of questions, which constrained the amount of firm-specific information on relationships with universities that we were able to collect. Note that the respondents sample does not include the car manufacturer FIAT that did not return the questionnaire; being the region's largest firm and thus an outlier its exclusion from the analysis should not be problematic.

Firms were asked whether, in the previous three years, they had engaged in "institutional collaborations" (through contracts and agreements signed with either a university or a structure affiliated to a university, such as a department, school, research center or technology transfer office) with any of the following: the three public universities based in Piedmont (Università di Torino; Politecnico di Torino; Università del Piemonte Orientale),[6] universities in the bordering regions of Lombardia, Liguria, and PACA/Rhone-Alpes, other universities in Italy, universities in Europe, and universities outside Europe. For each university with which the firm had cooperated, respondents were asked to indicate the objectives of the collaboration in a list of options: "research and technological development", "testing and analysis", "organization and management", "marketing", "logistics" and "legal issues", to state the overall amount of money that was invested in the collaborations, and to rate the quality of the collaborations (based on four levels of satisfaction).

Additional information on firm characteristics such as size, industry, internal structure (investment in R&D and design, investment in the acquisition of external embodied and disembodied knowledge), and performance was provided by the local Chamber of Commerce. Of the 1,052 respondents, 104 stated that they had engaged in institutional

[6] Firms were not asked about relationships with Università di Scienze Gastronomiche, due to the university's very small size and recent origin (see Section 3).

collaboration with universities in the previous three years (9.8%).[7] We should stress that, taking account of the 99% response rate, the small number of firms report institutional collaborations with universities reflects the skewed nature of the phenomenon rather than a biased sample.[8]

The 104 firms that engaged in collaborations with universities interacted at least once with universities in one of the locations considered. Due to missing observations on the objectives of the collaborations, we are left with 100 collaborating firms for which we have information on the location of the university partners and the objectives of the collaborations. Table 2 provides information on the number of firms that collaborate with universities in different locations, according to the objectives of the collaborations.

Table 2. Collaboration objectives and location of university partners

	Only regional university partners	Both regional and non-regional university partners	Only non-regional university partners	Total

[7] Compared with the 948 non-collaborating firms, the 104 firms that engage in collaborations with universities are more likely to be active in the Food, Beverage and Tobacco and Chemical, Rubber and Plastics industries, and less likely to be active in Textiles, Apparel and Shoes and Wood and Furniture industries. Collaborating firms are more likely to be headquartered in the metropolitan province of Torino and in the province of Asti, and less likely to be headquartered in the provinces of Novara and Vercelli. These latter provinces are characterized by an industrial structure composed of SMEs active in traditional industries, while the province of Torino is home to the largest and most technologically advanced firms, and Asti has a concentration of firms in the food sector. Larger firms (measured by employment or turnover) and firms that invest in internal R&D or design capabilities are more likely to collaborate with universities. This is in line with findings for other countries and regions (Mohnen and Hoareau, 2003; Arundel and Geuna, 2004; Laursen and Salter, 2004; Fontana et al., 2006), and points to the need for firms to have a sufficient level of internal competences (i.e., an adequate degree of "absorptive capacity", Cohen and Levinthal, 1990) to be able to communicate with university personnel and exploit the knowledge transferred through the collaboration.

[8] While a share of firms reporting engagement in collaborations with universities around ten percent might seem small, it must be noted that firms were asked to report only on collaborations that involved a university institution. When asked to indicate collaborations with academic researchers that did not involve the university institution (e.g. consultancies), the share of collaborating firms increased to 17.7%. A study by the Bank of Italy (Fantino et al., 2012) using data for 2005-2007, reports the share of Italian manufacturing firms that collaborate with universities as 24.6% (which includes research projects, consultancies, and student internships); so the figure from Piedmont appears in line with the national average. Since collaboration types vary across studies, it is difficult to compare with the results in the international literature; however, a figure of some 20% of firms collaborating with universities seems to be in line with international surveys (e.g. Mohnen and Hoareau, 2003, using CIS2 data and a broad definition of collaboration, show that about 22% of service and manufacturing firms collaborate with universities).

