THE EFFECTS OF INCUBATION ON ACADEMIC AND NON-ACADEMIC HIGH-TECH START-UPS. EVIDENCE FROM ITALY

Massimo G. Colombo[*], *Evila Piva*[*], *Francesco Rentocchini*[**, +]

[*]Dipartimento di Ingegneria Gestionale Politecnico di Milano

[**] Department of Economics, University of Trento

[+] Institute of Innovation and Knowledge Management (INGENIO), Polytechnic University of Valencia

Abstract. This study aims at empirically investigating whether technology incubators help academic high-tech start-ups to establish collaborations with other organizations, thus increasing the competitiveness of these firms. In doing so, we take into account the specificities of academic high-tech start-ups with respect to their non-academic counterparts. We compare the effects of incubation on academic and non-academic high-tech start-ups through econometric estimates using a large sample of Italian firms. Our findings suggest that incubated academic high-tech start-ups do not enjoy any advantages in establishing collaborations with respect to their non-incubated peers. Conversely, technology incubators do help non-academic high-tech start-ups in establishing collaborations with public research organizations. We thus come to the interesting conclusion that the effects of incubation are moderated by the genetic characteristics of incubated firms.

Keywords: academic start-ups; technology incubators; collaborations; high-tech.

Corresponding author: Evila Piva; Department of Management, Economics and Industrial Engineering, Politecnico di Milano, via Lambruschini 4B, 20156 Milano; email: evila.piva@polimi.it; phone: +39 02 2399 3961; fax: +39 02 2399 2710.

1. Introduction

Since the mid 1990s, European universities and other public research organizations have been increasingly involved in activities aimed at establishing new high-tech firms (OECD, 1998; Wright et al., 2008, ch. 1). The establishment of these firms has been seen by their parent organizations as an opportunity to pursue several objectives: i) commercially exploit the results of academic research, ii) contribute to the development of the areas where these organizations were located, and iii) provide an alternative source of employment for academic researchers (Iacobucci et al., 2011). Despite high expectations, the performance of the high-tech start-ups established by European public research organizations have been disappointing. In particular, these firms tend to remain small (Degroof and Roberts, 2004).

Understanding why the high-tech start-ups created by European public research organizations fail to grow has attracted the interest of the scientific community. Many scholars have, thus, started investigating the terms and conditions that may increase the economic competitiveness and favour the development of these firms (for a review, see Rothaermel et al., 2007).

One possible explanation of the dismal performance of academic high-tech start-ups[1] lies in the genetic characteristics that these firms inherit from their founders (Ensley and Hmieleski, 2005; Colombo and Piva, 2008). Being created by academic personnel with great technical and scientific education and work experience in academic research but limited industry-specific work experience, these firms generally have outstanding technological and scientific competencies, but lack industry-specific and managerial competencies. They also are short of the commercial resources (e.g., brand, sale force, distribution channels) necessary for rapid and effective commercialization of their products and services.

In order to obtain access to these resources and competencies, alliances with other firms could play a crucial role. Indeed, previous studies have highlighted that these arrangements allow high-tech start-ups to fill the resource and competence gaps they suffer from in the early stages of their existence (Pisano, 1991; Eisenhardt and Schoonhoven, 1996; Gans and Stern, 2003). Nevertheless, as the social capital of the founders of academic high-tech start-ups is generally oriented to the public research

[1] Academic high-tech start-ups are defined here as high-tech start-ups created by academics, i.e., (full-time or part-time) personnel of public research organizations and Ph.D. students who were actively involved in academic research immediately before founding the firm (Mustar *et al.*, 2006).

environment, it may prove difficult for these firms to establish collaborations with other firms because of lack of suitable business contacts. In accordance with this view, Colombo and Piva (2012) shows that academic high-tech start-ups are more inclined than non-academic ones to establish technological alliances with and purchase technical services from public research organizations. Conversely, they are not prone to establish alliances with other firms.

In this area, *technology incubators* may play a valuable enabling role. Technology incubators are property-based initiatives which provide young entrepreneurial firms with physical facilities and technical and business services (OECD, 1997), with the aim of promoting firm development (Hackett and Dilts, 2004). In addition to office space they provide newly founded ventures with a set of services including access to infrastructures and facilities, secretarial support, but also more elaborate services, such as financial consultancy, technical and managerial advise, and assistance in business plan development (Grimaldi and Grandi, 2005). Moreover, they may assist new ventures in establishing collaborations with a broad range of actors (Löfsten and Lindelöf, 2005; Rothschild and Darr, 2005; Bergek and Norrman, 2008). In particular, technology incubators may foster both formal agreements and informal interactions between the incubated firms and promote the establishment of linkages between them and academic organizations (Schwartz and Hornych, 2010). Therefore, technology incubators may be regarded as an effective mechanism to help academic high-tech start-ups collaborate with other organizations, thereby effectively contributing to the competitiveness of the former firms. In fact, the location of academic high-tech start-ups in technology incubators is a widespread phenomenon. Notably, incubators have been used by many technology transfer offices to foster the creation of new companies aimed at commercializing the results of academic research (Di Gregorio and Shane, 2003).

The aim of this paper is to investigate empirically whether technology incubators indeed help academic high-tech start-ups to overcome the obstacles they typically encounter in establishing collaborations with other firms. In order to assess the impact of incubation in this domain, we compare the propensity of incubated and non-incubated academic high-tech start-ups to establish collaborations with third parties. We distinguish collaborations with private firms from those with academic organizations. Moreover, we explore the impact of incubation on the establishment of collaborations also for incubated and non-incubated non-academic high-tech start-ups. In this way, we check whether the allegedly positive effect of incubation on firms' collaboration activity depends on whether the incubated firms are academic or non-academic high-tech start-ups.

The results of our econometric analysis on a sample of Italian high-tech start-ups suggest that technology incubators do not manage to foster the collaborative activity of academic high-tech start-ups. Indeed, incubated academic high-tech start-ups do not enjoy any advantage in establishing collaborations with third parties (and notably, with private firms) with respect to their non-incubated peers. This does not mean that technology incubators fail to help high-tech start-ups to establish collaborations. Indeed, our results show that incubated non-academic high-tech start-ups find it easier than their non-incubated counterparts to establish collaborations of commercial and technical nature with public research organizations and to in-source consultancy services from these organizations.

Our analysis is relevant in terms of both theory development and potential policy implications. On the one hand, it contributes to both the literature on academic entrepreneurship and the debate on the effectiveness of technology incubators, as we will extensively discuss in the conclusions. On the other hand, our findings have important implications for officers of both incubators and technology transfer offices and for policy makers in that they highlight the specific challenges that are to be faced to sustain the development of different types of high-tech start-ups.

