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The Governance of University-Industry Knowledge Transfer: Why small firms do (not) develop institutional collaborations?

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Abstract

This analysis is based on a representative sample of firms in the Italian region of Piedmont, and investigates the nature and intensity of collaborations between regional firms and universities in different locations. It contributes to the literature on university-industry knowledge transfer in investigating *institutional collaborations*, typically mediated by the university through its administrative structures such as departments or dedicated units such as technology transfer offices, and *contractual personal collaborations* between firms and individual academics, involving formal and binding contractual agreements, but carried out without the direct involvement of the university. We explore and compare the characteristics of firms involved in these two different governance forms of knowledge transfer, with those of firms that do not collaborate with universities. Our analysis shows that firms that use *contractual personal collaborations* are generally smaller and more often interested in the acquisition of external embodied and disembodied knowledge and open innovation strategies.

Keywords: University-industry relationships, consultancy, external sourcing, proximity technology transfer

JEL: O31; O32; L25

1. Introduction

There has been much policy discussion and academic research in recent years on university-industry relationships. Empirical data confirm the contribution of university-industry knowledge transfer for generating higher productivity and greater economic growth, as well as the role of universities as the sources of innovation (Mueller, 2006). Various aspects of collaboration have been studied - focusing on individual researchers (previous experience, entrepreneurial capacity to win both public and private funding, seniority and tenure, gender, etc.), university characteristics (disciplinary orientation, local development focus, local environment, culture, quality of the centre/department, existence of formal infrastructure of knowledge transfer, size, etc.) and firms (size, level of research and development (R&D) investment, openness of the firm to external knowledge sources, distance, technology/industry sector, independent or subsidiary, etc.). However, we know little about the governance of these interactions.

This paper contributes to ongoing debate by providing an analysis of an original dataset of 1,058 representative firms (a sample developed and validated by the Piedmont Chamber of Commerce) in Piedmont region in the north west of Italy. This is one of the wealthiest Italian regions with a population of about 4.5 million inhabitants. We develop an econometric analysis of university-industry links with the three local universities (Università di Torino, Politecnico di Torino and Università del Piemonte Orientale) and with other universities in Italy and abroad. Our analysis extends the literature on university-industry interactions in regional development in two main directions. First, we measure *institutional collaborations* (formal relationships with a university, mediated usually by administrative structures such as faculty departments or dedicated Knowledge Transfer Organizations - KTO), and *contractual personal collaborations* (reported by

companies with no institutional relationships with universities, but which engage in direct contractual collaborative arrangements with university researchers). This allows us to compare two alternative forms of governance of the collaboration relationship. We also investigate the reasons why firms choose *not* to engage in either *institutional* or *contractual personal* collaborations with universities.

In our representative sample, 104 firms (9.9%) stated that they had developed at least one *institutional collaboration* with a university in the previous three years, while 83 respondents (7.9% of the sample) had engaged in *contractual personal collaborations* with university researchers. While the companies involved in *institutional collaborations* may also have involvement in *personal* collaborations, the firms indicating engagement in *contractual personal collaborations* did not also engage in *institutional* collaboration. A significant number of companies had adopted a governance structure for sourcing academic knowledge from individual researchers (without an institutional arrangement). This analysis compares the two possible governance systems of university-industry interaction to try to identify what determines the firm's decision. Different governance structures may suit different industrial and geographical contexts. We would expect the local social network to facilitate *personal contractual relationships,* reducing the transaction costs associated with the development of an infrastructure for the development of institutionalized relationships (e.g. KTOs, incubators, science parks, etc..).

The paper is organized as follows. Section 2 frames the discussion within the general context of the literature on university-industry interactions and on the role of inter-organizational knowledge flows in regional development. Section 3 describes the data

and the methodology used and Section 4 presents the results. Section 5 presents the conclusions.

2. University industry interactions: *Institutional* versus *contractual personal* collaborations

Many studies examine the characteristics of university-industry collaboration at the regional, national and international levels. (We do not review this literature here; for a current discussion of the main themes see D'Este and Iammarino (2010), Rothaermel et al. (2007), Wang and Shapira (2010) and Muscio (2010) for the Italian case.) However, there is no overall agreement on the best way to govern such arrangements or on their results in terms of levels of knowledge transfer and the specific contribution to economic development. #

One of the reasons for the lack of consensus in these studies is that most rely on imprecise measurements due to a lack of standardized, validated, robust data on university-industry relationships. Some studies focus on data made available by KTOs and, thus, capture only the set of interactions managed directly by the university (see e.g. Joly and Mangematin, 1996; Thursby et al., 2001; Carayol, 2003). Other studies are based on information gathered from surveys of academics or/and firms and, therefore, include a wider range of alternative knowledge transfer channels, which are investigated from different viewpoints and often are categorized in different ways. Many authors disagree about their relative importance while commenting that several different channels are typically exploited simultaneously (Schartinger et al., 2001; D'Este and Patel 2007; Bekkers and Bodas Freitas, 2008). Community Innovation Survey (CIS)-type questionnaires simply enquire whether firms have relationships with universities, and ask

about their importance, but do not ask respondents to specify the nature or governance of these relationships. Other studies of university-industry knowledge transfer implicitly assume that personal contacts between industrial and academic researchers are mainly informal and, therefore, consider that the more formal channels of knowledge transfer are university-managed. In reality, some firms may have very formal contracts with universities, but may also interact directly with individual academics as consultants, without involving university structures. The relatively few studies that explicitly consider formal academic consulting as a specific channel distinct from university-managed collaborations (see e.g. Cohen et al., 1998; Jensen et al., 2010) tend to highlight its importance and specificity.