R&D	36	9	9	54
Testing	19	1	4	24
Business Consulting	8	2	0	10
R&D & Testing	2	4	1	7
R&D & Business Consulting	2	3	0	5
Total	67	19	14	100

The distributions of locations and collaboration objectives are skewed: 14 of the 100 collaborating firms did not collaborate with a regional university, 19 collaborated with both regional and non-regional universities, 67 firms collaborated only with regional universities. Of the 33 firms that collaborated with non-regional universities, the cooperation involved a maximum of two other geographical areas.

Most firms (66) collaborated with universities for research and technological development (*R&D*) objectives, and 31 firms collaborated for provision of testing and analysis services (*Test*). However, firms also developed relationships with universities to solve other problems: 15 firms had at least one collaboration with a university to address organizational, management, marketing, logistical and legal issues (*Business Consulting*) and 12 firms collaborated for multiple objectives (7 for both *R&D and Test*, and 5 for both *R&D* and *Business Consulting*. No firm indicated collaboration for all three possible objectives.

The raw data suggest that there may be a relationship between the choice of location of the university partner and the objective of the collaboration. None of the firms involved in *Business Consulting* objectives (individually or in combination with *R&D* objectives) collaborated only with non-regional university partners.

Table 3 provides some information on the linear differences among firms that collaborate with each of the three regional universities and with non-regional universities, with respect to several collaboration characteristics (objectives, amount

invested) and firm characteristics (size). Since these collaboration categories overlap (firms can collaborate with more than one university at the same time), the t-statistics reported in the table are used to test the equality of the sample means of the variables in each collaboration group vis-à-vis the rest of the sample.

Table 3. Linear differences between firms that collaborate with different regional and non-regional universities

	Università di Torino	Politecnico di Torino	Università del Piemonte Orientale	Non-regional universities
Number of objectives	1.25 **	1.14	1.28	1.24 **
t (98 observ.)	(-2.55)	(-0.69)	(-1.39)	(-2.61)
% R&D collaborations	0.57	0.58	0.57	0.66
t (98 observ.)	(0.45)	(0.88)	(0.19)	(-0.88)
% Test collaborations	0.27	0.27	0.14	0.24
t (98 observ.)	(0.18)	(0.48)	(0.88)	(0.75)
% Business Consulting collaborations	0.16	0.16**	0.29	0.10
t (98 observ.)	(-0.95)	(-2.08)	(-1.6)	(0.29)
Amount invested	18780.04	29786.79	45414.29	43047.21
t (98 observ.)	(1.18)	(0.01)	-0.72	-1.62
Size	172.71	289.01	1133.36 ***	453.03 ***
t (98 observ.)	(0.60)	(-1.46)	(-4.73)	(-2.88)

Note: significance levels *** p<0.01, ** p<0.05, * p<0.1

Firms that collaborate with the Università di Torino and with non-regional universities on average have a greater number of objectives than firms that do not collaborate with these universities, while collaborations with Politecnico di Torino appear to be more focused (fewer objectives on average). Firms that collaborate with the Politecnico have a smaller share of collaborations focused on business consulting. There are no significant differences in terms of average amounts invested.

Firms collaborating with Università del Piemonte Orientale on average are significantly larger than those that collaborate with other universities (this result is due mainly to two collaborations, one with a very large firm in the Transportation equipment producing sector and one with a large firm in the food sector). Firms collaborating with universities outside the region are also more likely to be large compared to firms that collaborate with universities in the region.

4.2 Empirical Strategy

Our objective is to examine whether and how the knowledge objectives of the collaboration shape the collaboration, particularly the choice of the university partner. We examine the relationship between the collaboration's knowledge objectives and the location of the university partner using the UIPIE data described above.

Although our sample is representative of the Piedmont region, the numbers of firms that collaborate (104) and that provided information on the amount spent on collaboration with university (69) are rather small.[9] Based on our 99% response rate, we would stress again that this reflects the skewed nature of the phenomenon rather than sample bias. However, the small number of observations means that the evidence is exploratory.