The paper proceeds as follows. Section 2 describes the data collection procedures and provides some empirical evidence on both academic high-tech start-ups and technology incubators in Italy. Section 3 presents some descriptive statistics on the collaboration activity of the sample firms, specifies the econometric models, introduces the variables used in our empirical analysis, and presents the results of the estimates. Section 4 discusses the main findings, highlights their contribution to the literature, acknowledges the limitations of the study, identifies new avenues for future research, and presents policy implications.

2. Data

This section is aimed at describing the database we use in the empirical analysis and presenting some empirical evidence on Italian academic high-tech start-ups and on the phenomenon of technology incubation in Italy. Specifically, Section 2.1 describes the methodology of construction of our dataset. Section 2.2 illustrates the distributions by industry, location and year of foundation of the academic high-tech start-ups included in our database and compares them to the distributions of non-academic high-tech start-ups. Section 2.3 presents some figures about Italian technology incubators.

2.1. Data collection

To study the impact of incubation on the propensity of academic and non-academic high-tech start-ups to establish collaborations we used a sample of 615 Italian owner-managed high-tech firms. The sample firms were drawn from the 2010 release of the *RITA* (*Research on Entrepreneurship in Advanced Technologies*) *directory* and were representative of the Italian population of young (i.e., less than 25-year-old) high-tech start-ups. They operate in the following manufacturing and service industries: aerospace; robotics and process automation equipment; ICT manufacturing (i.e., computers; electronic components; telecommunication equipment; optical, medical and electronic instruments); biotechnology; pharmaceuticals; chemicals and advanced materials; equipment and components for energy production; multimedia content; Internet services (ISP, e-commerce, web-related services); telecommunication services; software; environmental services; and R&D and engineering services. Developed at Politecnico di Milano by the *RITA Observatory* research team, the RITA directory is the most reliable source of data presently available on Italian high-tech start-ups. As of January 1st, 2009, it stored information on 1,646 firms that were representative of the Italian population of high-tech start-ups by both industry and geographic area. This information included data on firms' characteristics obtained through periodic surveys and interviews with the firms' owner-managers. In particular, respondents were asked whether their firms established commercial and/or technological alliances with other companies and public research organizations. They also indicated whether they purchased R&D and other technical services from these latter organizations and whether they were backed by corporate venture capitalists (CVC). Moreover, the RITA directory included information relating to the educational attainments and prior work experience of each founder classified according to the functional activity (R&D, production, sales, etc.), hierarchical position, and sector of activity of the employer. Relying on this information we were able to distinguish academic and non-academic high-tech start-ups.

2.2. Academic high-tech start-ups in Italy

The 1,646 firms included in the RITA directory as of January 1st, 2009 comprise 244 academic high-tech start-ups. In this section we use information on these firms to provide empirical evidence on Italian academic high-tech start-ups. It is fair to acknowledge that, as no official census exists of Italian academic high-tech start-ups, we cannot be sure that these 244 firms were representative of the population of Italian academic high-tech start-ups. However, being the 1,646 firms included in the RITA directory representative of the Italian population of high-tech start-ups, we are quite confident that also the 244 academic high-tech start-ups were representative of the Italian population of academic high-tech start-ups.

Table I reports the distributions by industry, macroarea of location, and year of foundation of both the 244 academic high-tech start-ups and the remaining 1,402 non-academic high-tech start-ups included in the RITA directory.

[Table I around here]

The table reveals that Italian academic high-tech start-ups mainly operate in the software (23.0% of the 244 firms), biotechnology and pharmaceuticals (18.8%), and ICT manufacturing industries (17.2%). Quite interestingly the distribution of academic high-tech start-ups by industry is significantly different from the distribution of non-academic high-tech start-ups. The former firms are indeed relatively more present in science-based industries such as biotechnology and pharmaceuticals and R&D and engineering services, and in environmental services, while they are less present in Internet services and ICT manufacturing industries.

As to the geographical distribution, academic high-tech start-ups are mainly located in the North-West (33.6%) of Italy and are particularly concentrated in the provinces of Milan (12.7%) and Turin (10.2%). No significant differences exist between academic and non-academic high-tech start-ups as to the distribution across the four geographical macroareas ($\chi^2(3)=4.02$).

As to the year of foundation, 77.9% of the sample academic high-tech start-ups have been established since 2000. The significant increase in the rates of new firms' foundation that was registered after the Nineties may be a consequence of the growing support that Italian public research institutions started providing to the creation and development of academic high-tech start-ups. In the last decade, many universities have indeed promoted measures such as the creation of technology transfer offices or the constitution of university venture capital funds. Quite interestingly, academic high-tech start-ups are on average younger than their non-academic counterparts; the percentage of non-academic high-tech start-ups founded after 2000 is indeed much lower (46.5%).

2.3. Incubation in Italy

In Italy technology incubators can be classified into three groups: incubators within science parks,[2] incubators within Business Innovation Centres (BICs) and university incubators. At the beginning of 2010, in Italy there were 29 science parks affiliated to the national network of scientific and technological parks APSTI, 33 BICs affiliated to the European BIC Network, and 10 university incubators. Table II reports the distributions of these organizations by macroarea of location and year of establishment.

[Table II around here]

Italian technology incubators are mainly situated in most developed northern regions (53.5% of the total). Quite interestingly, the three groups of incubators mentioned above exhibit significant differences as to their geographical distribution. While most science parks and university incubators are located in the North of the country (55.2% and 60%, respectively), the percentage of BICs in this area is lower (48.5%). The higher percentage of BICs in the less developed regions of the Centre and South of Italy is in line with the view according to which such initiatives are instrumental to the restructuring and rejuvenation of disadvantaged regions.

As to the year of foundation, most incubators have been established in the Nineties. However, the three groups of incubators again exhibit different distributions across the three decades considered in Table II. While all Italian university incubators have been founded since 2000, with the only exception of the incubator of Politecnico di Torino, which was established in 1999, only 24% of the science parks and 12% of the BICs were established in the last decade.

[2] We define a "science park" as a property-based initiative which (i) has formal operational links with centers of knowledge creation, such as universities and (public and/or private) research centers, (ii) is designed to encourage the formation and growth of innovative (generally science-based) businesses, and (iii) has a management function which is actively engaged in the transfer of technology and business skills to "customer" organizations (Colombo and Delmastro, 2002).

To provide figures on the firms hosted in Italian technology incubators, we surveyed the websites of the 71 incubators identified in Italy and the websites of the national associations they are members of.[3] Altogether, at the beginning of 2010 Italian incubators hosted more than 1,800 companies with more than 13,000 employees.