It has been argued that at least two different models of university-industry collaboration have developed over time and now are co-existing (Geuna and Muscio, 2009). University-industry knowledge exchange can be governed by *contractual personal* interactions between university researchers and company engineers and researchers, a form of governance that pre-dates the institutionalization of university-industry links and has been in place since the end of the 19th century, in Germany, and the early 20th century in the US (Meyer-Thurow, 1982; Liebenau, 1985; Swann, 1989; MacGarvie and Furman, 2005). This type of governance is often the result of the participation of academic and industry researchers and engineers in the same networks (Colyvas et al., 2002), and is based on some form of trust (sometimes due to a common educational background, as in the case of alumni associations in the US or the *Esprit du Corp* of the French Grandes Écoles or Italian Politecnici). These interactions are not informal: although the university structure may not be involved, they are usually formalized through binding contracts and agreements. At the same time, since the late 1980s there has been an increase (spurred

mainly by public policies) in *institutional* university-industry relationships mediated by units such as departments, university technology transfer offices and other kinds of KTOs. More and more universities are organizing and supporting interactions between academics and firms. In a small number of cases, this responds to a need expressed by the academics involved in these interactions and also to the university's desire to regulate and benefit from industry contracts (see Geuna and Muscio, 2009, for a discussion). In most cases, however, the creation of an institutional infrastructure for the exchange of knowledge between universities and firms is a direct or indirect result of policy actions oriented towards structured knowledge transfer activities within universities.

While some (Etzkowitz and Leydesdorff, 2000; Gibbons et al., 1994) argue that the supposedly more efficient new 'institutional' knowledge transfer model is substituting for the older model and should be developed further, we propose (and provide supporting evidence) that the two models can coexist and are complementary. In countries where there is less emphasis on public polices to support an institutional model, such as Italy, we would expect both models of governance of university-industry relationships to thrive in response to different knowledge exchange needs.

Here, we investigate firms in the Piedmont region and their interactions with universities in the same region, in the rest of Italy, and in other countries. Based on the results of the Piedmontese Chamber of Commerce survey of a representative sample of industrial firms we assess the role of *contractual personal collaborations* compared to *institutional agreements*; and evaluate whether different knowledge sourcing needs resulting from different firm characteristics explain the decision to use one form of knowledge exchange governance or both.

3 Data and Methodology

The region of Piedmont is located in the north west of Italy. With a total population of about 4.4 million, it produces about 8.5% of Italian GDP. The 450,000 or so companies active in the region in 2006 were focused relatively more on manufacturing. Thus, employment in manufacturing is quite high (33% vs 63% in services) when compared with other Italian and European regions. While Italy generally suffers from structural weaknesses in R&D investment (R&D expenditure in 2006 as a percentage of GDP was 1.1% vs an average of 1.9% in EU-25), Piedmont is better positioned with the third highest value of R&D expenditure among the Italian regions in both absolute and relative terms (public expenditure on R&D as a percentage of regional GDP was around 1.8% in 2006). In particular, Piedmont is characterized by high levels of private R&D in total R&D investment: Italian average private R&D investment is 47%, of which Piedmont accounts for almost 80% (€1.4 bn). This is due mostly to some large Piedmont-based firms which invest heavily in R&D, particularly FIAT (with its CRF research centre) and Telecom Italia (and its TiLab research centre). The third CIS indicates that about 33% of Piedmontese companies are innovative, a few percentage points higher than the Italian average.

3.1 Data

We use data from an original survey (UIPIE) sent to a sample of representative firms in the Piedmont region. This sample was developed and validated by the local chamber of commerce, which integrated our questionnaire with its quarterly regional economic foresight survey. Because completion of the survey was compulsory, the Piedmont Chamber of Commerce asked us to limit the number of questions. This dictated the

amounts of information we were able to collect on firm relationships with universities and firm-specific data. Also, the chamber of commerce was more interested in institutional collaborations. Nevertheless, the chamber of commerce gave us access to a rich dataset on firm characteristics such as firm size, industry, internal structure, R&D activities, investment activities, exports and export performance, which allowed us to build numerous control variables (see the Methodology subsection).