Our dependent variable *Location of the university partner* is a categorical variable that takes values between 1 and 3; 1 if the firm collaborates only with regional universities, 2 if the firm collaborates with both regional and non-regional universities, and 3 if the firm collaborates only with non-regional universities. Given the data presented in Table 2 (i.e. showing no firm that cooperated for business

[9] Compared with the representative sample, these small subsamples are constituted by slightly larger and more open firms, that invest in R&D, design, and export. In the subsample of firms that report collaboration with university, textiles are slightly under represented and chemicals are slightly over represented. In the subsample of firms that reported the amount spent on collaboration, the mechanical industry is slightly over represented than in the representative sample.

consultancy did not collaborate with a regional university partner), and the nature of the dependent variable *Location of the university partner*, we run a multinomial logit on the categorical variable to examine how the knowledge objectives of the collaboration influence the firm's choice to collaborate only with regional, only with non-regional or with both regional and non-regional universities.[10]

Our independent variables are four dichotomous variables related to the objectives of the university collaboration. The variable *Only Test* takes the value 1 if the firm collaborated only for testing and analysis services; the variable *Only Business Consulting* takes the value 1 if the firm collaborated for business consulting activities related to organization, management, marketing, logistics, and legal issues. The variable *R&D and Test* takes the value 1 if the firm collaborated for both R&D and testing activities, and the variable *R&D and Business Consulting* takes the value 1 if the firm collaborated for R&D and organizational, management, marketing, logistics, and legal issues. The reference category is the variable *Only R&D* which takes the value 1 if the firm collaborated with universities for R&D activities only.

In order to account for the multiple firm characteristics that might influence the pattern of collaboration with universities, we include a series of control variables. The literature shows that larger firms are more likely to collaborate with universities outside the region, while small firms, with fewer resources to dedicate to university-industry collaboration, may be more likely to collaborate with regional universities in order to take advantage of more customized returns from the collaboration and of

[10] In our dataset, every firm that collaborated for business consulting did it with a regional university partner; as a consequence we have no variance across knowledge objectives and location necessary to run a multivariate probit model that estimates the effect of knowledge objectives on the choice of exclusive categories of university partner location (i.e. the model would be fully identified). Similarly, we cannot run a binary probit for the variable collaboration with a regional university partner. Results of the binary probit for the variable collaboration with non-regional university partner are in line with the results of the multinomial probit reported in Table 5. Firms that collaborate with non-regional university partners are less likely to collaborate for only *business consulting*, and slightly more likely to collaborate for *R&D* and *Test*.

lower monitoring costs (e.g. Fritsch and Lukas, 1995; Fritsch, 2001). Therefore, we include controls for firm size. In particular, we included the variable *Size,* which reports the logarithm of number of employees.

We would argue that geographic proximity to the university partner will be less important for firms with higher absorptive capacity: closer cognitive proximity to the university may enable lower transaction costs associated with university-industry collaboration and easier appropriation of the returns from an investment in collaboration. Since our data do not allow us to build an articulated measure of absorptive capacity (Lane et al., 2006), we simply control for firms' investment in R&D and design: the variable *R&D intensity* provides information about whether firms invest in internal R&D or design activities. There are several studies that show that firms with dedicated internal resources for R&D (or a large share of qualified human resources) have closer cognitive proximity to universities (Cohen et al., 2002; Belderbos et al., 2004; Laursen and Salter, 2004; Fontana et al., 2006; Laursen, Reichstein and Salter, 2011).

Also, firms that are open to exchanges with other organizations (e.g. firms that trade technology via licenses, but also firms that have commercial, production and organizational relationships with distant organizations) may be more experienced in setting up and organizing interactions and may have better availability of internal resources to manage the external relationships. Hence, more open firms may be able to lower the transaction costs associated with university-industry collaborations, and consequently to collaborate with non-regional universities and to invest more in university-industry collaboration. We use several variables to control for firms' openness to their environment.

We include the variable *Technology Openness*, which provides information on whether the firm invests in the acquisition of external embodied and disembodied knowledge, especially patents, know-how, and informational and processing software and hardware. Technology openness is often understood as the degree of technology sourcing and engagement in technology market transactions (Arora et al., 2001; Cassiman and Veugelers, 2006).

We control for the level of outsourcing, presence of production units abroad, and export intensity in order to account for firm's "openness" to organizational and production relationships with external partners. The variable *Outsourcing* provides information on the level of production outsourced (logarithm of production outsourced to other firms in Italy or abroad). The variable *Multinational* contains information on whether the firm owns production activities abroad that represent more than 5% of total output; the variable *Export* provides information on whether the firm exports more than 20% of its production. Unlike the variable *Outsourcing* where despite its being discrete, the observations are distributed around 16 different values, the variables *Export* and *Multinational* have properly discrete distributions and are skewed. Given the small number of observations, we use dichotomous rather than discrete variables to reduce the risk of spurious analysis of variance when using them in combination with other categorical and ordinal variables. The thresholds were set taking into account the upper and lower tails of 25%-30% of the observations. The results hold when we exclude these controls from the model (see Table 5). Finally, we control for industry effects by including industry dummies (reference category: other manufacturing).