3. Empirical analysis

This Section illustrates the empirical analysis. Section 3.1 presents some descriptive statistics on the collaboration activity of the sample firms. In Section 3.2 we specify the econometric models and describe the (dependent and independent) variables included in these models. Section 3.3 illustrates the econometric results.

3.1. Academic high-tech start-ups, incubation and collaboration activity: qualitative evidence

The sample considered here is composed of 615 out of the 1,646 high-tech start-ups included in the RITA directory as of January 1st, 2009. The sample comprises only the firms for which we were able to build a complete dataset relating to the variables of interest. The sample firms included 99 incubated start-ups (16.0% of the sample). 45.4% of the incubated firms were academic start-ups (45 firms). The percentage of academic start-ups out of the 459 non-incubated start-ups was significantly lower: less than 12.4% (57 firms). This evidence indicates that incubation is a much more common phenomenon among academic high-tech start-ups than among their non-academic peers.

[Table III around here]

Table III provides some descriptive statistics on the collaboration activity of the sample firms. The table distinguishes four groups of firms: incubated academic high-tech start-ups, non-incubated academic high-tech start-ups, incubated non-academic high-tech start-ups, and non-incubated non-academic high-tech start-ups.

As to the establishment of alliances with other firms, the share of collaborating firms is systematically greater in the incubated categories than in the corresponding

[3] We considered the following associations: the Italian Association of Scientific and Technological Parks (APSTI), the Italian association of BICs (BIC Italia Net), the Association of the Italian Incubators and Academic Business Plan Competitions (PNICube), and the Italian Network for the Valorisation of University Research (Netval).

non-incubated ones for both academic and non-academic high-tech start-ups. However, none of these differences are found to be statistically significant at conventional confidence levels. Hence, from this preliminary analysis, we conclude that location in a technology incubator seems to have no positive effects on the ability of neither academic nor non-academic high-tech start-ups to establish collaborative relationships with other firms.

However, incubation helps non-academic high-tech start-ups establish collaborations with and purchase consultancy services from public research organisations. The differences are significant at conventional confidence levels. Conversely, no difference emerges as to this type of relationships between incubated and non-incubated high-tech academic start-ups. It is also noteworthy that we do not find any significant difference in the propensity to establish collaborations of the different types between incubated non-academic high-tech start-ups and academic high-tech start-ups, be they incubated or not.[4] This evidence suggests that incubators' ability to promote the establishment of linkages between incubated firms and academic organizations reduces the advantages that academic high-tech start-ups enjoy in this respect.

In Table III we do not distinguish incubated high-tech start-ups by the type of incubator. However, one may wonder whether science parks, BICs and university incubators have different effects on the collaboration activity of the incubated academic and non-academic high-tech start-ups. In Table A.I of the Appendix we report descriptive statistics on the collaboration activity of the sample firms incubated in science parks, BICs and university incubators. The share of collaborating firms does not differ at conventional confidence levels across the three groups of incubators.

In the Appendix we also further investigate the effects of incubation on the collaboration activity of academic high-tech start-ups by considering the composition of firm founding team. In particular, we distinguish the high-tech start-ups founded by academics only and those created by teams including both academics and non-academics. The data reported in Table A.II are in line with those shown in Table III:

[4] For the sake of synthesis these results are not reported in Table III. They are available from the authors upon request.

incubation has no effects on the collaboration activity of any academic high-tech start-ups.

3.2. *Econometric methodology*

We compare the impact of incubation on academic and non-academic high-tech start-ups, by estimating the following Logit models:

$$D_{is} = \alpha_{1s} + \beta_{1s} DAsu\_Inc_i + \beta_{2s} DAsu\_NoInc_i + \beta_{3s} DNoAsu\_Inc_i + \delta_s Z_i + \varepsilon_{is} \quad (1)$$

where D_{is}, with s ranging from 1 to 6, indicates a set of 6 dummy variables, measuring whether firm i established a collaboration of type s (see below). $DAsu\_Inc_i$, $DAsu\_NoInc_i$, and $DNoAsu\_Inc_i$ are the key explanatory variables; Z_i is a vector of firm-specific control variables; and ε_{is} is the error term.

The 6 dependent variables (see Table IV for definitions) indicate the different types of collaborations that might have been established by the focal start-ups with other companies and public research organisations. We first consider the formation of alliances with other firms, and we distinguish between commercial alliances ($DCommAllFirm_i$) and technological alliances ($DTechAllFirm_i$). The same distinction is made for alliances established with public research organizations ($DCommAllResOrg_i$ and $DTechAllResOrg_i$). In addition, we consider CVC-backing ($DCVC_i$) as a special type of collaboration established with firms, and the acquisition of consultancy services from public research organizations ($DConsultResOrg_i$) as a special form of collaboration with academic institutions.

[Table IV around here]

Table IV also provides the definitions of the explanatory variables. The models include three independent dummy variables: $DAsu\_Inc_i$, $DAsu\_NoInc_i$, and $DNoAsu\_Inc_i$. $DAsu\_Inc_i$ and $DNoAsu\_Inc_i$ indicate firms that have been located in a technology incubator. The former variable takes value 1 if the incubated firm i is an academic high-tech start-up, while the latter equals 1 for incubated non-academic high-tech start-ups. $DAsu\_NoInc_i$ takes value 1 if firm i is an academic high-tech start-up that has never been located in a technology incubator. Its inclusion in the model specification allows to highlight the effects of incubation on academic high-tech start-ups by comparing the coefficients of $DAsu\_Inc_i$ with those of $DAsu\_NoInc_i$. Similarly the coefficients of $DNoAsu\_Inc_i$ allow us to assess the impact of incubation on non-academic high-tech start-ups.

The controls include a series of indicators of the human capital characteristics of the firm's founders at the time of firm's foundation. As for education, we distinguish between average university-level education in economic and managerial fields ($EcoEduc_i$) and in scientific and technical fields ($TechEduc_i$). As for work experience, we differentiate the experience gained by firm's founders in the same industry of the start-up by function. We indeed distinguish the average number of years of work experience in R&D, design, engineering, and production departments ($TechWorkExp_i$), and in marketing, sale, and customer care functions ($ComWorkExp_i$). In addition, we consider founders' prior work experience in other industries than the one of the start-up ($OtherWorkExp_i$). We also control for founders' managerial competencies through $DManager_i$. $DManager_i$ is a dummy variable taking value 1 if one or more founders had a managerial position in a medium-large company prior to the establishment of the firm.

The controls also include the number of years elapsed since firm's foundation (Age_i) and its squared value ($SqAge_i$), four geographical dummy variables[5] and four industry dummies.[6] Correlation among the explanatory variables is low overall, thus suggesting the absence of any relevant problems of multicollinearity.