Firms were asked whether they had engaged in *institutional collaborations* (through contracts and agreements with university institutions) in the previous three years, and if so, which universities they collaborated with (universities in Piedmont, in the surrounding regions, in Italy, in Europe or outside Europe). For each university collaboration, respondents were asked about the objectives of the collaboration (from the options technological development, testing and analysis, organization and management, marketing, logistics, and legal issues), the amount of money spent, and whether the collaboration was satisfactory (based on four levels of satisfaction). Those firms indicating no *institutional collaborations* were asked to indicate their reasons for not collaborating. One of the reasons given was the existence of *contractual personal collaborations* with a university researcher.

The questionnaire was circulated in October/November 2008. From the representative sample of 1,058 firms, we obtained 1,052 valid responses, although some of the variables have a few missing observations. Such and high response rate is due to the institutional character of the survey, which is administered every three months by the Piedmontese Chamber of Commerce to an up-to-date representative sample.

About 17.5% of firms are involved in some form of collaboration with university researchers (*institutionally* or *personally).* 104 firms (9.9%) responded that they had engaged in *institutional collaborations* with universities in the previous three years. While some of these firms may have been involved in other ways of interacting with universities, we can identify 83 respondents (7.9%) that had only *contractual personal collaborations* with university researchers (i.e. they stated that they did not collaborate *institutionally* with any university because they had contracts with individual university researchers). Finally, 865 responded that they were not involved in any kind of collaboration with universities. The governance of university-industry linkages based on *personal contractual* agreements plays an important role in the Piedmont innovation process.

[Insert Table 1 about here]

Table 1 shows the distribution of firm characteristics across different subgroups of respondents: the entire sample, the set of firms with institutional collaborations with universities, the set of firms with only personal collaborations with universities, and those firms that do not collaborate at all. We found some important differences in the characteristics of firms choosing different modes of governance. In the total sample, the firms that engage in institutional collaborations are large (in size and turnover) and are significantly over-represented in the province of Torino and in the Chemicals, Rubber and Plastics industry, and under-represented in the province of Novara and in the Textiles industry. They are also more likely to invest in internal R&D and design. Firms that engage only in personal contractual collaborations are over-represented in the Production of Electrical, Electronic and Communication Equipment industry, and under-represented in the province of Novara, and are also more likely to engage in internal R&D. Firms that

do not engage in either form of collaboration are significantly over-represented in the small firms category and under-represented in the large firms category – in line with the findings in the empirical literature (Mohnen and Hoareau, 2003; Arundel and Geuna, 2004; Laursen and Salter, 2004; Fontana et al., 2006). They are also more likely to belong to the Textiles industry, and less likely to engage in internal R&D. The presence of *contractual personal collaborations* between small firms and university researchers suggest that it is possible for small firms to engage in knowledge transfer activities without any institutionalized infrastructure for knowledge transfer, which contrasts with the claims made by the proponents of the Bayh-Dole act, who saw the institutionalization of knowledge transfer processes as essential in order to involve small firms (see Schacht, 2005; Feldman and Stewart, 2006).

Of the 104 firms that engage in institutional collaborations with universities, only 15 did not collaborate with a local university. Of the firms that collaborated with local universities (89) only 36 engaged in collaborations outside Piedmont - and in no more than two other geographical areas.

3.2 Methodology

The objective of this paper is to analyse the role of local universities in supporting local development and innovation, focusing on the model of governance of these interactions (*institutional or personal*). *Institutional collaborations* are formal relationships with a university mediated by a department or other university KTO; *contractual personal collaborations* were reported by companies with no institutional relationships with a university, but which had contractual arrangements with individual university researchers. In order to address these objectives empirically, we test three econometric models.

Firms are faced by three decisions: (1) to collaborate *institutionally* with the university; (2) to engage only in *contractual personal collaboration* with university researchers; or (3) not to collaborate. Our expectations are that these decisions are made not within a sequential process where only two options at a time are considered (i.e. the firm does not decide first whether to collaborate or not and then at a later time decides to develop an *institutional collaboration* or a *contractual personal collaboration*). Rather we would expect firms to consider all three options together. Firms do not decide to collaborate and then select the 'best' governance structure, *institutional* or *personal*. Rather, when faced with a technological problem, the firm will decide to collaborate with someone that it knows will be able to help, usually a person that the firm has had previous experience, i.e. through a *personal contract with a researcher*. Alternatively, the firm may decide to contact the university either because it has no history of interaction with a specific researcher or because of the type of problem may need the involvement of more than a single researcher, and require access to university laboratories. This would involve *institutional collaboration*. Finally, there may be reasons why firms decide that they do not need to collaborate with either researchers or universities, e.g. in the case that they are part of a group where there are partner firms with internal competences which they can exploit, or because they have well developed in house competences.

