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"THE ROLE OF UNIVERSITIES IN THE LOCATION OF INNOVATIVE START-UPS[a]"

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The role of universities in the location of innovative start-ups[a]

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Abstract

Start-ups increasingly find the prospect of university-industry collaborations to be a powerful driver of innovation and entrepreneurship activity. Moreover, at the geographical level, they are attracted by teaching and research institutions, either public or private. This paper focuses on the role played by universities. Our hypothesis is that geographical proximity favors the transfer of knowledge and technology from universities to industries and, consequently, represents a positive factor for regional economic development.

Results show that university spillovers are positively correlated with the creation of innovative start-ups. Furthermore, the presence of human capital (graduates) exerts a significant influence on the location decisions of start-ups, being a source for competitiveness for firms close to universities. Research quality, especially in the social sciences area, attracts innovative start-ups, while *third-mission* activities have a weak impact on locational choice.

Keywords: Knowledge transfer, Innovative start-up, University spillovers.
JEL Classification: M13, L20, R30.

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[b]And Mo.Fi.R., Ancona.

1 Introduction

This paper aims at analyzing the role played by knowledge and technology transfer services of Italian universities in attracting innovative start-ups and, therefore, favoring economic growth. Indeed, one of the most recurrent issues concerning the Italian economy is its lack of dynamism. The existence of a flexible exchange rate regime up to the adoption of the Euro and a labor market that has become increasingly flexible since the mid-Nineties have made postponing industrial policy decisions convenient. Issues such as the need to back out of traditional industries, where competition from new industrialized countries is stronger, and to favor an increase in the size of Italian firms, have remained confined within academic circles.[1] Therefore, Italian manufacturing still finds itself 'locked-in' with a production structure that has not changed much during the last 25-30 years, and has failed to converge towards that of the most developed European countries. Consequently, its international competitiveness has, on average, lost significant ground.

This picture worsened in recent years when the economic crisis weakened the already low level of the R&D investment rate and strengthened the specialization of Italian firms in low-technology activities. Thus, the various Italian governments have started undertaking policy measures to reform investment incentives in R&D (i.e., by means of the *Fondo per la Crescita Sostenibile*), encourage the extension of research and innovation activities for innovative start-ups and support firms in their access to credit (Nascia and Pianta, 2014). On October 18, 2012, Italian Law Decree no. 179 on 'Further urgent measures for Italy's economic growth', commonly known as the *Decreto Crescita bis*, introduced a comprehensive new framework regulating innovative start-ups. On December 13, 2012, Law Decree no. 179 was modified by the Parliament and subsequently converted into law (Law no. 221 known as *Start-Up Regulation*). The *Start-Up Regulation* Law provides a new set of rules promoting the creation and development of innovative start-ups with a view to encouraging innovation and strengthening business competitiveness. The new legal framework is directed at creating incentives that aim at removing obstacles and costs for business start-ups, and incubators are considered one of the keys for stimulating the labour market and the Italian economy.[2]

These policy measures are inspired by the idea that the reallocation of resources from less towards more productive businesses is mainly affected by businesses' dynamism, both in terms of growth and contraction. A less dynamic business growth distribution is associated with lower productivity growth. Importantly, both a higher share of growing

[1] On the role of Italian small-sized firms see Calcagnini and Favaretto (2011).

[2] The *Start-Up Regulation* Law introduced several exceptions to the general legal principles applicable to enterprises, namely: (a) the reduction of setting-up costs; (b) the possibility of providing work-for-equity instruments to remunerate directors, employees and consultants, and the introduction of significant tax incentives to the subscription of such instruments; and (c) the signature of fixed-term contracts with employees by derogating general labour laws, to lower labour costs. Further, the *Start-Up Regulation* allows the public offering of quotas of innovative startups incorporated under the form of limited liability companies (otherwise forbidden under Italian law) and tax incentives are specifically introduced for both individuals and legal entities that subscribe such offerings. Finally, it provides exceptions to Italian bankruptcy law: in the event of an insolvency crisis of the innovative start-up, the ordinary pre-insolvency and insolvency procedures are not applicable. Innovative start-ups are only subject to the so-called 'over-indebtness procedures' that will provide a fast track to liquidating the firms' assets and restart other businesses, therefore reducing the damage to reputation that could arise from ordinary insolvency procedures.

and shrinking firms are correlated with faster productivity growth. This business churning means more experimentation/innovation and, in the long run, higher productivity through the selection of the most efficient firms. In a 'locked-in context', such as the Italian one, firms pursue risk-averse approaches. Too many firms appear either unwilling or unable to experiment and exploit new growth opportunities. As a result, they fail to innovate effectively. The benefits of innovation are only maximized when firms build on it. This means expanding and replacing less successful firms, driving productivity growth in the process (Biosca, 2010).

Escaping the 'locked-in context' means favoring a wave of dynamic firms such as innovative start-ups, which can translate into a more efficient transmission of knowledge thanks to advantages tied with geographic proximity to academic institutions.[3]

Newly established firms increasingly find the existence of university-industry collaborations a powerful driver of innovation and entrepreneurship activity, and are also attracted at the geographical level by teaching and research institutions, whether public or private. This paper focuses on the role played by universities. Our hypothesis is that geographical proximity favors the transfer of knowledge and technology from universities to industries and, consequently, it represents a positive factor for regional economic development.

We analyze the role played by knowledge and technology spillovers on the locational choice of Italian innovative start-ups, and follow Audretsch et al. (2005), according to which the locational choice of a new firm is a strategic decision that takes into account knowledge spillovers and, more specifically, university spillovers.[4] We improve on their work in three main aspects: first, we recognize that different types of innovative start-ups exist and account for it in our empirical analysis; second, knowledge spillovers are considered for a broader group of disciplines, broken down into fourteen sectors established by the Italian research quality evaluation 2004-2010 (*Valutazione Qualità della Ricerca*, VQR)[5]; third, we make use of quantitative information on what is known as the university *third mission*, (i.e. the set of activities concerning the knowledge and technology transfer such as patents, spin-offs, and collaboration agreements) to analyze its impact on firm proximity to universities.[6]

The strategic locational choice of start-ups falls within classical models that describe the agglomeration of economic activity as the result of pecuniary and localization externalities due, for instance, to other firms engaged in similar activities or knowledge spillovers from institutions.[7]

Several studies have addressed the different aspects of the university-industry collaboration. Leten et al. (2007) focuses on the benefits accruing to firms from the presence of universities when developing a technology that takes into account the size of the regional university knowledge, while Muscio (2013), Muscio and Pozzali (2013), Carboni (2013), Fantino et al. (2012), Cardamone et al. (2012, 2014) underline the positive impact of geographical, cognitive and industry distance on the occurrence of university-industry

[3]Start-ups also generate jobs during recessions. Kane (2010) showed that, between 1997 and 2005, startups created around three million jobs, while other firms lost around one million jobs.

[4]See also Stuart and Sorenson (2003).

[5]eValuation of Research Quality.

[6]The last Italian university reform, L.240/2010, widely known as the *Gelmini Act*, explicitly sets out three missions: education, research, knowledge/technology transfer.

[7]See Krugman (1991a, b), Fujita and Krugman (1995), Fujita et al. (1999), Berliant and Konishi (2000), Ellison and Glaeser (1997), Kim (1995), Berliant et al. (2002), Henderson (1977, 1988).

partnerships. Overall, these papers suggest that geographical closeness asserts beneficial effects on research collaborations and provides firms' incentives to innovate through interpersonal contacts, the exchange of tacit knowledge, and coordination and transport costs. The aforesaid are more important for small- and medium-sized firms.