Table 4 lists the independent and control variables and their descriptive statistics. Appendix Table A presents the correlation coefficients.

Table 4. Descriptive statistics for the variables used in the regression

Variables	Variable name	Description	N	Min	Max	Mean	Std. Dev.
Dependent variable							
Location of university partners	Only Regional	1 if the firm collaborates only with regional universities	100	0	1	0.67	0.47
	Both	1 if the firm collaborates with both regional and non-regional universities	100	0	1	0.19	0.39
	Only Non-regional	1 if the firm collaborates only with Non-regional universities	100	0	1	0.14	0.35
Independent variables							
Objectives of university collaboration	Only R&D	1 if the firm collaborates only in Research and technology development activities	100	0	1	0.54	0.50
	Only Test	1 if the firm collaborates only in Testing and analysis activities	100	0	1	0.24	0.43
	Only Business Consulting	1 if the firm collaborates only in business-related issues: organization and management, marketing, logistics and legal issues	100	0	1	0.10	0.30
	R&D and Test	1 if the firm collaborates in R&D and Test activities	100	0	1	0.07	0.26
	R&D and Business Consulting	1 if the firm collaborates in R&D and business consulting activities	100	0	1	0.05	0.22
Control variables							
Size	Size	Logarithm of the number of employees	100	2.08	8.56	4.47	1.29
R&D intensity	R&D intensity	1 if the firm commits efforts to internal R&D or design activities, 0 otherwise	95	0	1	0.59	0.49
Technology Openness	Technology Openness	1 if the firm invested in either acquisition of patents, external know-how or informational and data process equipment and software, 0 otherwise	90	0	1	0.53	0.50
Export	Export	1 if the firm exports more than 20% of their production, 0 otherwise	100	0	1	0.68	0.47

Multi national	Multi national	1 if the firm produces 5% or more of their product in plants outside the country	100	0	1	0.21	0.41
Production Outsourcing	Outsourcing	Logarithm of the share of production outsourced in Italy or abroad to subcontractors	100	0	1	0.08	0.27
Industry	Food	Food, Beverages and Tobacco	100	0	1	0.16	0.37
	Textiles	Textiles, Apparel and Shoes	100	0	1	0.06	0.24
	Wood	Wood and Furniture	100	0	1	0.02	0.14
	Paper	Paper, Printing and Publishing	100	0	1	0.05	0.22
	Chemical	Chemicals, Rubber and Plastics	100	0	1	0.17	0.38
	Metals	Production of Metals and Metal Goods	100	0	1	0.13	0.34
	Equipment	Machinery	100	0	1	0.19	0.39
	Electronic	Production of Electrical, Electronic and Communication Equipment	100	0	1	0.06	0.24
	Transport	Production of Transportation Equipment	100	0	1	0.07	0.26
	Other	Other Manufacturing companies	100	0	1	0.06	0.24

5. Empirical results

5.1. Main results

Table 5 reports the results of the multinomial logit regression on the categorical variable *Location of the university partner*, which identifies whether the firm collaborates only with regional universities, with both regional and non-regional universities, or only with non- regional universities. In order to show the robustness of our results based on a relative small size of our sample, we report the results of regressions based on the subsample of firms that provided information on the amount spent on university collaboration (model 1 columns 1-3), and the full sample of firms that provided information on the knowledge objectives of university collaboration (models 2 and 3 columns 4-9). For the full sample of firms that provided information

on the knowledge objectives of university collaboration, we give the results for an extended list of control variables accounting for technology openness and international openness (90 observations, model 3 columns 6-9) and a reduced list of control variables (95 observations, models 1 and 2 columns 1-6). The results are quite similar regardless of the sample and controls used.

Table 5. Multinomial logit model of the location of university partners: only regional universities, both regional and non-regional universities and only non-regional universities.