A multinomial logit model would be the logical choice for this analysis; however, due to the fact that we have more information about *non-(institutional) collaborations* (such as reasons for not collaborating), we first run a set of independent logit models to extract as much information as possible from our dataset. We start by analysing the reasons why do firms decide not to develop *institutional collaboration* with a university. In particular, we

explore the differences between firms that do not collaborate institutionally but have contractual arrangements with university researchers, and firms that do not collaborate at all with universities. To do this, we extract the principal components of the reasons given for not collaborating institutionally with universities in the previous three years. We explore how these reasons affected the firms' decisions to engage in *no collaboration* with a university or to forge *only contractual personal collaborations* with individual university researchers. We run a logit analysis on a dependent variable that takes the value 1 if the firm engages in *contractual personal collaborations* with university researchers and zero if the firm does not collaborate with either a researcher or a university. Next, we explore the characteristics of *institutional collaborators* to understand how they differ from *non-institutional collaborators*. We explore the differences between these firms and the full sample of non-institutional collaborators and between these firms and the restricted sample of firms that engage only in *contractual personal collaborations* with university researchers. Are the firms that engage in *institutional collaborations* with universities significantly different from those that either do not cooperate or that cooperate with university researchers through *personal contracts*? We estimate two logit models on the variable *institutional collaboration*. In the first, *institutional collaboration* takes the value 1 if the firm engages in institutional collaboration with a university, and zero otherwise. In the second, *institutional collaboration* takes the value 1 if the firm engages in institutional collaboration with a university, and zero if the firm has *contractual personal collaborations*.

In all the regression analyses we examine the effect of innovative activities, organizational structure and the market characteristics of firms. In particular, we explore the impact of investment in internal R&D and design activities, investment in the

acquisition of external embodied and disembodied knowledge, presence of production units abroad, export intensity, and level of outsourcing. We also control for size and industry. Table 2 reports the independent and control variables and their descriptive statistics. Table A in Appendix 1 presents the correlation coefficients for the entire population of firms.

[Insert Table 2 about here]

Investment in internal R&D and design efforts can be used as a proxy for the firm's research competences and, consequently, for the ability to learn from research collaborations with a university – as a proxy for absorptive capacity (Cohen and Levinthal, 1990). The variable *Innovation Capabilities (Innov_C)* gives information about whether firms invest in internal R&D or design activities. The degree to which firms are open to external knowledge can be expected to influence the firms' decision to collaborate or not with a university (Laursen and Salter, 2004; Fontana et al., 2006). The variable *Technology Sourcing (Tech_Sourcing)* captures information on whether the firm invests in the acquisition of external embodied and disembodied knowledge, in particular patents, know-how and informational and processing software and hardware. We would expect that firms involved in international competition would have a greater incentive to innovate and to develop local and international linkages and collaborations that allow the internal integration of different knowledge sources (Powell et al., 1996; Bodas Freitas et al., 2008). To measure the degree of exposure to international competition we use the export intensity of firms, and whether the firm has multinational activities. The variable *Dexport* provides information on whether the firm exports more than 20% of production. The variable *Multin* contains information on whether the firm owns production activities

abroad that represent more than 5% of total output. Firms that outsource more of their production and development processes are more likely to experience greater organizational challenges in integrating learning and production activities developed in other locations (Wang and von Tunzelmann, 2000; Brusoni et al., 2001). Outsourcing also implies the development of relational (network) skills that can be used in other forms of cooperation. Therefore, we would expect that outsource heavily would have greater incentives to collaborate with universities to keep up to date with the knowledge involved in the outsourced technologies and components, and also a better capacity to manage collaborative relationships with an outside partner. The variable *Outsour* provides information on the level of production outsourced (logarithm of production outsourced to other firms in Italy or abroad). Finally, we control for size effects by including the variables *Lnempl* and *Sqsize* which report the logarithm of number of employees and its square, and for industry effects by including industry dummies (other manufacturing is the reference category).

4. Why firms do (not) develop institutional collaborations? An Econometric Estimation

In the following we present the estimations for the firm's decisions: (1) to collaborate *institutionally* with the university; (2) to engage only in *contractual personal collaboration* with university researchers; or (3) not to collaborate.

4.1 Reasons for not collaborating with universities

The survey asked respondents to identify their reasons for not having developed *institutional collaborations* with universities in the previous three years, choosing among seven options (firms could choose more than one option). The distribution of

respondents' answers is presented in Table 3. Slightly more than 50% of firms identified a single reason for not collaborating, about 17% indicated two reasons; 6.4% indicated three or more reasons; about 10% did not answer the question.

[Insert Table 3 about here]

Table 3 shows that most firms do not collaborate because they do not feel they need to do so, or have in house competences. The third most frequent reason was lack of resources. In order to understand the factors underlying firms' decisions not to collaborate institutionally with universities, we extracted the principal components factors of these data.