To test our hypothesis, we constructed a database with information on the road and linear distance between each start-up registered in Italy between 2012 and 2014 and the university closest to each. A set of variables controlling for firm (such as size, legal entity type, industry) and university characteristics considered (total number of graduates broken down by field, the share of graduates with residency in the same province where the university is located, the presence of more than one university in the same province, and measures related to the 2004-2010 research quality evaluation carried out by the National Agency for the eValuation of Universities and Research institutes - ANVUR). Then, we estimated firms' locational decisions by means of linear and quantile regression models, to take into account their skewed spatial distribution.

Results show that university spillovers are positively correlated with innovative start-ups. Furthermore, the presence of human capital (measured by the number of graduates) exerts a significant influence on location, constituting a source for competitiveness for firms close to universities. Research quality, especially in the social sciences area (where knowledge is less codified and needs direct interaction between partners in order to be transmitted), attracts new firms; while the *third-mission* activities have a weak impact on locational choice.

The remainder of this paper is divided into five Sections. Sections 2 reviews previous literature and provides testable predictions on the role of knowledge and technology transfer on start-up locational choices. Section 3 describes the data used, while Section 4 shows our approach to model estimation and empirical results. Finally, our main conclusions and some policy implications are presented in Section 5.

2 Literature review and research hypotheses

Recent economic literature has shown that different factors affect the geographical proximity of firms to universites. They can be grouped into three categories: a) firm characteristics, such as the sector of activity or firm propensity to innovate (see, for instance, Mansfield, 1995; Muscio, 2006); b) the presence of university spillovers such as knowledge transfer and human capital (Audretsch et al., 2005); c) the presence of complementarity or substitutability between academic research, industry applications and the local industrial structure (Adams, 2002).[8]

Here we are mostly interested in the role of university spillovers on the location of innovative start-ups. The theory of localized knowledge spillovers states that firms might choose to locate close to a university to gain access to external knowledge at a cost that is lower than what they would bear to produce such knowledge internally. Furthermore, university spillovers tend to be mostly spatially bounded, so that their cost is usually correlated with the physical distance between the firm and the university. Thus, university spillovers act as a kind of externality towards firms, and have been

[8]In the model of entrepreneurial choice (Knight, 1921), and its extensions (Khilstrom and Laffont (1979), Holmes and Schmitz (1990), Alvarez and Barney (2004)), the role of location has been neglected, and geography has no effect on expected firm returns.

traditionally divided into knowledge and human capital spillovers. While the former refer to the transfer of results from high-quality academic (or basic) research, the latter refer to the number of graduates as an additional source of knowledge transfer.

Improving on previous research, we explicitly introduce into our analysis a third mechanism through which universities transfer knowledge to firms, the so-called *third mission* activities. The latter are the sum of activities from the generation of to the use of knowledge, outside of academic environments. Thus, they refer to universities as co-creators of industrially, socially and environmentally relevant and applicable knowledge, including its applications (patents, spin-offs and collaboration agreements). Effective *third-mission* engagement also depends on universities continuing to perform at high levels in relation to their other two missions (research and teaching).

In this Section we discuss in turn the potential impact of three types of university spillovers on the location of innovative start-ups.

The quality of academic research

Academic research is the first mechanism of knowledge spillover and, once it is published in scholarly journals, is generally classified as codified knowledge. Thus, it might be transferred at a low cost that is not dependent on firm location, i.e.: accessing this knowledge might be invariant to locational distance from the university where it is produced.

However, the degree of knowledge codification depends on the scientific area of research. While research related to natural sciences is codified, research related to the social sciences and the humanities does not have a unique and established methodology, being rather idiosyncratic to specific disciplines, sub-disciplines and research approaches. Given this, its output is much less codified. Therefore, in the case of research produced by the social sciences and the humanities, university department proximity can be still relevant for firm locational choices.

Empirical studies have found evidence that the university contribution to industrial innovation is larger the higher the quality of academic research is and the closer universities and firms are (Mansfield, 1995). The author also finds evidence of the different role of applied research in determining firm-university collaborations with respect to basic research. Specifically, in the case of applied R&D, firms tend to prefer geographical proximity to high-quality research, while in the case of basic research, location does not affect firm choice concerning which universities to work with and which to support.

From the university perspective, geographical distance from firms matters, as academic spillovers are more localized than industry spillovers (see Muscio, 2013). Indeed, university research affects the stock of intangible assets within regions (Del Barrio-Castro and Garcia-Quevedo, 2005), while firm proximity to academic institutions and regional economic conditions influence university knowledge transfer activities and determine the intensity of the university-firm interactions (D'Este and Iammarino, 2010). Thus, academic externalities are not uniformly distributed and, frequently, there are important differences across sectors in terms of agglomeration effects (Anselin et al., 2000).Moreover, the geographic proximity of universities to industrial districts fosters university-industry collaborations (Muscio et al. 2012). However, other papers find that the applicability of research to a specific industrial context can also drive universities to engage in distant collaborations (Muscio 2013).

Finally, Audretsch and Thurik (2001) and Hall et al. (2003) find that young rather than established firms gain more from spillovers, because firms in the early stages do not devote many resources to research, and thus try to take advantage of external knowledge. Therefore, geographical proximity represents a source of competitive advantage based on intangible assets such as new ideas and projects, innovative knowledge, and human capital. The positive effect of proximity also depends on the ability of companies to exploit spillovers, which obviously differs across firms.

Thus, our first testable hypothesis relates to the location of innovative start-ups relative to university research quality, as follows:

Hypothesis 1*: In order to exploit knowledge spillovers, the higher the quality of academic research the more innovative start-ups are attracted to the area near more productive universities. Further, this relationship is expected to be stronger for less codified areas of research, such as the social sciences.*

Human capital

The second part of *Hypothesis 1* is based on the fact that knowledge is either codified or tacit. In the latter case, the transfer of knowledge is more effective in the presence of a tighter spatial relationship between academic institutions and businesses. In other words, knowledge transfer, for example in the social sciences, cannot simply be codified in a document, but requires direct contacts between entrepreneurs, researchers and/or graduates. Following Audretsch et al. (2005) we assume that a proxy for tacit knowledge is the number of graduates, which are also a proxy for the size of human capital. Graduates disseminate knowledge from universities to local industries, and when they experience close geographic proximity, firms may experience competitive advantages, and lower search costs, compared with firms located away from educational institutions. According to endogenous growth theory models, human capital is an important input in the creation of new ideas, and this mechanism provides a justification for education as a main determinant of economic growth (Romer, 1990; Aghion and Howitt, 1998; Grossman and Helpman, 1991).

Thus, our second testable hypothesis relates the location of innovative start-ups to the number of graduates, as follows:

Hypothesis 2*: The number of graduates (as a whole and broken down by the three broad academic fields, i.e., the natural sciences, the social sciences and the humanities) represents a source of attraction for innovative start-ups and positively affects their locational choices.*

Third-mission activities

In the recent years of low economic growth, policy makers have often turned to universities, and their *third-mission* activities, to favor the creation of new firms (Veugelers and Del Rey, 2014). At the same time, universities have started devoting specific resources to these activities and established so-called Technology Transfer Offices (TTOs) to foster knowledge transfer.