	Model 1			Model 2			Model 3		
	Both Regional and Non-regional university partners versus Only Regional university partners	Only Non-regional university partners versus Only Regional university partners	Both Regional and Non-regional university partners versus Only Non-regional university partners	Both Regional and Non-regional university partners versus Only Regional university partners	Only Non-regional university partners versus Only Regional university partners	Both Regional and Non-regional university partners versus Only Non-regional university partners	Both Regional and Non-regional university partners versus Only Regional university partners	Only Non-regional university partners versus Only Regional university partners	Both Regional and Non-regional university partners versus Only Non-regional university partners
R&D and Test	2.610+	1.188	1.421	3.509**	0.425	3.085	3.377*	0.190	3.187
	[1.509]	[2.703]	[3.033]	[1.177]	[1.673]	[2.198]	[1.385]	[1.856]	[2.446]
R&D and Business Consulting	1.502	-16.655***	18.157***	1.282	-16.047***	17.328***	1.000	-17.049***	18.048***
	[2.321]	[1.277]	[2.627]	[1.111]	[1.043]	[1.278]	[1.144]	[1.244]	[1.280]
Only Test	0.273	-0.532	0.805	-0.213	0.046	-0.259	-0.930	-0.048	-0.882
	[0.858]	[0.951]	[1.156]	[0.984]	[0.702]	[1.142]	[2.023]	[0.828]	[2.147]
Only Business Consulting	0.024	-16.754***	16.778***	-0.928	-16.736***	15.808***	-0.365	-17.121***	16.756***
	[1.126]	[1.110]	[1.322]	[0.756]	[1.119]	[1.125]	[1.023]	[1.320]	[1.196]
Size	0.640	0.343	0.297	0.916*	0.286	0.631	0.903+	0.444	0.459
	[0.458]	[0.453]	[0.630]	[0.384]	[0.354]	[0.523]	[0.488]	[0.345]	[0.570]
Export	-0.465	1.639	-2.104	-0.677	0.907	-1.585	-0.467	1.162	-1.629
	[1.280]	[1.413]	[1.876]	[0.977]	[0.807]	[1.176]	[1.283]	[0.741]	[1.364]
R&D intensity	0.866	-0.392	1.258	0.517	-0.142	0.659	0.182	0.150	0.032
	[0.731]	[1.050]	[1.201]	[0.751]	[0.675]	[1.016]	[0.821]	[0.862]	[1.170]
Technology							1.050	0.053	0.998

Openness									
							[1.018]	[0.795]	[1.186]
Outsourcing							-0.449	-0.850	0.401
							[2.239]	[1.635]	[2.140]
Multinational							-1.390	-0.123	-1.267
							[1.490]	[1.125]	[1.840]
Constant	-5.573*	-3.471*	-2.102	-6.233**	-3.089*	-3.144	-4.811*	-4.605**	-0.206
	[2.416]	[1.582]	[2.888]	[2.000]	[1.226]	[2.327]	[2.084]	[1.606]	[2.184]
Industry dummies	Significant			Significant			Significant		
Observations	64			95			90		
Degrees of Freedom	24			24			38		
Wald Chi Square	3881.2***			2415.3***			4207.11***		
log Likelihood	-38.18			-60.74			-54.17		
Pseudo R2	0.29			0.276			0.336		

Note: Robust standard errors in parentheses***<0.001, ** p<0.01, * p<0.05, +< 0.1

Firms that collaborate only with regional universities are less likely to collaborate for *R&D and Test* activities, compared to firms that collaborate with both regional and non-regional universities (Table 5, columns 1, 4, 7). Firms that collaborate only with universities outside the region differ significantly from firms that collaborate only with regional universities (Table 5 columns 2, 5, 8) or with regional universities as well (Table 5 columns 3, 6, 9), since they are less likely to engage in collaboration with a university aimed at business consulting, in combination or not with R&D.

The controls behave as follow. Firms that collaborate only with universities in the same region tend to be smaller sized than firm that collaborate with both regional and non-regional universities. Firms' R&D intensity, openness to knowledge exchange, and commercial, organizational, and production relationships with external partners are not predictors of the choice of location of university partners, suggesting that while these features may be important for collaborating with a university in general (Mohnen and Hoareau, 2003; Arundel and Geuna, 2004; Laursen and Salter, 2004; Fontana et al., 2006), they confer no specific advantage related to collaborating with distant universities.