[Insert Table 4 about here]

The motivations for firms not to collaborate institutionally with universities differ: the results in Table 4 show that there are two main reasons, which explain 41.9% of total variance. The first (Factor 1) is that *collaboration with university is difficult and costly*, in financial terms and in terms of the time required to establish an institutional contact with a university. The second (Factor 2) is the recognition that there are *other ways to develop the relevant know-how* than through collaboration with a university. The firm can develop know-how internally or in collaboration with industry partners or research centres that are not universities. In both cases, the reason that 'The firm has no need for collaboration' is negatively loaded, which might itself be a reason. In both cases, the reason that 'The firm only engages in collaborations with individual researchers (payment is made directly to the researcher or to his/her own firm)' is loaded with very

low scores. This would suggest that firms that do not engage in formal collaboration with a university because they collaborate with individual researchers fall into a specific group not highly correlated with any of the other reasons for non-institutional collaboration.

To better understand the differences between the 865 firms that did not undertake any form of collaboration with universities and the 83 firms that engaged only in *contractual personal collaborations* with university researchers, we run a logit model. The dependent variable is the dichotomous variable *no institutional collaboration but engagement in contractual personal collaborations* with university researchers.[1] We estimate the basic model and three variables for the reasons for non-collaboration, based on the factor analysis. One categorical variable captures information on whether the firm considers collaboration with university a difficult and costly investment *(F_cost),* one captures information on whether the firm has other ways to develop relevant know-how *(F_other),* both were created as from the sum of the variables that scored high for the two factors referred to above. We also include a dichotomous variable to capture information on whether the firm indicated that it did not feel the need to collaborate *(F_need).*

[Insert Table 5 about here]

Table 5 reports the results of the logit estimation of the probability that the firm that did not collaborate institutionally, and engaged in only *contractual personal collaborations* with university researchers. We found weak evidence to suggest that firms that do not collaborate at all and firms that engage only in *contractual personal collaborations* with specific university researchers differ in terms of their organizational and market

[1] This variable takes the value 0 if the firm does not collaborate with a university (either institutionally or through a contractual personal collaboration), and 1 if the firm does not collaborate institutionally with a university, but engages in contractual personal collaboration with individual researchers.

characteristics, but not their innovative efforts. Larger firms are less likely to engage in *contractual personal collaborations* than to be non-collaborators, while firms that rely on outsourcing are more likely to engage in *contractual personal collaborations*. Firms that engage in *contractual personal collaborations* are more likely than total non-collaborators to acknowledge *other ways to develop relevant know-how* and to find *collaboration with university a difficult and costly investment*. The model controls for differences across industries, but they are not significant. The results are robust if we run the same model in backward rather than enter mode. To some extent, our results for the coefficient of the variable *F_other*, and less so for the variable *Outsource*, indicate that compared to *non-collaborators*, firms that engage only in *contractual personal collaborations* with individual university researchers, adopt more 'open' innovation strategies, based on the exchange of knowledge with external partners (including individual academics).

4.2 Reasons for institutional collaboration

Having explored the differences between non-collaborators (those with personal collaborations and those without no collaborations at all), we now look at the characteristics of the 104 firms that engaged in *institutional collaborations* during the previous three years.

Using a logit estimation model, we examine the factors that lead firms to become *institutional collaborators*. In particular, we explore the specificities of *institutional collaborators* in relation to the full sample of non-collaborators, and restrict the sample of firms that develop *contractual personal collaborations* with individual university researchers. The results are presented in Table 6.

[Insert Table 6 about here]

The second and third columns of Table 6 present the results for the full sample. Larger firms and firms that invest internally in innovation through R&D or design are more likely to collaborate institutionally with universities. We found some industry differences: firms active in the food industry are more likely to develop *institutional collaborations*, while firms active in textiles are less likely to do so. These results are robust when we run the same model with backward rather than enter mode (column 2, Table 6).

To examine the differences between firms that engage in *institutional collaborations* with universities and those that engage in *contractual personal collaborations* with individual university researchers, we repeat the logit analysis for these subsamples. Columns 4 and 5 in Table 6 suggest that larger firms that invest internally in innovation through R&D or design, but do not invest in the acquisition of external embodied or disembodied knowledge and know-how (*complementary investment*) are more likely to collaborate institutionally with universities.[2] Firms active in textiles are less likely to engage in institutional collaborations with industry.

These results suggest the existence of three types of firms and innovation strategies, which confirms that the choice between collaborating either through *institutional collaborations* or *through contractual personal collaborations*, and not collaborating, is

[2] Ceteris paribus, firms that invest in the acquisition of external knowledge show a reduced probability (23 percentage points) of collaborating institutionally with a university as opposed to maintaining individual contracts with researchers.

not a sequential decision process.[3] Firms that maintain only *contractual personal collaboration* with a university researcher invest more in the acquisition of external knowledge than firms that collaborate institutionally, and also are more likely to rely on external sources of technological knowledge than firms that do not collaborate at all (Table 5). Also, these firms tend to be smaller.