Many different activities are classified under the label of *third mission* activities, such as patents, collaboration agreements, and spin-offs. The latter are considered one of the most promising ways to transfer academic results to the market. Spin-offs are considered an important driving force in renewing industrial structures and recent empirical findings

on the Italian economy show that sizable financial resources and full-time highly-skilled employees are key factors for increasing their number (Algieri et al., 2013). However, even though the quantitative effects of spin-offs on local economies seem to be quite scarce, to fully evaluate their role, both direct and indirect qualitative effects (such as the provision of R&D services) must also be taken into account (Iacobucci and Micozzi, 2012).

Among *third-mission* activities, business incubators also received substantial attention, as they promote innovative firms in many countries. Auricchio et al. (2014) found that incubators were effective in supporting new entrepreneurial initiatives in Italy.

Finally, innovative start-ups are also an effective way to facilitate technology transfer from the university to the economy (Boh et al., 2012). Indeed, studies have shown that geographical proximity to universities is positively correlated with regional start-up rates in high-tech industries (Rothaermel and Ku, 2008).

With this in mind, we formulate our third hypothesis, as follows:

Hypothesis 3*: University efforts in the third-mission activities are expected to produce a differentiated impact on innovative start-up proximity, which is conditional on the type of activity undertaken and the level of knowledge codification present.*

3 Data and Descriptive Statistics

The dataset contains observations on variates obtained from several sources. Our dependent variable is the start-ups' location choice, measured as the distance (kilometers) from the closest university; the latter has been computed by means of a three-step procedure, as described below.

The independent variables are categorized into three main groups, following Audretsch et al. (2005). The first group contains variables related to academic research, *third-mission* activities and human capital. The second group includes firm-specific variables, related to the characteristics of the start-ups. Finally, the third group consists of controls related to the area where start-ups and the universities are located. Table 1 describes variables used and data sources.

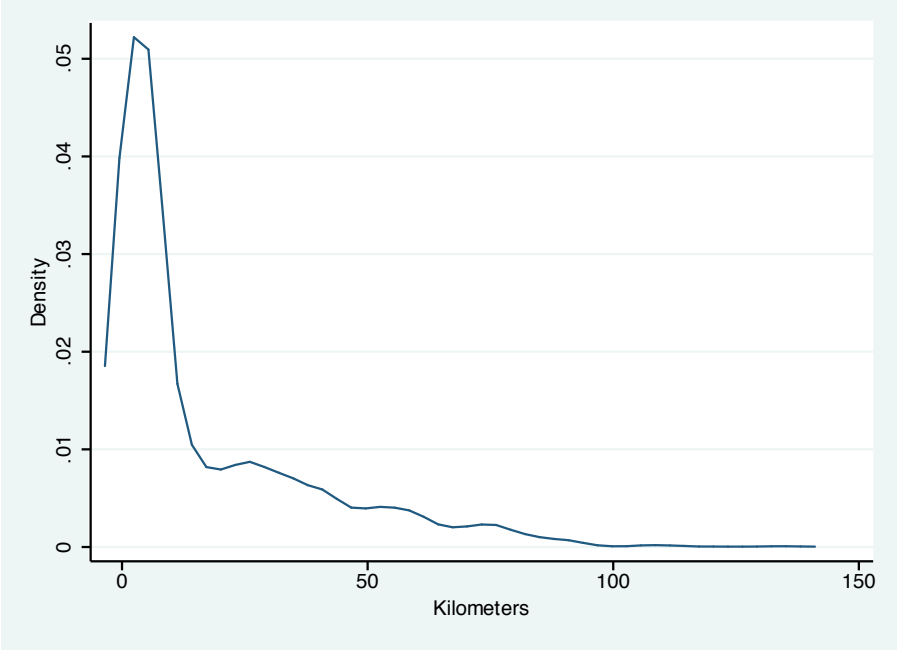
Distance

The dependent variable of interest is the geographical distance (kilometers) between start-ups and the closest university, which has been computed by means of a three-step procedure. First, we converted start-ups and university addresses into geographic coordinates (latitude and longitude) through the Google Geocoding API process. Then the linear distance (Euclidean distance) among each start-up and each university was computed and the first three shortest distances were saved. Third, Google Maps calculated the corresponding street distances and saved the shortest one.[9] A closer examination of Figure 1 shows that the endogenous variable *Distance* is highly skewed. The median distance between a start-up and the closest university is 5.72 km, while the mean is around three times the median distance, 16.90 km.[10]

[9]The procedure has been implemented by Codinglab. The distance dataset is available upon request.

[10]These figures are very close to those shown in Audretsch et al. (2005).

Figure 1: Kernel Density Estimation of *Distance* (epanechnikov)



Source: Our estimation from *Distance* data.

Knowledge spillovers: university research quality and *third-mission* activities

Data on university research quality and on the *third-mission* activities were taken from the first VQR report carried out by ANVUR. The report shows the VQR results for the period 2004-2010, i.e. there were 133 research and academic institutions in the fourteen scientific and disciplinary sectors (SSD or Area) as defined by the Italian National University Council (CUN) (ANVUR, 2013):

(a) Science and Technology: Mathematics (Area 1); Physics (Area 2); Chemistry (Area 3); Earth Sciences (Area 4); Biology (Area 5); Medicine (Area 6); Agricultural and Veterinary Sciences (Area 7); Architecture and Civil Engineering (Area 8); Industrial and Computer Engineering (Area 9).

(b) Humanities: Classics, Philology, Literary Studies, Art History (Area 10); History, Philosophy, Pedagogy and Psychology (Area 11); Law (Area 12).

(c) Social Sciences: Economics and Statistics (Area 13); Political and Social Sciences (Area 14).

The VQR 2004-2010 was one of the biggest university evaluation initiatives ever carried out in Italy, with the purpose of providing a detailed picture of the quality of higher education and research.[11]

Departments and scientific research areas were also evaluated, together with universities, by analyzing 184,878 research products (such as articles, books, critical editions, patents, software, etc.) assessed on their level of significance, originality and internationalization. The ANVUR used both a bibliometric analysis, based on journals' Impact Factor (IF) and citations, as well as a peer review analysis carried out by referees selected by the GEV members.

The VQR report classifies several indicators of research quality, among which we selected the composite indicator IRFS2 (Final Indicator of University Research) that takes into account the qualitative and quantitative characteristics of university research.[12] We use the overall IRFS2 and its version broken down by aggregated scientific area (i.e., Science and Technology, Humanities, Social Sciences).

The VQR report also shows a set of indicators related to the university *third mission* activities. ANVUR defined eight indicators, some related to the economic exploitation of knowledge, such as research and collaboration agreements, patents, spin-offs, participation in incubators and consortia to promote technology transfer. Other indicators include activities improving societal well-being, such as the management of archaeological sites, museum centers and other *third-mission* activities. For our purposes we use a concise indicator (ITMFSb) and indicators of single *third-mission* activities (ITMS1-ITMS4). A detailed description of these indicators is shown in Table 1.

[11] ANVUR evaluated 95 academic institutions, 12 public research bodies under the vigilance of the Italian Ministry of Education, University and Research (MIUR), and 16 "voluntary" organizations (9 research bodies and 17 inter-university consortia). The evaluation process started on November 2011 and lasted 20 months, involving 450 experts divided into 14 groups corresponding to different scientific areas (Group of eValuation Experts, GEV).