Overall, these results suggest that firms collaborating for *Business Consulting* objectives (in combination or not with *R&D* activities) are less likely to interact only with non-regional university partners than firms that collaborate for *only R&D* or *only Test* activities. Hence, they provide support for *H1* that firms that collaborate for business consulting tend to rely more on local university partners. The results provide partial confirmation also for *H2* and *H3*, that R&D and Test activities might require collaboration with university partners outside the region.

Business-related collaboration might require context-specific knowledge. Hence, in order to solve organizational problems, firms may prefer collaboration with a regional university, embedded within a similar social, legal, and cultural context, and easy to reach for on-site visits: geographical as well as cultural and social proximity facilitate communication and knowledge transfer. Firms' specific organizational and market characteristics only marginally differentiate their choice of location of the university partner, with size being an important predictor of the propensity to collaborate with a university outside the region.

5.2. Further analysis

To further analyze the influence of firms' knowledge needs for shaping collaboration with universities, we examine whether the choice of the location of the university partner and the objective of the collaboration influence the amount of monetary investment in the cooperation. Different types of collaborations have different costs due for example to the size of the research team involved, the need for costly equipment and materials, duration of the project, scarcity of the competences involved. Thus, collaborations directed at R&D might involve higher investment than those directed at provision of services and business consulting.

Previous work on the location of university partners provides no information on the knowledge objectives of the collaboration, and its absence in the empirical analyses is most likely the cause of the endogeneity problems suggested by the results in Table 6.

Table 6 shows estimations of the logarithm of total amount spent on collaborations with universities in the previous three years, with treatment for the effects of endogeneity of the binary variable *Only regional university partners (versus only or also collaboration with non-regional university partners)*. As instrumental variables,

we used the knowledge objectives of the collaboration described in Section 4 and used to estimate *Location of the university partner*. We include the following control variables *Size, R&D intensity, Export,* and a set of industry dummies.[11]

The amount spent on collaboration is positively influenced by firm size and R&D intensity, and negatively affected by collaboration with only regional university partners. Rho and sigma suggest that *Only regional university partners* is endogenous and that the knowledge objectives of the collaboration are good instruments.

Table 6. Estimation of the effect of choice of location of university partner on the logarithm of total investment in collaborations with universities, with treatment effect of endogeneity for the variable *Only regional university partners*

	Investment in collaboration with universities	Only Regional university partners
Size	0.337*	
	[0.152]	
Export	-0.303	
	[0.425]	
R&D intensity	0.785**	
	[0.291]	
Only Regional University Partners	-3.593***	
	[0.467]	
R&D and Test		-0.968***
		[0.164]
R&D and Business Consulting		0.103
		[0.131]
Only Test		0.421*
		[0.183]
Only Business Consulting		1.442***
		[0.329]
Constant	10.253***	0.508***
	[0.718]	[0.130]
Industry dummies	Significant	
Athrho	2.504***	
	[0.582]	
Lnsigma	0.678***	
	[0.108]	
Observations	64	
Num. of Observations	64	
Degrees of Freedom	8	

[11] Given the small number of observations, we cannot repeat this exercise for the extended list of control variables.

Wald Chi2	33.59***
log Likelihood	-140.2

Note: Robust standard errors in parentheses***<0.001, ** p<0.01, * p<0.05

To further stress the importance of collaboration objectives vis-à-vis location in influencing the amount invested in university-industry collaborations, we estimate a complete model which includes both the information on the location of the university partners and on the objectives of the collaboration, as well as a series of controls for firms' characteristics. By including collaboration objectives, we eliminate the omitted variables problem, which was introducing endogeneity on the analysis of location of university partner, and we can estimate a Tobit model. The dependent variable is the logarithm of the total amount spent on collaborations with universities in the previous three years. Table 7 presents the Tobit estimates of the logarithm of the total amount spent on collaborations with universities in the previous three years. Column 1 provides estimates using an extended control list (Model A), Column 2 provides estimates using a short control list (Model B). The results for models A and B are quite similar.

Table 7. Tobit estimation of the logarithm of total investment in collaborations with universities.