To check robustness, we compute a multinomial logit on the variable *Governance*, which takes the values 0 if the firm did not collaborate at all, 1 if the firm maintained only personal collaboration with individual researchers, and 2 if the firm had institutional collaborations with universities. The results of this model (Table 7) are consistent with the results of the above logit models, confirming the independence of the three decisions. Firms collaborating with universities via *personal contractual* linkages only, tend to be smaller than firms that collaborate institutionally, and also rely upon the acquisition of knowledge from other complementary investments, such as patents or know how, more than non-collaborators and institutional collaborators.

[Insert Table 7 about here]

Overall, our analysis shows that *contractual personal collaborations* are more often associated with small firms' acquisitions of external embodied and disembodied knowledge compared to collaborations using institutional channels. Moreover, firms that use *contractual personal collaborations* are more likely to engage in open innovation strategies than *non-collaborators*. Thus, *contractual personal collaborations* with individual researchers seem to play a role in both the absorption of externally acquired

[3] As a robustness check we ran a Heckman logit analysis to account for the selection mechanism in the firm's decision-making process: the model was statistically rejected.

knowledge and the integration of knowledge and know-how developed in collaboration with other partners. Hence, individual university researchers play an important role in regional knowledge transfer.

5. Conclusions

We analysed the collaboration patterns of Piedmontese firms with universities using data from an original survey addressing the representative sample of local firms that the Piedmont Chamber of Commerce selects and maintains for its regular quarterly regional economic foresight survey. We find that the majority of firms (82.2%) do not collaborate with a university, 9.9% collaborate institutionally, and 7.9% of firms have *contractual personal collaborations* with specific university researchers, although no institutional collaboration with a university. Clearly, companies that engage in *institutional collaborations* with universities may also use *personal contractual relationships*, and the two can be complementary. However, we identified a significant share of companies that *do not* collaborate institutionally, but interact directly with individual university researchers through *personal contracts*. We conceptualize these interactions in terms of different governance systems. The data do not allow us to develop a more fine-grained classification of these typologies in terms of companies that use both types of interactions, those that only uses personal contractual relationships and those that only rely upon institutionalized collaboration. Work in this direction based on a new survey of industry inventors is ongoing (Fondazione Rosselli, 2010).

The results in this paper suggest that larger firms are more likely to engage in *institutional collaboration* with universities, compared to both non-collaborators and to firms that engage in only *contractual personal collaboration* with researchers. Among

large firms, those that invest in internal R&D and design labs have a higher probability of developing *institutional collaborations.* Firms that engage in *contractual personal collaborations* are more likely to be small firms and are more likely to invest in the acquisition of external embodied and disembodied knowledge than either non-collaborators or institutional collaborators. Firms with contractual personal arrangements are more likely to engage in open innovation strategies than non-collaborators. Thus, *contractual personal collaborations* with specific university researchers seem to play a role in the absorption of externally acquired knowledge and the integration of knowledge and know-how developed in collaboration with other partners.

While much of the literature on university-industry knowledge transfer focuses on collaborations mediated by university institutions, and the focus on institutional collaborations drives public policy interventions, our data show that in Piedmont university-industry knowledge transfer is frequently via contractual personal arrangements between firms and individual academics. Both forms of governance of university-industry relationships are important, and involve firms with different characteristics, in terms of size, sector of activity (firms in more traditional sectors such as textiles are more likely to engage in *contractual personal collaborations*) and propensity to adopt open approaches to innovation. In fact, firms that engage in *contractual personal collaborations* appear to favour open innovation strategies based on multiple forms of collaborations with external partners and the integration of internal and external R&D. It is important, therefore, to take account of these contractual personal links between firms and academics when studying university-industry technology transfer and when devising public policies to support it. It is especially important in the case of regional interaction where the existence of local network links may minimize the

transaction costs involved in setting up *personal* contractual relationships compared to establishing institutional arrangements. Further research is needed to explore these results, which suggest a specific role for different forms of involvement with university research. In particular, it is important examine the specific contribution to the process of knowledge development and integration of different forms of interaction with university.

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Table 1. Distribution of firm characteristics across different subgroups of respondents