[12] ANVUR (2013), Sections 4.1-4.3. We opted to use IRFS2 because it only considers research evaluation, while IRFS1 takes into account the university size together with research quality evaluation. We have other controls for university size.

Table 1: **Variables used in the empirical analysis**

Variable	Definition	Source
Distance	Road distance between the innovative start-up and the closest university (km)	Googlemaps
	Spillover Mechanism: Human Capital	
Graduate Tot	Number of undergraduates (*Laurea*) + graduates (*Laurea Magistarle*) (hundreds)	MIUR
Graduate	Number of graduates (hundreds)	MIUR
Graduate ST	Number of graduates in Science and Technology (hundreds)	MIUR
Graduate SS	Number of graduates in the Social Sciences (hundreds)	MIUR
Graduate HU	Number of graduates in the Humanities (hundreds)	MIUR
	Spillover Mechanism: Research Quality	
Research Quality Tot	IRFS2: Indicator of final assessment for the research quality of the structure	ANVUR
Research Quality ST	Indicator of final assessment for the research quality for Science and Technology (obtained as a share of the total IRFS2)	ANVUR
Research Quality SS	Indicator of final assessment for the research quality for the Social Sciences (obtained as a share of the total IRFS2)	ANVUR
Research Quality HU	Indicator of final assessment for the research quality for the Humanities (obtained as a share of the total IRFS2)	ANVUR
	Spillover Mechanism: Third Mission	
Collaboration Agreements	ITMS1: Third parties indicator, calculated as the sum of turnover derived from contracts with third parties for consultancies/research	ANVUR
Patents	ITMS2: Number of patents in the period 2004-2010	ANVUR
Incubators	ITMS4: Number of partnerships with firm incubators in the period 2004-2010, and 0 otherwise	ANVUR
Consortia	ITMS5: Number of partnerships with consortia for technological transfer in the period 2004-2010	ANVUR
Archeological Sites	ITMS6: Number of archeological sites	ANVUR
Museums	ITMS7: Number of museums	ANVUR
Other *Third Mission*	ITMS8: Other *third-mission* activities	ANVUR
Spin-offs	Dummy variable: it is equal 1 if the start-up is a spin-off	NETVAL, UNIVPM
Third Mission Tot	ITMFSb: Indicator of final assessment for *third-mission* activities, obtained as a weighted sum of the eight third mission indicators by area	ANVUR
	Start-up characteristics	
Industrial District	Dummy variable: it is equal 1 if the municipality of the start-up is within an industrial district	ISTAT
Social-oriented	Dummy variable: it is equal 1 if the start-up is with social purposes	Italian Chamber of Commerce
High-tech	Dummy variable: it is equal 1 if the start-up is high-tech	Italian Chamber of Commerce
D(Sector$i$)	Set of dummies variables: they are equal 1 if the start-up activity corresponds to the i economic sector	ISTAT, EC
D(Legal Entity$i$)	Set of dummies variables: they are equal 1 if the start-up legal entity corresponds to the i legal type	Italian Chamber of Commerce
	Location characteristics	
Population	Provincial population (log) in the year 2010	ISTAT
Uni-Branch	Dummy variable: it is equal 1 if a university branch of a university located in another province is present in the same province	CINECA

Table 1: continues on the next page

Table 1: continues from previous page

Variable	Definition	Data source
Uni-Number	Provincial number of universities (with the exclusions of branches) located within a province	CINECA
Innovation Intensity	Number of European patents published by the EPO (European Patent Office) per million of inhabitants in the year 2009 (last year available)	ISTAT
Social Capital	Indicator of social capital (provincial share of volunteers and salaried employees in social cooperatives on total employed) in the year 2010	ISTAT
Bad Loans	Indicator of local capital market (provincial share of deteriorated loans on total loans) in the year 2010	ISTAT

Table 1: end from previous page

Human capital spillovers: graduates

Data on graduates are taken from the MIUR (the Ministry of Education, University and Research) database. At present, the Italian university system is made up of 96 legally recognized institutions, of which 66 are state-owned and 30 are not state-owned. The 96 institutions include 77 traditional universities, 11 online universities, 5 institutions of higher education for graduates and postgraduates, and 3 universities for foreigners.[13] For our analysis we focus on 76 institutions, as we do not take into account the online universities and universities for which either data on graduates or results from the VQR are not available. Geographically, these institutions (universities hereafter) are equally distributed among provinces, with few exceptions, most notably the provinces of Rome, Milan and Naples that host 9, 7 and 4 universities, respectively.[14]

The Italian graduation system allows three cycle degrees. The 1st cycle degree (*Laurea*), characterized by both theoretical and applied studies, is equivalent to a bachelor's degree. The 2nd cycle degree (*Laurea Magistrale*), characterized by a strong theoretical part and specialistic studies in a given subject field, provides graduates with advanced education for highly qualified professions in specific sectors, as well as with adequate training for advanced independent research. Finally, postgraduate studies include PhD and second-level university master's degree programs. In our empirical analysis we focus on the *Laurea Magistrale* graduates in 2010.[15]

Descriptive statistics from Table 2 show that the largest share of graduates comes from two scientific areas, "Architecture and Civil Engineering" and "Classics, Philology, Literary Studies, Art History", followed by "Economics and Statistics", "History, Philosophy, Pedagogy and Psychology", and "Law".

Start-up Data

The *Start-up Regulation* Law defines "innovative start-up" as an Italian or European private stock company (such as a joint-stock company, a limited liability company or a cooperative), which is not listed and fulfills the following requirements:

(a) it must hold fiscal residence in Italy;

[13] `http://cercauniversita.cineca.it`

[14] The CINECA database also contains information on the location of university branches.

[15] For robustness purposes, we also used the total number of *Laurea* and *Laurea Magistrale* graduates. Information on PhDs is unavailable.

Table 2: **Composition of graduates by scientific area. Year 2010.**

Discipline	Area	Total	Undergrad	Grad	%Total	% Undergrad	% Grad
Science and Technology	01	23,929	14,656	9,273	8.3	9.1	7.4
Science and Technology	03	6,486	1,654	4,832	2.3	1.0	3.8
Science and Technology	04	49	10	39	0.0	0.0	0.0
Science and Technology	06	33,117	22,780	10,337	11.5	14.1	8.2
Science and Technology	07	5,996	3,074	2,992	2.1	1.9	2.3
Science and Technology	08	51,063	27,609	23,454	17.8	17.1	18.6
Science and Technology	09	32	0.0	32	0.0	0.0	0.0
Humanities	10	47,881	30,674	17,207	15.3	16.6	13.6
Humanities	11	34,183	17,903	16,280	11.9	11.1	12.9
Humanities	12	19,488	3,500	15,988	6.9	2.2	12.7
Social Sciences	13	43,864	26,769	17,095	15.3	16.6	13.6
Social Sciences	14	21,443	12,834	8,599	7.5	7.9	6.8
Total		287,534	161,463	126,071	100	100	100

Source: our calculations on MIUR data. Areas: 1 Mathematics; 3 Chemistry; 4 Earth Sciences; 5 Biology; 6 Medicine; 7 Agricultural and Veterinary Sciences; 8 Architecture and Civil Engineering; 10 Classics, Philology, Literary Studies, Art History; 11 History, Philosophy, Pedagogy and Psychology; 12 Law; 13 Economics and Statistics; 14 Political and Social Sciences.