	Model A	Model B
R&D and Test	1.475**	1.532**
	[0.453]	[0.505]
R&D and Business Consulting	-1.118+	-1.240*
	[0.639]	[0.598]
Only Test	-1.237**	-1.110**
	[0.375]	[0.364]
Only Business Consulting	-1.783	-1.754
	[1.249]	[1.338]
Only Regional University Partners	-0.659+	-0.505
	[0.372]	[0.356]
Size	0.265	0.238
	[0.172]	[0.171]
Export	0.190	0.329
	[0.411]	[0.382]
R&D intensity	0.398	0.179

	[0.436]	[0.404]
Technology Openness	-0.384	
	[0.411]	
Outsourcing	-0.034	
	[0.036]	
Multinational	0.711	
	[0.640]	
Constant	9.425***	9.252***
	[0.878]	[0.799]
Industry dummies		
Sigma	1.179***	1.191***
	[0.108]	[0.107]
Observations	60	64
Degrees of Freedom	17	14
F Statistic	9.85***	7.93***
log Likelihood	-95.00	-102.0
Pseudo R2	0.1633	0.151

Note: Robust standard errors in parentheses*** p<0.01, ** p<0.05

Firms that collaborate for *R&D and Test* spend significantly more on collaboration activity than those that cooperate only for *R&D;* firms that collaborate for *Only Test* spend significantly less than those that collaborate only for R&D. There is weak evidence that firms that collaborate for *R&D and Business Consulting* spend slightly less than those that collaborate only for *R&D*. The location variable is not significant.

Overall this additional analysis provides some insights into how the knowledge objectives of the collaboration are determinants of collaboration, and consequently of the location of the partner and the amount invested in the collaboration. Our evidence questions assumptions that collaborating with a university outside the region requires higher investment just in order to cover the higher costs of establishing and monitoring the collaboration, and accessing and using the results of the collaboration. Rather, our results suggest that collaborations with universities outside the region tend more often to involve R&D activities, which are more expensive, rather than non-regional being more expensive *per se*.

6. Conclusions

This paper explored how the knowledge objectives of a collaboration affect the firm's decision to collaborate with a university within and/or outside the region. We examined these issues empirically using data collected through an original survey of a representative sample of manufacturing firms with 10 or more employees, located in the Piedmont region in Italy.

Our evidence indicates that the knowledge objectives of the collaboration matter for the choice of location of the university partner. Collaborations based on provision of business consulting services are more likely to involve regional universities while collaborations focused on R&D and provision of testing and analysis services by the university are less likely to involve a regional university. These results confirm our hypotheses and are in line with the literature showing that R&D activities are more likely than business consulting to involve more abstract and general knowledge. Business consulting activities are designed and carried out to address firm-specific organizational environments, and consequently involve the development and transmission of firm-specific knowledge (Perkmann and Walsh, 2008). They are in line also with the study by Bouba-Olga, Ferru and Pepin (2012) which shows that collaborating with universities specialized in the social sciences and humanities (which are less likely to involve R&D and testing and more likely to involve business consulting) significantly increases the probability of local collaboration.

We also examined how location of the university partner and the knowledge objectives of the collaboration influence the level of firms' investment in university collaborations. Our evidence suggests that the choice of location of the university partner is endogenous to the amount spent on the collaboration, mainly due to fact that the knowledge objectives of the collaboration are the real determinants of the location and amount of money invested in the collaboration. Collaborations with non-

regional universities are more likely to involve *R&D and Test* activities, which generally involve the highest investment when compared to the other knowledge objectives examined. The provision of testing and analysis services only, and to a lesser extent, R&D and business consulting combined seem to be the less expensive objective than R&D activities only.

With the exception of size, firm characteristics such as R&D intensity and openness to external sources of knowledge, which have been shown to be important factors differentiating firms that decide to collaborate with universities from those that do not (Mohnen and Hoareau, 2003; Arundel and Geuna, 2004; Laursen and Salter, 2004; Fontana et al., 2006), do not seem to influence the firm's decision about the location of the university partner.

Our results have some implications for policy. Our evidence that firms that seek specialized R&D and testing competences are more likely to look for partner universities outside the region suggests that the knowledge base of the regional universities is an important determinant of the location of the university partner. Hence, if the policymaker's objective is to support regional firms' innovation and technological capabilities, it should not support collaborations among local actors only, given that relationships with non-regional universities may provide firms with much-needed external knowledge.

Additionally, our results show that collaboration for business consultancy requires local university partners, which suggests that adoption and adaptation of new technologies or best practice involve co-location. Thus, universities and policymakers might consider supporting the integration of a full range of knowledge activities - including testing and analysis, and consultancy, around technical and "soft" issues

that affect firms' organizational processes, rather than focusing their attention narrowly on collaboration related to R&D activities.