		Sample N = 1052 % of sample	No collaboration n = 865 % of respondents		Institutional collaboration n = 104 % of respondents		Personal collaboration n = 83 % of respondents	
Sector	Food, Beverages and Tobacco	10.1	9.5		15.4		9.6	
	Textiles, Apparel and Shoes	15.3	16.5	**	5.8	**	14.5	
	Wood and Furniture	5.8	6.4		1.9		4.8	
	Paper, Printing and Publishing	5.9	6.4		4.8		2.4	
	Chemicals, Rubber and Plastics	9.9	9	*	17.3	*	9.6	
	Production of Metals and Metal Goods	17.8	18.6		12.5		15.7	
	Mechanics	14.6	14.1		19.2		14.5	
	Production of Electrical, Electronic and Communication Equipment	6.7	6.1		6.7		12	*
	Production of Transportation Equipment	4.3	3.9		6.7		4.8	
	Other Manufacturing companies	9.7	9.5		9.6		12	
	Total	100	100		100		100	
Province	Alessandria	12.5	12.1		16.3		12	
	Asti	8.1	7.7		12.5		6	
	Biella	10.3	10.6		5.8		12	
	Cuneo	14.1	14		14.4		14.5	
	Novara	14	15.7	***	4.8	***	7.2	*
	Torino	26.7	24.7	**	39.4	**	31.3	
	Verbania-Cusio-Ossola	7	7.4		3.8		7.2	
	Vercelli	7.3	7.6		2.9		9.6	
	Total	100	100		100		100	
Size	10-49 employees	70.6	74.7	***	36.5	***	71.1	
	50-249 employees	23.6	21.4	***	40.4	***	25.3	
	more than 250 employees	5.8	3.9	***	23.1	***	3.6	
	Total	100	100		100		100	
Turnover	less than 2m	30.6	34.2	***	0	***	31.3	
	2-5m	22.9	25.7	***	1.9	***	20.5	
	5-10m	16.6	16.2		16.3		21.7	
	10-20m	12	9.9	***	30.8	***	9.6	
	20-50m	9.6	5.8	***	41.3	***	9.6	
	over 50m	8.3	8.2		9.6		7.2	
	Total	100	100		100		100	
R&D or design investment	Yes	35	31	***	58	***	41	**
	No	65	69	***	42	***	59	**
	Total	100	100		100		100	

Note: *** Significance at 1% (2-tailed), ** Significance at 5% (2-tailed); * Significance 10% (2-tailed),

Table 2. Descriptive statistics for independent variables used in the regressions

Variables	Variable name	Description	N	Minimum	Maximum	Mean	Std. Deviation
Size	Size	Logarithm of the number of employees	1,058	0	9.47	3.42	1.20
	Sqsize	Square of the logarithm of number of employees	1,058	0	89.60	13.17	9.62
Innovation Capabilities	Innov_C	1 if the firm commits efforts to internal R&D or design activities, 0 otherwise	950	0	1	0.35	0.48
Technological Sourcing	Tech_Sourcing	1 if the firm invested in either acquisition of patents, external know-how or informational and data process equipment and software, 0 otherwise	915	0	1	0.37	0.48
Export	Dexport	1 if the firm exports more than 20% of their production, 0 otherwise	1,058	0	1	0.42	0.49
Multinational	Multin	1 if the firm produces 5% or more of their product in plants outside the country	1,058	0	1	0.19	0.39
Production Outsourcing	Outsour	Logarithm of the share of production outsourced in Italy or abroad to subcontractors	1,058	0	1	0.10	0.29
Industry	Food	Food, Beverages and Tobacco	1,057	0	1	0.10	0.30
	Textiles	Textiles, Apparel and Shoes	1,057	0	1	0.15	0.36
	Wood	Wood and Furniture	1,057	0	1	0.06	0.23
	Paper	Paper, Printing and Publishing	1,057	0	1	0.06	0.24
	Chemical	Chemicals, Rubber and Plastics	1,057	0	1	0.10	0.30
	Metals	Production of Metals and Metal Goods (excluding Jewellery)	1,057	0	1	0.18	0.38
	Equipment	Mechanics	1,057	0	1	0.15	0.36
	Electronic	Production of Electrical, Electronic and Communication Equipment	1,057	0	1	0.07	0.25
	Transport	Production of Transportation Equipment	1,057	0	1	0.04	0.21
	Jewellery	Jewellery	1,057	0	1	0.02	0.15
	Other	Other Manufacturing companies	1,057	0	1	0.08	0.27

Table 3. Reasons for not collaborating with universities: distribution of answers

	No. of Cases	% of Cases
The firm has no need for collaborations	568	53.7%
The firm already has the advanced internal competences it needs	168	15.9%
The firm acquires the necessary knowledge from other partner firms	88	8.3%
The firm collaborates with external non-university research centres	76	7.2%
The firm may be interested in collaborating with universities, but it lacks the resources for this kind of investment	124	11.7%
The firm only engages in collaborations with individual researchers (payment is made directly to the researcher or to his/her own firm)	83	7.8%
The firm finds it difficult to contact universities	55	5.2%
Other reasons (specify)	14	1.5%

Note: 927 observations

Table 4. Rotated load factors for reasons for not participating in institutional collaborations with universities in the previous 3 years

	Factor analysis		Independent variables used		
	1	2	F_Need	F_Other	F_Cost
The firm has no need for collaborations	-0.45	-0.51	+		
The firm already has the advanced internal competences it needs	-0.05	0.63		+	
The firm acquires the necessary knowledge from other partner firms	0.04	0.58		+	
The firm collaborates with external non-university research centres	0.03	0.62		+	
The firm may be interested in collaborating with universities. but it lacks the resources for this kind of investment	0.76	-0.06			+
The firm only engages in collaborations with individual researchers (payment is made directly to the researcher or to his/her own firm)	0.39	0.27			
The firm finds it difficult to contact universities	0.74	-0.07			+
Share of Variance explained	24.5%	17.3%			
Eigen value	1.7	1.2			
Min			0	0	0
Max			1	2	3
Average			0.613	0.192	0.358
Std. Deviation			0.487	0.470	0.626