(b) it shall have existed for no more than 48 months;

(c) its total turnover, starting from the second year of activity, shall not exceed €5m resulting from its last yearly approved balance sheets;

(d) the majority of the corporate capital and voting rights shall be owned by individuals for the first 24 months following its incorporation;

(e) it cannot distribute profits;

(f) its core business consists of innovative products or high-tech services;

(g) it shall not result from a merger, de-merger or transfer of business or a part thereof.

Moreover, innovative start-ups (and certified incubators) must always register with the Chamber of Commerce in a Special Section of the Business Register, and periodically update their status to guarantee information transparency and accessibility. Once registered, an innovative start-up can take advantage of a set of fiscal and financial benefits, and simplified procedures.

The *Start-up Regulation* Law also specifies that a start-up is considered innovative if at least one of the following requirements are met:[16]

(a) the costs allocated to research and development must be equal to or higher than 20% of the higher value between (i) the company's production costs and (ii) the company's production value;

(b) at least one-third of its work force are individuals having a PhD, carrying out a PhD or possessing a degree and having completed a three-year research program at state-owned or private research institutions in Italy or abroad;

[16]For more details see *Executive summary of the new Italian legislation on start-ups*, available at `http://www.sviluppoeconomico.gov.it`.

(c) the start-up is the owner or assignee, or applied for the registration with the relevant authorities, of an industrial property right (i.e., a patent) related to its core business.

As of May 2014, there are 1,978 companies registered in the Special Section of the Business Register.[17] Regarding their geographical distribution, 46% of start-ups are located in the North of Italy, 37% in the Centre and only 17% in the South. Almost 58% of the start-ups are located in five regions (Lombardia, Emilia-Romagna, Lazio, Veneto and Piemonte).

The dataset contains information on the sector in which each start-up operates, according to the ATECO 2007 definition.[18] Manufacturing industries are classified into: High-tech, Medium-high-tech, Medium-low-tech, and Low-tech industries.[19] Similarly, services have been classified into Knowledge Intensive Services (KIS: High tech services; Market services, financial services), Less Knowledge Intensive Services, and Cultural Services.[20]

Table 3 shows the industry distribution of Italian start-ups that also takes into account the latter classification of manufacturing industries and services. 41.21% of start-ups are classified as High-tech manufacturing, while only 27.31% of KIS are High-tech services. Finally, start-ups belonging to the Construction and Cultural services sectors account for about 1% of all start-ups.

Table 3: **Start-up distribution by knowledge-intensive sectors. Years 2012-2014.**

Sector	Number	%
Agriculture, hunting, forestry	5	0.26
High-tech industries	806	41.27
Medium-high-tech industries	42	2.15
Medium-low-tech	59	3.02
Low-tech	79	4.05
High tech services	532	27.24
Market services	215	11.01
Financial services	3	0.15
Less Knowledge Intensive Services	159	8.14
Cultural services	27	1.38
Construction	19	0.97
Not available	7	0.36
Total	**1,953**	100

Source: Our calculations on Italian Chamber of Commerce data.

The *Start-Up Regulation* Law introduced the sub-category of innovative start-ups with social purposes. They differ from ordinary innovative start-ups because the com-

[17] For our analysis we dropped 15 start-ups because they are near to closing, and lost other 10 start-ups because of missing information.

[18] This classification is the national version of the European nomenclature, Nace Rev. 2, published in the Official Journal of 20 December 2006 (Regulation (EC) no. 1893/2006 of the European Parliament and of the Council of 20 December 2006.

[19] See European Commission (2013, p. 25, footnote 32).

[20] See European Commission (2013, p. 21, footnote 20), Istat (2007, p. 458) and Gotsch et al. (2011, p. 13 Table 1.2).

pany's sector of activity is exclusively identified under Law Decree no. 155/2006.[21] The innovative start-ups with social purposes, which are around 3% of the total, are granted a more favorable tax regime.

A share of all start-ups are spin-offs. Data on spin-offs are provided by the Centre for Entrepreneurship and Innovation at the Università Politecnica delle Marche and Netval, the Italian University Network for the Valorization of Research. According to common definitions of academic spin-offs, three types of companies are included in such a category: 1) companies founded by university teachers, researchers or other staff-members; 2) companies founded by students and graduates to commercially exploit the results of the research in which they have been involved at the university; 3) companies founded by outsiders that exploit the results of university research.[22] Up to June 2014, the Netval database has information on 1,021 spin-offs, of which 171 are start-ups (i.e., 8.71% of all start-up firms).

Finally, information allows us to identify start-ups located within an industrial district from those located outside.[23] In contexts characterized by a widespread level of industrialization, like the Italian one, innovation results from complex interactions between different stakeholders and institutions, each with its own competence, resulting in an outcome which is often unpredictable. Therefore, it may be possible that the technology transfer mechanism for firms located within a district is different from that of firms outside of one (Favaretto and Zanfei, 2007). Specifically, Muscio et al. (2012) find that universities' proximity to industrial districts seems to have a positive effect on university-industry collaboration.

Control variables

A group of independent variables controls for the environmental characteristics of the province in which the start-up and the university are located. The province size is measured by the log of the number of inhabitants in 2010. Further, we control for the provincial level of social capital and the intensity of innovation (number of patents) as additional mechanisms that may influence the start-up locational choice and foster the technology transfer process.

Social capital, defined in terms of norms and networks, by connecting people across different organizations and combining information and knowledge flows among firms and external actors within regions, may favor innovation (Laursen et al., 2012).

To the same extent, the presence of patents may generate a trade-off between a static efficiency loss due to higher prices and potential dynamic gains from providing incentives for investment in innovation and fostering technology transfer (Hall and Helmers, 2010).

Finally, we also control for local financial market conditions by means of the provincial rate of deteriorated loans. Indeed, high-tech firms are found to be more likely to be credit-constrained than low-tech ones (Guiso, 1998), thus we might expect that provinces

[21] The sectors are: social assistance, health care, health and social care, education, instruction and training, protection of the environment and the ecosystem, promotion of cultural heritage, social tourism, university and post-graduate education, research and provision of cultural services, training outside school, and operating services of social enterprise services.

[22] `http://www.netval.it` See also the MIUR Decree no.168/2011 for the legal definition of spin-off.

[23] In Italy, an industrial district indicates an agglomeration of small-, medium-sized firms located in a well defined historically determined territory. They are specialized in one or more segments of the productive process and are connected through a complex network of social and economic interrelations.

characterized by worse credit market conditions (i.e: a higher share of bad loans) are a less suitable environment in which to locate innovative firms than provinces in which the share of bad loans is lower. Indeed, because of the high share of bad loans, banks have less free capital to make loans. Further, the high share of bad loans may signal that doing business in those provinces is riskier than in others, thus reducing bank propensity to lend to even riskier firms such as start-ups.

Our final sample, obtained by merging different data sources, contains information on 1,953 start-ups and 76 universities (i.e., 79% of all Italian universities) located in 52 provinces. Variable descriptive statistics are shown in Table 4.