3.3. Results

[Table V around here]

The results of the econometric analysis are illustrated in Table V. Let us start from some preliminary considerations about the differences between academic and non-academic high-tech start-ups in the propensity to establish collaborative relationships with third parties. Both $DAsu\_Inc_i$ and $DAsu\_NoInc_i$ exhibit negative coefficients (significant at 10%) in Model 2 and positive ones (significant at 10% and 5%, respectively) in Model 6. This is in line with Colombo and Piva (2012). Academic high-tech start-ups (be they incubated or not) are relatively less prone to establish technological alliances with other firms, but more likely to acquire consulting services from public research organizations than non-incubated non-

[5] In order to control for economical, historical and cultural differences, Italy's twenty administrative regions were grouped into five macroareas: North-West; North-East; Centre; and South and islands.

[6] We consider four main industries: ICT manufacturing; other high-tech manufacturing; ICT services; and other high-tech services. Other high-tech manufacturing includes aerospace, robotics and process automation equipment, biotechnology, pharmaceuticals, chemicals and advanced materials, and equipment and components for energy production. ICT services include multimedia content, Internet services, telecommunication services, and software. Other high-tech services include environmental services and R&D and engineering services.

academic high-tech start-ups. *$DAsu\_NoInc_i$* exhibits also a negative and (weakly) significant coefficient in Model 1 and a positive and significant (at 1%) coefficient in Model 5. The coefficients of *$DAsu\_Inc_i$* in these regressions have the same signs but are not significant. Hence, non-incubated academic high-tech start-ups are also less prone to establish commercial alliances with other firms and more prone to establish technological alliances with research organizations than their non-academic peers.

In order to assess whether technology incubators help academic high-tech start-ups to establish collaborations with third parties, we have compared the coefficients of *$DAsu\_Inc_i$* and *$DAsu\_NoInc_i$* through the Wald χ^2 tests reported in the last row of Table V. For most dependent variables no statistically significant difference is found between the two coefficients. The only exception is the (weakly) significant difference as to commercial alliances with research organisations. Altogether these results suggest that location in a technology incubator does not contribute to remove the obstacles that academic high-tech start-ups encounter in teaming up with private firms.

Let us now check whether technology incubators are of any help to non-academic high-tech start-ups to establish collaborations with third parties. To do so, we examine the coefficients of *$DNoAsu\_Inc_i$*. *$DNoAsu\_Inc_i$* exhibits positive and significant coefficients in three out of the six models: the exceptions are Models 1 to 3, relating to alliances with other firms and CVC-backing. Our estimates suggest that incubated non-academic high-tech start-ups are more likely than their non-incubated peers to establish both technological alliances with other firms and any type of collaboration with public research organisations. As to this latter type of collaborations, our findings suggest that the likelihood of establishing commercial and technological alliances increases by respectively 9% and 33% for incubated non-academic high-tech start-ups with respect to their non-incubated counterparts, when other regressors are evaluated at their mean, while the likelihood of purchasing consultancy services from these organizations increases by 17%.

For the sake of synthesis we do not discuss here the coefficients of the control variables.

To check the robustness of our results we performed two different tests. First, we checked whether a survivorship bias in data might undermine the empirical analysis on the propensity to establish collaborative relationships with third parties.

To do so, we focused attention on the RITA 2000 sample. We do have exit data for these firms in the 2000-2003 period. Out of the 401 firms composing the sample, 86 exited before 2003. As a direct way to control for a possible survivorship bias, we adapted a typical Heckman two-step procedure commonly used in empirical studies on firm growth dynamics (e.g., Evans, 1987; Dunne and Hughes, 1994) to our specific framework.

In particular, we first estimated a probit model on the exit of firms in the RITA 2000 sample in the 2000–2003 period conditional on survival up to the end of 1999. The independent variables of this selection model include founders' human capital variables ($EcoEduc_i$, $TechEduc_i$, $TechWorkExp_i$, $ComWorkExp_i$, $OtherWorkExp_i$, and $DManager_i$), firm's age in 1999 ($Age1999_i$), two dummy variables aimed at signaling, respectively, the firms that received a venture capital investment by 2000 ($DVC1999_i$) and the academic high-tech start-ups ($DAsu_i$), and industrial and geographical controls. The estimates are shown in the Appendix Table A.III.

Based on these estimates, we could compute the Inverse Mills Ratio of firm exit for 383 out of the 615 sample firms. This ratio was then inserted as a control for survivorship bias in the models presented in Table V. This additional variable controls for the unobserved heterogeneity that affects both a firm's probability of being sampled in following years and its propensity to establish collaborative relationships with third parties, allowing more consistent estimates of the parameters of the models presented in Table V.

The estimates shown in the Appendix Table A.IV indicate that the coefficient of the Inverse Mills Ratio is negative and statistically significant in four models out of six. This points to the presence of unobserved factors that are positively (negatively) correlated with a firm's likelihood of exit and are negatively (positively) correlated with the establishment of technological alliances (with either other firms or public research organizations), CVC-backing and the purchase of consultancy services from public research organizations. Moreover, the inclusion of the Inverse Mills Ratio control determines some changes in the coefficients of the explanatory variables. First, in contrast with the results in Table V, the coefficients of $DAsu\_Inc_i$ and $DAsu\_NoInc_i$ are not significant in Models 1 and 2. In line with Colombo and Piva (2012), we do not find any significant differences between academic and non-academic high-tech start-ups, be they incubated or not, with respect to the propensity to establish alliances with other firms, either of a technological or commercial nature. Second, the results in Table A.IV indicate that academic high-tech start-ups are more likely to be CVC-backed than their non-academic counterparts. This may be a consequence of a greater likelihood of receiving an offer from a CVC investor for academic high-tech start-ups. Indeed, as CVC investments are frequently aimed at opening a "technology window" on a promising new technology (Ernst et al., 2005), the strong scientific and technological competencies of academic high-tech start-ups may make these firms more attractive for CVC investors than non-academic high-tech start-ups. In spite of these differences, the results of the estimates in Table A.IV indicate that location in a technology incubator does not affect the collaboration activity of academic high-tech start-ups. We may thus conclude that our key findings are not affected by survivorship bias.

The second check of robustness is aimed at taking into account possible unobserved heterogeneity. Indeed, there may be unobserved factors (such as the size of founders' network of social contacts) that explain both the probability of being incubated and the probability to establish collaborations. To account for possible unobserved heterogeneity that, if correlated with regressors, may lead to biased estimates of the parameters of interest, we run additional estimates replacing the geographical and industry dummies with five industry- and area-specific control variables (see the Appendix Table A.V for a description). These additional estimates are shown in the Appendix Table A.VI. The coefficients of our independent variables are almost unchanged in terms of significance and sign (with the only exception of the coefficient of $DNoAsu\_Inc_i$ that is not significant in Model 4).