Note: Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization

Table 5. Logit model estimation of probability of non-institutional collaborators to engage in personal collaborations with universities

	Normal Enter Mode	**Backward Mode**
Size	-1.153* (0.695)	-1.115* (0.614)
Sqsize	0.109 (0.0852)	0.106 (0.0799)
Innov_C	-0.0249 (0.425)	
Tech_Sourcing	0.476 (0.435)	0.447 (0.413)
Outsourc	0.0198 (0.0129)	0.0184* (0.0108)
Multin	-0.0387 (0.611)	
Dexport	0.0125 (0.560)	
F_cost	1.084*** (0.359)	1.065*** (0.294)
F_other	1.531*** (0.283)	1.515*** (0.268)
F_need	0.416 (0.440)	0.412 (0.407)
Intercept	-2.104 (1.286)	-2.520** (1.112)
	Industry dummies non significant	
Observations	759	759
Wald chi2	64.28***	56.43***
Df	18	9
Pseudo R2	0.21	0.2
Log pseudolikelihood	-109.8	-110.6

Note 1: *** Significance at 1% (2-tailed), ** Significance at 5% (2-tailed); * Significance 10% (2-tailed),
Note 2: Robust standard errors in parentheses

Table 6. Logit model estimation of institutional collaboration with universities

	Institutional collaboration versus non-institutional collaboration		Institutional collaboration versus contractual personal collaboration	
	Normal Enter Mode	**Backward Mode**	**Normal Enter Mode**	**Backward Mode**
Size	1.434*** (0.524)	1.321** (0.552)	1.246 (0.776)	0.800*** (0.185)
Sqsize	-0.0866 (0.0567)	-0.0771 (0.0590)	-0.0525 (0.0889)	
Innov_C	0.832*** (0.252)	0.779*** (0.248)	0.679* (0.409)	0.720* (0.395)
Tech_Sourcing	-0.192 (0.258)		-0.962** (0.433)	-0.903** (0.399)
Outsourc	0.00216 (0.0139)		0.0185 (0.0206)	
Multin	-0.252 (0.437)		-0.360 (0.660)	
Dexport	0.350 (0.285)	0.316 (0.269)	0.0584 (0.421)	
Intercept	-6.546*** (1.129)	-6.589*** (1.221)	-3.556** (1.666)	-2.779*** (0.736)
	Food and textiles significant		Textiles significant	
Observations	908	908	166	166
Wald chi2	108.66***	110.39***	38.56***	42.10***
Df	15	8	15	8
Pseudo R2	0.19	0.18	0.19	0.18
Log pseudolikelihood	-245.8	-247.0	-91.88	-92.55

Note 1: *** Significance at 1% (2-tailed), ** Significance at 5% (2-tailed); * Significance 10% (2-tailed),
Note 2: Robust standard errors in parentheses

Table 7. Multinomial logit model estimation of institutional collaboration, personal links and non-collaboration with universities

	Personal links versus non-collaboration	**Institutional collaboration versus no collaboration**	**Institutional collaboration versus Personal links|**
Size	0.19 (0.60)	1.45*** (0.53)	1.26* (0.76)
Sqsize	-0.04 (0.07)	-0.09 (0.06)	-0.06 (0.09)
Innov C	0.32 (0.26)	0.87*** (0.25)	0.54 (0.349
Tech Sourcing	0.68** (0.28)	-0.12 (0.26)	-0.8*** (0.36)
Outsourc	0.00 (0.01)	0.00 (0.01)	0.00 (0.029
Multin	-0.17 (0.41)	-0.27 (0.44)	-0.10 (0.57)
Dexport	0.51* (0.29)	0.40 (0.29)	-0.11 (0.39)
Intercept	-3.1*** (1.15)	-6.52*** (1.13)	-3.42** (1.52)
		Food and textile industries significant	Textile industry significant
Observations	908		
Wald chi2	125.18***		
df	30		
Pseudo R2	0.12		
Log pseudolikelihood	-480.48		

Note 1: *** Significance at 1% (2-tailed), ** Significance at 5% (2-tailed); * Significance 10% (2-tailed),
Note 2: Robust standard errors in parentheses

Appendix 1

Table A. Correlation coefficients of the control variables for all firms

	Size	Sqsize	Dexport	Outsour	Multin	Innov_C	Tech_Sourcing
Size	1						
Sqsize	0.969**	1					
Dexport	0.428**	0.409**	1				
Outsour	0.142**	0.151**	0.128**	1			
Multin	0.149**	0.135**	0.149**	0.647**	1		
Innov_C	0.307**	0.295**	0.205**	0.081*	0.075*	1	
Tech_Sourcing	0.371**	0.355**	0.201**	0.116**	0.158**	0.230**	1

Note: 908 firms