Table 4: **Summary statistics of regression variables**

Variable	**Min**	**Max**	**Mean**	**Median**	**St Dev**	**Obs**
Distance	0.00	137.58	16.90	5.72	21.56	1953
Spillover Mechanism: Human Capital						
Graduate Tot	0.29	197.11	52.21	41.89	40.58	1953
Graduate	0.29	185.37	47.90	37.83	36.88	1953
Graduate ST	0.00	89.19	20.60	13.63	20.62	1953
Graduate HU	0.00	59.94	16.93	12.14	16.36	1953
Graduate SS	0.00	40.62	10.36	9.02	8.96	1953
Spillover mechanism: Research Quality						
Research Quality Tot	0.00	6.02	1.85	1.49	1.55	1953
Research Quality ST	0.00	3.87	1.14	0.96	1.00	1952
Research Quality HU	0.00	1.29	0.42	0.33	0.34	1952
Research Quality SS	0.00	0.86	0.29	0.23	0.22	1952
Spillover mechanism: Third Mission						
Third Mission Tot	0.00	6.11	1.84	1.43	1.62	1953
Collaboration Agreements	0.00	5.97	1.98	1.55	1.72	1953
Patents	0.00	6.32	1.64	0.46	2.02	1953
Incubators	0.00	14.47	2.38	0.00	4.37	1953
Consortia	0.00	8.50	1.65	1.31	1.58	1953
Archeological Sites	0.00	20.13	1.23	0.10	3.45	1953
Museums	0.00	9.07	1.44	0.00	2.60	1953
Other *Third Mission*	0.00	44.30	2.62	0.23	8.84	1953
Spin-offs	0.00	1.00	0.09	0.00	0.28	1953
Firm Characteristics						
Social-oriented	0.00	1.00	0.03	0.00	0.18	1953
High-tech	0.00	1.00	0.19	0.00	0.39	1953
District Area	0.00	1.00	0.10	0.00	0.30	1953
Location Variables						
Uni-Branch	0.00	1.00	0.59	1.00	0.49	1953
Uni-Number	1.00	9.00	2.89	1.00	2.87	1953
Bad Loans	0.66	7.78	2.34	1.92	1.09	1953
Social Capital	1.99	7.99	4.27	4.17	1.10	1953
Innovation Intensity	2.47	221.29	91.34	94.86	60.20	1953
Population	11.76	15.25	13.90	13.81	0.87	1953

Source: MIUR, ANVUR, ISTAT, Italian Chamber of Commerce.

A simple correlation analysis between university spillovers, both in terms of human capital and research quality, and the number of provincial start-ups shows that the correlation coefficients are all significant and positive, with *third-mission* activities showing the strongest relationship with innovative start-ups (Table 5). Specifically, the correlation matrix indicates that patents and collaboration agreements in particular seem to

favor the creation of innovative start-ups. Finally, it is evident that all the *third-mission* activities are complementary to one each other.

Table 5: **Cross-correlation matrix between provincial start-ups and university spillovers**

Var	1	2	3	4	5	6	7	8	9	10	11
1	1.00										
2	0.12*	1.00									
3	0.22*	0.94*	1.00								
4	0.33*	0.78*	0.87*	1.00							
5	0.34*	0.79*	0.76*	0.72*	1.00						
6	0.24*	0.75*	0.85*	0.78*	0.57*	1.00					
7	0.20*	0.52*	0.60*	0.78*	0.40*	0.50*	1.00				
8	0.06*	0.49*	0.56*	0.45*	0.25*	0.53*	0.23*	1.00			
9	0.28*	0.09*	0.16*	0.51*	0.17*	0.19*	0.42*	-0.11*	1.00		
10	0.04	0.46*	0.45*	0.47*	0.31*	0.24*	0.17*	0.14*	-0.03	1.00	
11	0.12*	0.57*	0.57*	0.52*	0.40*	0.42*	0.57*	0.22*	-0.05	0.49*	1.00

Legend: 1 Start-up Number; 2 Graduate; 3 Research Quality Tot; 4 *Third Mission* Tot; 5 Collaboration Agreements; 6 Patents; 7 Incubators; 8 Consortia; 9 Archeological Sites; 10 Museums; 11 Other *Third Mission*.

4 Empirical Models and Discussion of Results

This Section discusses the empirical model we use to test our hypotheses as stated in Section 2, i.e: the locational choice of the innovative start-up firm, measured by its distance from the local university, is particularly affected by university spillovers in terms of human capital, research quality and third mission activities.[24]

Formally, our empirical model assumes that *Distance* is a linear function of Graduate, Research Quality, *Third-Mission* activities, Firm Characteristics, and Locational Characteristics, as follows:

$$\begin{aligned} Distance_{i,j} &= \beta_0 + \beta_1 Graduate_j + \beta_2 ResearchQuality_j + \beta_3 ThirdMission_j \\ &+ \beta_4 FirmCharacteristics_i + \beta_5 LocationalCharacteristics_j + u_{i,j} \end{aligned} \quad (1)$$

where i refers to the firm and j to the university. Finally, $u_{i,j}$ is an i.i.d error term. We expect the coefficients β_1, β_2, and β_3 to be negative.

We estimate model (1) by means of OLS and Quantile regression, and check for possible spatial autocorrelation as discussed in the following Sub-sections.

4.1 University spillovers

OLS results from alternative specifications of model (1), shown in Table 6. Column (1) focuses on the impact of human capital as measured by *Graduate*, research quality and *third-mission* spillovers. In columns (2) and (3) the impact of the number of graduates and research quality is broken down by scientific areas (Science and Technology, Humanities, and Social Sciences). Column (4) shows estimation results of an augmented version of column (3), in which *Third Mission* is also broken down into the *third-mission*

[24]We define 'local' the closest university to the firm, as described in Section 3.

activities. Finally, as a robustness check, column (5) show estimates of the same model specification as in column (1) but with *Graduate* defined as the sum of undergraduates and graduates.

First, as expected the coefficient of human capital, *Graduate*, is negative and statistically significant, meaning that the larger the number of graduates of the closest academic institution, the nearest the firm locates to it (see Table 6, columns (1)). This result holds even when the number of graduates is broken down by scientific areas (see columns (2) to (4)), especially in the Science and Technology, and Social Sciences ones.

These findings also hold when we use the total number of undergraduates and graduates to proxy for human capital, meaning that the number of undergraduates also help to attract innovative start-ups close to academic institutions (see Table 6, columns (5)).

Regarding the role of research quality, the coefficient of the aggregate indicator (*Research Quality Tot* - IRFS2) is positive and statistically significant in columns (1) and (5) of Table 6. It suggests that the location decision of innovative new firms is, on average, independent of the research quality of the closest university. However, this result seems to depend on the type of knowledge, i.e., tacit or codified. Indeed, when *Research Quality Tot* is broken down by scientific area, the estimated coefficient of *Research Quality Tot* is positive or not statistically significant for the Humanities, and Science and Technology areas, for which knowledge is more codified, at the same time it is negative and statistically significant for the Social Sciences area for which knowledge is mostly tacit (see columns (3) and (4)), inducing innovative start-ups to locate closer to universities in order to exploit technology and knowledge spillovers.[25]

The *third-mission* variables do not exhibit significant statistical estimated coefficients, the only exception being the coefficients of *Patents* and *Spin-offs* (see Table 6, column (4)). Overall, these results show that the advantages from collaborating with universities do not diminish with distance and, therefore, proximity to a research institution is not a necessary condition for start-up locational choices. The most interesting result is the positive and statistically significant coefficient of *Patents* that suggests, in the most evident case of codified knowledge, how little weight innovative start-ups assign to being located in proximity to a university. Surprisingly, the coefficient of *Incubators* is not statistically significant, while is is internationally acknowledged that they represent a valid solution to promote innovative start-ups. However, in Italy incubators are still relatively small and highly dependent on public contributions, which could explain why start-ups' locational decisions are not influenced by their presence.[26] As expected, the coefficient of *Spin-offs* is negative and statistically significant: spin-offs are considered one of most important *third-mission* activities carried out by academic institutions and, therefore, they normally locate close to universities.