This study has some limitations associated mainly with the empirical setting, which offer opportunities for future research. First, it focuses on the region of Piedmont, and like other studies that focus on only one region, our results may reflect the specific industrial structure and university system characterizing the Piedmont Region. At the same time (see Section 3), Piedmont has a fairly diverse industrial and university base, which is not too dissimilar from that in other industrial regions of Europe, making it easier to draw implications for other contexts.

Second, this study relies on a small number of observations: 104 firms reported institutional collaboration, and 100 firms provided information on the knowledge objectives of the collaboration but missing values for the controls left only 95 observations. Since the sample is a representative sample used by the local Chamber of Commerce, and the response rate was 99%, this small number reflects the skewed nature of collaboration with universities rather than response or sample bias. Indeed, there is some evidence that the share of collaborating firms in our sample is in line with the Italian (Fantino et al., 2012) and European (Mohnen and Hoareau, 2003) averages, although the different definitions of "university-industry collaboration" adopted in various studies make it difficult to make comparisons. Further research to extend the study to different regions or countries would enable the building of a larger dataset and allow more robust and finer grained econometric analyses.

Third, research focusing on other characteristics of university collaboration such as the involvement of other regional or non-regional firms, universities, and consultants, and the knowledge objectives and location of the university partner might provide a better understanding of the knowledge dynamics of university-industry collaborations.

Fourth, this study focuses only on the location of university partners and the knowledge objectives of institutional linkages, thus we are neglecting both formal personal contracts signed with individual academics (rather than with the university institution) and informal contacts. A growing line of inquiry is investigating the characteristics of consultancy contracts stipulated with individual academics, highlighting their importance and their complex nature (see, e.g. Perkmann and Walsh, 2008; Boardman and Ponomariov, 2009; Bodas Freitas et al, 2013). Informal contacts have also been found to be important mechanisms of knowledge transfer (Cohen et al, 2002; Bekkers and Bodas and Freitas, 2008). Because of their casual nature, they may be more likely to build upon networks of personal and professional acquaintances and therefore to involve geographically proximate partners. The types of interactions not included in the analysis may also be more likely to involve specific types of objectives, for example personal contracts with individual academics may be more likely to be aimed at business consulting than institutional contracts (PACEC/CBR, 2009, report high level of engagement in individual consulting on the part of academics in the social sciences), although there is evidence that personal contracts can also have an important research component (Perkmann and Walsh, 2008). Further research examining the location of the university and industrial partners, knowledge objectives and content of the transfer of informal contacts and of individual contacts would provide an important contribution to the literature on university-industry interaction.

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Appendix

Table A. Correlation coefficients

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Size	1													
2 Square Size	0.986**	1												
3 Absorptive Capacity	0.279**	0.268**	1											
4 Technology Openness	0.397**	0.385**	0.327**	1										
5 Export	0.359**	0.338**	0.084	0.236*	1									
6 Outsourcing	0.212*	0.232*	0.153	0.188	0.123	1								
7 Multinational	0.136	0.115	-0.064	0.167	0.248*	0.391**	1							
8 Only Regional	-0.315**	-0.330**	-0.159	-0.157	-0.162	0.05	0.101	1						
9 Both	0.379**	0.415**	0.203*	0.266*	0.114	-0.049	-0.125	-0.690**	1					
10 Only Non-regional	-0.002	-0.022	-0.015	-0.09	0.091	-0.013	0.004	-0.575**	-0.195	1				
11 Only R&D	-0.011	-0.018	0.144	0.173	-0.117	0.05	-0.017	-0.008	-0.064	0.083	1			
12 Only Test	-0.328**	-0.325**	-0.151	-0.250*	0.034	-0.079	-0.002	0.145	-0.212*	0.043	-0.609**	1		
13 Only Organization	0.288**	0.305**	-0.022	-0.059	0.014	0.025	0.074	0.092	0.008	-0.134	-0.361**	-0.187	1	
14 R&D and Test	0.016	-0.006	0.072	-0.061	0.104	-0.081	-0.141	-0.224*	0.267**	0.002	-0.297**	-0.154	-0.091	1
15 R&D and Organization	0.254*	0.266**	-0.091	0.227*	0.059	0.101	0.107	-0.132	0.240*	-0.093	-0.249*	-0.129	-0.076	-0.063