4. Discussion and conclusions

The present study was aimed at understanding whether technology incubators contribute to the competitiveness of academic high-tech start-ups by helping these firms to establish collaborations with third party organizations. In doing so, we also checked whether incubation differently affects the collaboration activity of academic and non-academic high-tech start-ups.

We have analysed and compared the effects of incubation on academic and non-academic high-tech start-ups through the estimates of several Logit models using a sample of Italian high-tech start-ups. The results of the econometric estimates provide several original insights. First, they show that the impact of incubation on the collaboration activity of academic high-tech start-ups is negligible. Quite unsurprisingly, technology incubators do not foster the establishment by this type of firms of collaborations with research organizations. Academic high-tech start-ups find it easier to collaborate with academia than their non-academic peers, irrespective of incubation. As academic founders possess a wider network of social contacts in the public research sector than non-academic founders, academic high-tech start-ups are more embedded within the scientific community (Murray, 2004). Hence, the support eventually offered in this domain by technology incubators is useless. More interestingly, location in a technology incubator does not foster academic high-tech start-ups' collaborations with other firms either. This is a missing opportunity for increasing the competitiveness of academic high-tech start-ups. Indeed, because of their genetic characteristics, and the associated lack of industry-specific technical and commercial competencies, academic high-tech start-ups have great incentives to establish this type of collaborations in order to access and take advantage of the competencies and resources possessed by industrial partners, notably in the commercial sphere. However, in spite of these incentives they find it difficult to engage in collaborations with other firms because they lack suitable social capital. Hence, technology incubators may be a surrogate for academic high-tech start-ups' lack of business contacts, by creating a bridge between these firms and potential industrial partners. However, our findings suggest that in Italy technology incubators have failed to perform this crucial bridging function. They seem to have even reduced the incentives of academic start-ups to obtain CVC-backing, even though the evidence on this issue admittedly is weak.

Second, despite these disappointing results concerning the contribution of technology incubators to academic high-tech start-ups' collaboration activity, our estimates provide evidence of a substantial impact of incubation on the collaboration activity of *non-academic* high-tech start-ups. In line with the studies which found that incubated firms exhibit a higher propensity to collaborate with academic institutions than comparable non-incubated firms (Colombo and Delmastro, 2002; Lindelöf and Löfsten, 2004; Fukugawa, 2006; Yang et al., 2009), we find that technology incubators indeed help non-academic high-tech start-ups in establishing collaborations with public research organizations, thereby providing an effective bridge with the academia. As collaborations with academic institutions allow high-tech start-ups gain access to the most recent scientific knowledge and expertise in specific technological fields, and to tools and machinery not available in-house due to cost reasons, the bridging role performed by technology incubators may clearly have positive effects on the performance of non-academic high-tech start-ups.

This study has a number of limitations that open up interesting avenues for future research. First, although technology incubators may increase the competitiveness of academic high-tech start-ups in several ways, we have restricted our analysis to their contribution to the establishment of collaborations. To have the whole picture of the role of technology incubators in promoting the development of academic entrepreneurship, a more comprehensive analysis of the impact of incubation on academic high-tech start-ups' performance is on order. Second, because of a "small number" problem, we have not considered here the heterogeneity among Italian technology incubators. Further research work is thus needed to understand whether and how incubator-specific characteristics, such as their overall size, the competencies of the incubator staff, the nature of the sponsoring organizations, and the types of services offered, moderate the effects of incubated location on the collaboration activity of incubated firms. Third, all the sample firms are located in a single country with specific institutional characteristics. For instance, in Italy public policies to support the creation and development of technology incubators are quite recent. This clearly influences the contribution of incubators to start-ups' development. Thus, it would be interesting to extend the comparative analysis presented in this paper to other countries to check whether and how national institutional characteristics influence the effects of incubation on academic high-tech start-ups and its differential impact on distinct types of high-tech start-ups.

Notwithstanding the limitations of this study, we think that our findings contribute to both the literature on academic entrepreneurship and the research stream on technology incubators. They also are very informative for the officers of incubators and technology transfer offices, and, more generally, for policy makers.

In terms of contribution to the literature on academic entrepreneurship, our analysis adds to the research stream on new firm creation (Rothaermel et al., 2007). Several studies in this stream have examined the contribution of incubators to new firm creation (see, e.g., Clarysse et al., 2005; Rothaermel and Thursby, 2005a). Here we take a step further by providing insights on the contribution of incubators to firms' collaboration activity and, indirectly, to their competitiveness.

Our paper also adds to the studies that investigated the effectiveness of technology incubators. Many local economic development agencies, governments and other public institutions have looked at incubators as a policy instrument for enhancing the local economic and technological development and have provided resources to support incubating initiatives (OECD, 1997; European Commission, 2002). As a consequence, since the Eighties several incubators have been created. After a period of euphoria about incubating initiatives, doubts were raised about their effectiveness in contributing to economic development (Autio and Klofsten, 1998; Sherman, 1999). A growing number of scholars have thus started investigating the impact of incubation at the firm level. The evidence provided by these studies is mixed (see, e.g., Siegel et al., 2003; Rothaermel and Thursby, 2005b; Squicciarini, 2008; 2009. See Colombo and Delmastro 2002 for a review of earlier studies), suggesting that technology incubators' effectiveness possibly depends on their own characteristics, those of the geographical area where they are located, and the characteristics of incubated firms. Moreover, there are still important gaps in our understanding of the mechanisms that link incubation and firm performance. In this perspective, this paper makes two important contribution to this literature by showing that i) technology incubators do influence the collaboration activity of incubated firms and ii) the effects of incubation in this domain differ according to the different types of high-tech start-ups (namely, academic versus non-academic).

This study has also interesting policy implications. Our findings highlight a key weakness of Italian technology incubators: they are not very effective in helping academic high-tech start-ups to establish collaborative relationships with other firms. Since 2000 the Italian government has subsidised the creation of several technology incubators by Italian universities with the aim of supporting the establishment and development of newly created firms. Most firms located in these incubators indeed are academic high-tech start-ups. The lack of support offered by technology incubators to the collaborative activity of this type of firms highlighted by our study points to a serious weakness of these initiatives. In order to overcome such a weakness, the officers of technology incubators should enlarge their network of contacts with firms and create more opportunities of interaction between incubated start-ups and non-incubated firms. However, officers of technology incubators and policy makers should be aware that, because of the genetic characteristics of academic high-tech start-ups, these firms that are naturally prone to partner with research organizations, encounter serious difficulties in collaborating with private firms (e.g., due to differences in objectives, language and cognitive frames). In fact, incubation showed a more positive impact on the ability of non-academic high-tech start-ups to establish alliances with other firms, even though this positive effect was confined to technological alliances and was of small magnitude. Whether the difficulties experienced by academic high-tech start-ups make it impossible for technology incubators to foster the collaborative links between incubated academic high-tech start-ups and other private firms is open to debate. Conversely, our findings indicate that another important mission of technology incubators is more likely to prove successful. Italian technology incubators have been able to create an effective bridge between non-academic high-tech start-ups and public research organizations. This is an important contribution to the development of these firms that incubators' officers should duly take into account when deciding about applications by non-academic high-tech start-ups. Our study clearly indicates that discrimination against application from this type of firms would make technology incubators far less successful.