4.2 Control variables

Innovative start-ups' decision as to where they locate also depends on firm and environmental characteristics, which we need to control for.

Among the group of firm characteristics, the negative estimated coefficient of *Social-oriented* suggests that when the start-ups pursue social purposes they choose to stay closer to academic institutions (see Table 6). This result is consistent with the previous

[25] See Audretsch et al. (2005).

[26] Concerning this point see Auricchio et al. (2014).

one according to which a more efficient transfer of knowledge in Social Sciences areas requires a closer proximity between universities and start-ups. Diversely, the positive estimated coefficient of the *Industrial District* dummy shows that for start-ups belonging to an industrial district the need for closer proximity to universities is less important than for those located outside. Indeed, start-ups may find industrial districts to be alternative sources of knowledge with respect to academic institutions. Thus, even though the evolutive pattern of industrial districts is at a turning point, innovative start-ups are still more attracted by district agglomerations than by clusters based on human capital and university knowledge.[27]

Among the group of environmental characteristics, the number of universities within the same province (*Uni-Number*) and the simultaneous presence of university branches belonging to academic institutions located in a different province (*Uni-Branch*) aim at controlling for metropolitan areas and at capturing cluster and competition effects among universities. Contrary to our expectations the findings show that competition among universities does not favor a closer proximity between start-ups and local universities (see Table 6). Further, provincial *Social Capital* and *Innovation Intensity* exert a significant influence on the locational choice of start-ups, reinforcing firm proximity to academic institutions, and thus acting as complements to the university spillovers.

Finally, the market dimension (proxied by the demographic dimension of the province, *Population*) is an attractive factor for innovative start-ups.

Table 6: **The determinants of new firm location: OLS regressions**

VARIABLES	1	2	3	4	5
	Spillover Mechanism: Human Capital				
Graduate	-0.195***				
	(0.074)				
Graduate ST		-0.186**	-0.114	-0.247**	
		(0.088)	(0.094)	(0.123)	
Graduate HU		0.103	-0.049	-0.259	
		(0.132)	(0.135)	(0.167)	
Graduate SS		-0.614***	-0.445***	-0.323	
		(0.121)	(0.139)	(0.228)	
Graduate Tot					-0.101***
					(0.037)
	Spillover Mechanism: Research Quality				
Research Quality Tot	2.200**	1.219			2.470**
	(1.044)	(1.167)			(1.095)
Research Quality ST			-0.195	0.292	
			(1.675)	(2.527)	
Research Quality HU			26.088***	20.396***	
			(5.807)	(7.148)	
Research Quality SS			-32.396***	-36.139*	
			(10.982)	(18.881)	
	Spillover Mechanism: Third Mission				
Third Mission Tot	0.246	0.446	0.727		0.237
	(0.592)	(0.593)	(0.601)		(0.592)

Table 6: continues on the next page

[27] Muscio et al. (2012).

Table 6: continues from previous page

VARIABLES	1	2	3	4	5
Collaboration Agreements				0.958	
				(0.705)	
Patents				1.501**	
				(0.603)	
Incubators				-0.064	
				(0.162)	
Consortia				-0.079	
				(0.533)	
Archeological Sites				-0.079	
				(0.197)	
Museums				0.439*	
				(0.259)	
Other *Third Mission*				0.380***	
				(0.097)	
Spin-offs	-9.782***	-9.579***	-9.189***	-8.742***	-9.790***
	(1.107)	(1.101)	(1.100)	(1.120)	(1.113)
			Firm Characteristics		
Social-oriented	-9.084***	-9.211***	-8.960***	-8.843***	-9.103***
	(3.235)	(3.226)	(3.224)	(3.282)	(3.240)
High-tech	1.520	1.348	1.148	0.995	1.530
	(1.594)	(1.603)	(1.605)	(1.592)	(1.594)
Industrial District	8.950***	9.138***	8.901***	8.994***	8.925***
	(1.792)	(1.774)	(1.796)	(1.740)	(1.787)
D(Legal Entity$i$)	yes	yes	yes	yes	yes
D(Sector$i$)	yes	yes	yes	yes	yes
			Location characteristics		
Uni-Branch	3.772***	3.526***	4.725***	2.127	3.403***
	(1.065)	(1.060)	(1.157)	(1.449)	(1.060)
Uni-Number	0.809**	0.928***	0.514	0.401	0.765**
	(0.323)	(0.322)	(0.336)	(0.367)	(0.320)
Bad Loans	-0.363	-0.270	-0.614	-0.940	-0.402
	(0.554)	(0.553)	(0.579)	(0.601)	(0.553)
Social Capital	-1.636**	-1.532**	-1.759***	-2.977***	-1.701***
	(0.647)	(0.655)	(0.657)	(0.752)	(0.648)
Innovation Intensity	-0.025**	-0.019	-0.021*	-0.062***	-0.027**
	(0.012)	(0.012)	(0.012)	(0.017)	(0.012)
Population	-9.851***	-10.062***	-8.658***	-7.761***	-9.720***
	(1.030)	(1.046)	(1.135)	(1.201)	(1.038)
Constant	165.522***	167.562***	150.803***	151.805***	164.956***
	(16.822)	(16.930)	(17.541)	(18.594)	(16.885)
Observations	1,953	1,953	1,952	1,952	1,953
R-squared	0.201	0.205	0.210	0.224	0.201

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6: end from previous page

4.3 Robustness checks: quantile regression and spatial autocorrelation

As already noted in Section 3, the endogenous dependent variable *Distance* is highly skewed and, therefore, there may be a weak predictive relationship or no relationship at all between the mean of *Distance* and the exogenous variables of the model. The latter

may, instead, show a stronger predictive relationship with other parts of the distribution of *Distance*, such as the median or other quantiles. A solution in this case is to use quantile regressions that take into account asymmetries in the data and, therefore, allow us to compare how some percentiles of the *Distance* may be more affected by certain university characteristics than other percentiles. Estimates of model (1) by means of quantile regressions are shown in Table 7.[28]

Columns (1) to (3) show estimation results of the regression on the 50th percentile (median) of the *Distance* distribution, while columns (4) to (6) show results of the regression on the 90th percentile. The latter corresponds to a distance of about 50 kilometers between each innovative start-up and the closest university.

Overall results from the median regressions confirm previous findings of Table 6. Thus, university spillovers in the form of human capital and research quality continue to affect locational decisions of innovative start-ups, while the estimated coefficients related to specific *third-mission* activities are mainly positive and statistically significant. However, the coefficient of *Archeological sites* is negative (see Table 7, column (3)). As other studies suggest (Muscio, 2013), the *third-mission* activities, considered jointly with results from applied research, can favor engagement in distant collaboration between universities and innovative start-ups.

Estimates at the 90th percentile of the *Distance* distribution reveal that human capital is one of the most important key factors in determining the proximity of innovative start-ups located within a distance of 50 kilometers to academic institutions (see Table 7, column (4) to (6)). Further, the impact of the research quality on innovative start-up location is still negative in the case of the Social Sciences area, positive for the Humanities, and not statistically significant for the Science and Technology area.

Overall, estimates from quantile regressions reveal an asymmetric impact of university spillovers in determining the proximity of innovative start-ups to academic institutions. This attraction exerted by human capital and research quality is stronger for start-ups located 50 kilometers or more from universities.

For the purpose of robustness, we also test for possible spatial autocorrelation in the data. Spatial autocorrelation, or more generally, spatial dependence, is the situation in which at each location the dependent variable or the error term (or both) are correlated with observations on the dependent variable (i.e.: *spatial lag* autocorrelation) or values for the error term (i.e.: *spatial error* autocorrelation) at other locations. The consequences of ignoring spatial autocorrelation in a regression model, when it is in fact present, lead to inefficient and potentially biased OLS estimates that depend on the form for the alternative hypothesis (Anselin, 1988). Thus, if there is evidence of spatial autocorrelation, one of the underlying assumptions of our analysis may be violated and results may not be valid. The test for the presence of spatial autocorrelation in model 1 is carried out by means of a set of statistics on a 40% random sample of our original dataset. Looking at the p-values of all tests, the null hypotheses of no spatial autocorrelation in the error term or in the lagged dependent variable are not rejected within a distance of 100 kilometers.[29]

[28] Specifically, we re-estimate the model specifications corresponding to columns (1), (2) and (4) in Table 6.

[29] We performed the following tests (p values in parentheses). *Spatial lag* Tests: Lagrange multiplier (0.17); Robust Lagrange multiplier (0.21). *Spatial error* Tests: Moran's I (0.24); Lagrange multiplier (0.53); Robust Lagrange multiplier (0.84).

Table 7: **The determinants of new firm location: Quantile Regressions**

VARIABLES	*50th Percentile*			*90th Percentile*		
	(1)	(2)	(3)	(4)	(5)	(6)
			Spillover Mechanism: Human Capital			
Graduate	-0.074**			-0.385***		
	(0.032)			(0.133)		
Graduate ST		-0.069**	0.023		-0.222	-0.208
		(0.035)	(0.038)		(0.163)	(0.198)
Graduate HU		-0.042	-0.129**		-0.050	-0.629**
		(0.046)	(0.054)		(0.214)	(0.275)
Graduate SS		-0.106*	0.412***		-0.806***	-0.649
		(0.061)	(0.079)		(0.306)	(0.404)
			Spillover Mechanism: Research Quality			
Research Quality Tot	0.512	0.383		4.041**	2.355	
	(0.466)	(0.435)		(1.869)	(1.970)	
Research Quality ST			0.407			1.025
			(0.900)			(4.089)
Research Quality HU			20.653***			41.037***
			(2.787)			(12.835)
Research Quality SS			-59.525***			-74.010**
			(5.892)			(29.147)
			Spillover Mechanism: Third Mission			
Third Mission Tot	0.071	0.073		0.156	0.275	
	(0.236)	(0.210)		(1.015)	(0.986)	
Collaboration Agreements			1.024***			1.533
			(0.210)			(1.034)
Patents			1.020***			2.482***
			(0.193)			(0.957)
Incubators			0.163***			-0.787***
			(0.062)			(0.292)
Consortia			1.043***			-0.957
			(0.171)			(0.855)
Archeological Sites			-0.165***			-0.162
			(0.060)			(0.285)
Museums			0.054			0.722*
			(0.085)			(0.404)
Other *Third Mission*			0.097***			1.141***
			(0.031)			(0.151)
Spin-offs	-3.190***	-3.163***	-3.359***	-15.074***	-16.263***	-9.020***
	(0.615)	(0.548)	(0.530)	(2.831)	(2.747)	(2.583)
			Firm Characteristics			
Social-oriented	-4.586***	-4.635***	-4.145***	-8.878	-11.214*	-6.505
	(1.406)	(1.244)	(1.199)	(5.861)	(5.736)	(5.786)
High-tech	0.510	0.503	0.652	8.412***	6.790**	5.732**
	(0.602)	(0.532)	(0.512)	(2.767)	(2.732)	(2.669)
District	14.722***	14.521***	14.936***	15.300***	14.725***	10.766***
	(0.605)	(0.536)	(0.517)	(2.518)	(2.542)	(2.489)
D(Legal Entity$i$)	yes	yes	yes	yes	yes	yes
D(Sector$i$)	yes	yes	yes	yes	yes	yes
			Location characteristics			

Table 7: continues on the next page

Table 7: continues from previous page

	50th Percentile			*90th Percentile*		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
Uni-Branch	2.308***	2.203***	2.598***	6.984***	6.335***	-1.659
	(0.379)	(0.337)	(0.418)	(1.782)	(1.757)	(2.089)
Uni-Number	1.524***	1.540***	1.180***	0.749	1.257**	0.076
	(0.122)	(0.109)	(0.121)	(0.509)	(0.502)	(0.543)
Bad Loans	-0.568***	-0.584***	-1.864***	0.585	0.785	-0.403
	(0.192)	(0.170)	(0.184)	(0.822)	(0.785)	(0.822)
Social Capital	-2.657***	-2.740***	-4.458***	0.097	0.325	-3.091***
	(0.224)	(0.201)	(0.221)	(0.975)	(0.995)	(1.043)
Innovation Intensity	-0.015***	-0.015***	-0.045***	-0.002	0.005	-0.104***
	(0.004)	(0.004)	(0.005)	(0.019)	(0.019)	(0.023)
Population	-9.372***	-9.409***	-7.892***	-19.965***	-21.263***	-16.326***
	(0.390)	(0.350)	(0.374)	(1.518)	(1.502)	(1.624)
Constant	148.950***	150.113***	143.409***	361.994***	376.530***	349.959***
	(5.775)	(5.137)	(5.380)	(21.054)	(20.689)	(21.215)
Observations	1,953	1,953	1,952	1,953	1,953	1,952
Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1						

Table 7: end from previous page

5 Conclusions

This paper contributes to the understanding of the role of the collaboration between universities and firms. Specifically, it analyzes how locational choices of Italian innovative start-ups are influenced by academic institutions' spillovers. Innovative start-ups are often invoked by the policy makers as one of the tools available to support innovation and, therefore, the strengthening of business competitiveness. Indeed, the new Italian legal framework, the so-called *Start-Up Regulation*, creates incentives that are aimed at removing obstacles and costs for business start-ups; herein incubators are considered one of the keys for stimulating the labour market and the Italian economy. As long as innovative start-ups find the proximity to academic institutions favorable for their own business prospects, the issue of understanding their locational choices is crucial.

Our results show that university spillovers are positively correlated with the creation of innovative start-ups. Furthermore, estimates suggest that the start-ups' locational choice is sensitive to the types of knowledge (tacit or codified) and spillover mechanisms (human capital, spin-offs, patents, collaboration agreements). Specifically, the presence of human capital (number of graduates) has a significant influence on location, and research quality, especially in the Social Sciences area, draws innovative start-ups close to academic institutions. *Third-mission* activities, instead, have a weaker impact on the locational choice of start-ups, with the exception of spin-offs.

Other results show that the some characteristics of the province where the academic institutions are located also favor the the start-ups' locational choice, such as the presence of high levels of social capital and innovation intensity, as well as a large market.

Finally, our findings show that, even for innovative start-ups, industrial districts are still more attractive than clusters of knowledge and human capital close to academic institutions.

Overall results are in favor of policies that support both innovation in regional pro-

ductive systems and academic institutions to foster technology and knowledge transfer by correctly identifying the eligible research fields to fund; it is crucial that this be done and according to their natural vocation and competitiveness levels.

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