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Table I: Descriptive statistics on Italian high-tech start-ups.

	Academic high-tech start-ups		**Non-academic high-tech start-ups**	
	No.	***%***	***No.***	***%***
Industry				
Aerospace	6	2.5	26	1.8
Robotics and process automation equipment	17	7.0	124	8.8
ICT manufacturing	42	17.2	370	26.4
Biotechnology, pharmaceuticals, chemicals and advanced materials	46	18.8	63	4.5
Equipment and components for energy production	5	2.0	19	1.4
Multimedia content	2	0.8	25	1.8
Internet services	25	10.2	327	23.3
Telecommunication services	7	2.9	36	2.6
Software	56	23.0	363	25.9
Environmental services	23	9.4	16	1.1
R&D and engineering services	15	6.2	33	2.4
Total	***244***	***100.0***	***1,402***	***100.0***
Macroarea of location				
North-West	82	33.6	566	40.4
North-East	61	25.0	311	22.2
Centre	50	20.5	256	18.3
South and Islands	51	20.9	269	19.2
Total	***244***	***100.0***	***1,402***	***100.0***
Year of foundation				
1984-1989	7	2.9	190	13.6
1990-1994	15	6.2	199	14.2
1995-1999	32	13.1	361	25.8
2000-2004	95	38.9	387	27.6
2005-2008	95	38.9	265	18.9
Total	***244***	***100.0***	***1,402***	***100.0***

Table II: Descriptive statistics on Italian technology incubators.

	No.	*%*
Macroarea of location		
North-West	22	31.0
North-East	16	22.5
Centre	15	21.1
South and Islands	18	25.3
Total	***71***	***100.0***
Year of foundation		
1980-1989	13	18.3
1990-1999	38	53.5
2000-2009	20	28.2
Total	***71***	***100.0***

Table III: Descriptive statistics on the collaborations established by the sample high-tech start-ups.

	Academic high-tech start-ups			Non-academic high-tech start-ups		
	***Incubated* (N=45)**	***Non-incubated* (N=57)**	***χ^2 test***	***Incubated* (N=54)**	***Non-incubated* (N=459)**	***χ^2 test***
Percentage of high-tech start-ups that have established alliances with other firms	55.6%	49.2%	0.42	61.1%	51.0%	1.99
-commercial alliances	46.7%	36.8%	1.00	53.7%	43.6%	2.00
-technological alliances	26.7%	22.8%	0.20	40.7%	29.8%	2.68
Percentage of high-tech start-ups that have established alliances with public research organizations	44.4%	50.9%	0.42	51.9%	20.7%	25.73***
-commercial alliances	11.1%	19.3%	1.27	18.5%	7.6%	7.16***
-technological alliances	40.0%	45.6%	0.32	50.0%	17.2%	31.69***
Percentage of high-tech start-ups that have acquired consultancy services from public research organizations	35.6%	31.6%	0.18	29.6%	12.0%	12.62***
Percentage of high-tech start-ups that have obtained equity financing from a corporate venture capitalist	6.7%	12.3%	0.90	3.7%	5.9%	0.43

Legend: *Significance level greater than 10%; **significance level greater than 5%; ***significance level greater than 1%.

Table IV: Definition of the variables included in the econometric models.

Variable	Description
Dependent variables	
DCommAllFirm$_i$	One for firms that have established one or more commercial alliances with other firms, zero otherwise.
DTechAllFirm$_i$	One for firms that have established one or more technological alliances with other firms, zero otherwise.
DCVC$_i$	One for firms that have obtained external equity financing from a corporate venture capitalist, zero otherwise.
DCommAllResOrg$_i$	One for firms that have established one or more commercial alliances with public research organizations, zero otherwise.
DTechAllResOrg$_i$	One for firms that have established one or more technological alliances with public research organizations, zero otherwise.
DConsultResOrg$_i$	One for firms that have acquired consultancy services from public research organizations, zero otherwise.
Independent variables	
DAsu_Inc$_i$	One for academic high-tech start-ups that have been located in a technology incubator, zero otherwise.
DAsu_NoInc$_i$	One for academic high-tech start-ups that have *never* been located in a technology incubator, zero otherwise.
DNoAsu_Inc$_i$	One for non-academic high-tech start-ups that have been located in a technology incubator, zero otherwise.
Controls	
EcoEduc$_i$	Average number of years of economic and/or managerial education of founders at university level.
TechEduc$_i$	Average number of years of scientific and/or technical education of founders at university level.
TechWorkExp$_i$	Average number of years of technical work experience of founders in the same sector of the start-up before firm’s foundation.
ComWorkExp$_i$	Average number of years of commercial work experience of founders in the same sector of the start-up before firm’s foundation.
OtherWorkExp$_i$	Average number of years of work experience of founders in other sectors than the one of the start-up before firm's foundation.
DManager$_i$	One for firms with one or more founders with a prior management position in a company with more than 100 employees.
Age$_i$	Number of years since firm’s foundation.
SqAge$_i$	Squared value of the number of years since firm’s foundation.

Table V: Results of the econometric estimates of the Logit models.

		Model 1 *DCommAllFirm*	Model 2 *DTechAllFirm*	Model 3 *DCVC*	Model 4 *DCommAllResOrg*	Model 5 *DTechAllResOrg*	Model 6 *DConsultResOrg*
α_0	*Constant*	-1.113***	-1.371***	-4.508***	-2.720***	-3.245***	-3.437***
		(0.420)	(0.470)	(0.715)	(0.644)	(0.541)	(0.669)
α_1	$DAsu\_Inc_i$	-0.180	-0.726*	0.179	-0.658	0.563	0.874*
		(0.387)	(0.415)	(0.806)	(0.643)	(0.433)	(0.449)
α_2	$DAsu\_NoInc_i$	-0.538*	-0.698*	0.699	0.428	1.091***	0.905**
		(0.325)	(0.381)	(0.525)	(0.464)	(0.345)	(0.370)
α_3	$DNoAsu\_Inc_i$	0.306	0.307	-0.493	0.998**	1.533***	1.089***
		(0.309)	(0.302)	(0.757)	(0.408)	(0.328)	(0.350)
α_4	$EcoEduc_i$	0.065	0.155	0.344**	0.216	-0.007	0.220
		(0.107)	(0.110)	(0.171)	(0.150)	(0.131)	(0.149)
α_5	$TechEduc_i$	0.086**	0.115***	0.152**	0.210***	0.216***	0.224***
		(0.042)	(0.044)	(0.072)	(0.068)	(0.051)	(0.055)
α_6	$TechWorkExp_i$	0.001	0.046**	0.055*	-0.193**	-0.017	-0.011
		(0.020)	(0.021)	(0.031)	(0.096)	(0.026)	(0.030)
α_7	$ComWorkExp_i$	0.048	0.038	0.016	0.015	0.066**	0.038
		(0.032)	(0.029)	(0.054)	(0.040)	(0.028)	(0.033)
α_8	$OtherWorkExp_i$	-0.014	-0.008	0.014	0.013	0.015	0.029**
		(0.012)	(0.013)	(0.021)	(0.017)	(0.014)	(0.014)
α_9	$DManager_i$	-0.091	0.072	0.302	0.292	0.225	0.551**
		(0.197)	(0.212)	(0.378)	(0.306)	(0.234)	(0.253)
α_{10}	Age_i	0.082	-0.028	0.021	-0.071	0.129**	0.045
		(0.053)	(0.058)	(0.103)	(0.081)	(0.062)	(0.074)
α_{11}	$SqAge_i$	-0.004**	0.001	0.000	0.002	-0.005*	-0.001
		(0.002)	(0.002)	(0.004)	(0.003)	(0.002)	(0.003)
Industry dummies		yes	yes	yes	yes	Yes	yes
Geographical dummies		yes	yes	yes	yes	Yes	yes
χ^2		39.119(17)***	37.452(17)***	24.978(17)***	35.399(17)***	84.269(17)***	64.544(17)***
No. observations		615	615	615	615	615	615
Log-likelihood		-401.118	-356.673	-137.974	-177.912	-296.193	-246.041

McFadden's Pseudo-R^2	0.049	0.050	0.050	0.105	0.133	0.125
Wald χ^2 test: $\alpha_1 = \alpha_2$	0.65 (1)	0.00 (1)	0.43 (1)	2.72 (1)*	1.26 (1)	0.00 (1)

Legend: *Significance level greater than 10%; **significance level greater than 5%; ***significance level greater than 1%. Robust standard errors and number of restrictions are in parentheses. For the sake of synthesis, estimated coefficients of industry and geographic area dummies are not reported.

APPENDIX

Table A.I: Descriptive statistics on the collaborations established by the sample high-tech start-ups incubated in science parks, BICs, and university incubators.

	Academic high-tech start-ups				**Non-academic high-tech start-ups**			
	***Incubated in science parks* (N=11)**	***Incubated in BICs* (N=4)**	***Incubated in universities* (N=29)**	***Fisher exact test***	***Incubated in science parks* (N=15)**	***Incubated in BICs* (N=22)**	***Incubated in universities* (N=6)**	***Fisher exact test***
Percentage of high-tech start-ups that have established alliances with other firms	54.6%	25.0%	62.1%	0.40	68.2%	53.3%	66.7%	0.69
-commercial alliances	54.6%	25.0%	48.3%	0.72	63.6%	46.3%	50.0%	0.60
-technological alliances	27.3%	25.0%	27.6%	1.00	45.4%	26.3%	50.0%	0.48
Percentage of high-tech start-ups that have established alliances with public research organizations	45.4%	25%	44.8%	0.8	50%	60%	66.7%	0.76
-commercial alliances	9.1%	0.0%	10.3%	1.00	27.3%	13.3%	33.3%	0.54
-technological alliances	45.4%	25.0%	38.0%	0.80	50.0%	53.3%	66.7%	0.84
Percentage of high-tech start-ups that have acquired consultancy services from public research organizations	27.3%	25.0%	38.0%	0.88	40.9%	20.0%	33.3%	0.44
Percentage of high-tech start-ups that have obtained equity financing from a corporate venture capitalist	27.3%	0.0%	0.0%	0.02	4.6%	6.7%	0.0%	1.00

Legend: *Significance level greater than 10%; **significance level greater than 5%; ***significance level greater than 1%.

Table A.II: Descriptive statistics on the collaborations established by the sample academic high-tech start-ups by type of founders.

	Academic high-tech start-ups with a founding team composed by academics only			**Academic high-tech start-ups founded by both academics and non-academics**		
	***Incubated* (N=25)**	***Non-incubated* (N=17)**	***Fisher exact test***	***Incubated* (N=19)**	***Non-incubated* (N=40)**	***Fisher exact test***
Percentage of high-tech start-ups that have established alliances with other firms	60.0%	41.2%	0.35	47.4%	52.5%	0.79
-commercial alliances	44.0%	29.4%	0.52	47.4%	40.0%	0.78
-technological alliances	20.0%	17.6%	1.00	36.8%	25.0%	0.37
Percentage of high-tech start-ups that have established alliances with public research organizations	40%	58.8%	0.35	52.6%	47.5%	0.78
-commercial alliances	16.0%	23.5%	0.69	5.3%	17.5%	0.42
-technological alliances	36.0%	52.9%	0.35	47.4%	42.5%	0.78
Percentage of high-tech start-ups that have acquired consultancy services from public research organizations	48.0%	47.1%	1.00	21.0%	25.0%	1.00
Percentage of high-tech start-ups that have obtained equity financing from a corporate venture capitalist	0.0%	17.6%	0.06	15.8%	10.0%	0.67

Legend: *Significance level greater than 10%; **significance level greater than 5%; ***significance level greater than 1%.

Table A.III: Determinants of firm inclusion in our sample: a probit model.

		Exit
α_0	*Constant*	-1.178**
		(0.485)
α_1	$EcoEduc_i$	0.175**
		(0.074)
α_2	$TechEduc_i$	-0.002
		(0.041)
α_3	$TechWorkExp_i$	0.011
		(0.023)
α_4	$ComWorkExp_i$	0.038
		(0.027)
α_5	$OtherWorkExp_i$	0.025**
		(0.010)
α_6	$DManager_i$	0.007
		(0.180)
α_7	$DAsu_i$	-0.214
		(0.370)
α_8	$Age1999_i$	-0.013
		(0.017)
α_9	$DVC1999_i$	0.444*
		(0.269)
Industry dummies		yes
Geographical dummies		yes
χ^2		26.565(14)**
No. observations		328.000
Log-likelihood		-167.870
McFadden's Pseudo-R^2		0.067

Legend: *Significance level greater than 10%; **significance level greater than 5%; ***significance level greater than 1%. Standard errors and number of restrictions are in parentheses. For the sake of synthesis, estimated coefficients of industry and geographic area dummies are not reported.

Table A.IV: Test for survivorship bias: Logit models.

	Model 1 *DCommAllFirm*	Model 2 *DTechAllFirm*	Model 3 *DCVC*	Model 4 *DCommAllResOrg*	Model 5 *DTechAllResOrg*	Model 6 *DConsultResOrg*
α_0 *Constant*	-0.242	1.709*	11.818***	-0.962	0.410	0.267
	(0.850)	(0.962)	(2.582)	(1.082)	(0.980)	(0.971)
α_1 $DAsu\_Inc_i$	-	0.814	-	-	0.093	-
		(0.681)			(0.667)	
α_2 $DAsu\_NoInc_i$	-0.224	0.124	6.179***	0.224	1.217***	1.113***
	(0.341)	(0.369)	(1.026)	(0.432)	(0.360)	(0.356)
α_3 $DNoAsu\_Inc_i$	0.141	0.154	-1.835**	0.847***	1.081***	0.566**
	(0.262)	(0.262)	(0.877)	(0.310)	(0.260)	(0.256)
α_4 $EcoEduc_i$	0.032	-0.124	-3.287***	0.194	-0.062	0.108
	(0.131)	(0.126)	(0.448)	(0.143)	(0.132)	(0.134)
α_5 $TechEduc_i$	0.093***	0.139***	0.838***	0.099*	0.168***	0.166***
	(0.036)	(0.036)	(0.149)	(0.052)	(0.039)	(0.038)
α_6 $TechWorkExp_i$	0.004	0.023	0.086*	-0.162***	0.000	-0.002
	(0.017)	(0.018)	(0.050)	(0.053)	(0.019)	(0.022)
α_7 $ComWorkExp_i$	0.033	-0.025	-0.353***	0.023	0.008	-0.011
	(0.031)	(0.032)	(0.093)	(0.041)	(0.033)	(0.031)
α_8 $OtherWorkExp_i$	-0.019	-0.048***	-0.159***	0.008	-0.013	-0.005
	(0.014)	(0.016)	(0.056)	(0.020)	(0.017)	(0.017)
α_9 $DManager_i$	-0.070	-0.039	-2.715***	0.060	0.001	0.262
	(0.167)	(0.177)	(0.816)	(0.244)	(0.189)	(0.189)
α_{10} Age_i	-0.048	-0.106**	0.025	-0.210***	-0.057	-0.096*
	(0.049)	(0.053)	(0.129)	(0.066)	(0.055)	(0.058)
α_{11} $SqAge_i$	0.001	0.004**	0.004	0.006***	0.002	0.003*
	(0.002)	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)
α_{12} $MillsExit_i$	-0.043	-1.181**	-13.180***	0.413	-1.017*	-0.982*
	(0.456)	(0.513)	(1.802)	(0.567)	(0.525)	(0.507)
Industry dummies	yes	yes	yes	yes	yes	yes
Geographical dummies	yes	yes	yes	yes	yes	yes
$\chi 2$	50.664(17)***	43.928(18)***	84.550(16)***	48.753(17)***	78.265(18)***	66.189(16)***
No. Observations	383	387	378	383	387	378

Log-likelihood	-234.183	-211.356	-15.489	-92.997	-178.030	-148.212
McFadden's Pseudo-R^2	0.102	0.092	0.741	0.221	0.191	0.168
Wald χ^2 test: $\alpha_1 = \alpha_2$	-	1.06 (1)	-	-	2.96 (1)*	-

Legend: *Significance level greater than 10%; **significance level greater than 5%; ***significance level greater than 1%. Robust standard errors and number of restrictions are in parentheses. For the sake of synthesis, estimated coefficients of industry and geographic area dummies are not reported.

Table A.V: Definition of the additional control variables included in the econometric models.

Variable	Description
$Competition_i$	Mean value of the normalised answers of RITA firms' owner-managers to questions concerning the degree of competition in the firm's sector of activity.
$TechnoOpportunities_i$	Ratio of the number of RITA firms that introduced radically innovative products or services compared to the offer of the industry to the total number of RITA firms in the industry.
$Appropriability_i$	Mean value of the answers of RITA firms' owner-managers to questions concerning the appropriability of technology in the firm's sector of activity measured through a Likert scale from 1 (weak appropriability) to 6 (strong appropriability).
$Infrastructures_i$	Value of the index measuring regional infrastructures in 1992 (mean value among Italian regions=100).
$HighTechIntensity_i$	Number of high-tech firms per thousand residents in the province where the focal start-up is located (source: ISTAT).

Table A.VI: Test for unobserved heterogeneity: Logit models.

		Model 1 *DCommAllFirm*	**Model 2** *DTechAllFirm*	**Model 3** *DCVC*	**Model 4** *DCommAllResOrg*	**Model 5** *DTechAllResOrg*	**Model 6** *DConsultResOrg*
α_0	*Constant*	8.956***	2.719	7.073	1.582	-2.438	-7.356*
		(2.923)	(3.098)	(7.113)	(5.069)	(3.512)	(4.152)
α_1	$DAsu\_Inc_i$	-0.188	-0.887*	0.796	-0.709	0.332	0.858*
		(0.449)	(0.498)	(0.794)	(0.632)	(0.512)	(0.492)
α_2	$DAsu\_NoInc_i$	-0.822**	-1.117**	0.848	-0.140	0.988**	0.899**
		(0.346)	(0.456)	(0.621)	(0.525)	(0.397)	(0.410)
α_3	$DNoAsu\_Inc_i$	0.386	0.290	-0.350	0.613	1.453***	0.933**
		(0.329)	(0.323)	(0.693)	(0.426)	(0.343)	(0.382)
α_4	$EcoEduc_i$	0.032	0.133	0.266	0.327**	-0.006	0.279**
		(0.112)	(0.118)	(0.183)	(0.155)	(0.139)	(0.142)
α_5	$TechEduc_i$	0.092**	0.103**	0.091	0.254***	0.212***	0.205***
		(0.044)	(0.046)	(0.083)	(0.069)	(0.054)	(0.059)
α_6	$TechWorkExp_i$	-0.005	0.034	0.017	-0.186*	-0.032	-0.028
		(0.020)	(0.022)	(0.038)	(0.099)	(0.028)	(0.034)
α_7	$ComWorkExp_i$	0.038	0.026	-0.011	0.006	0.061**	0.034
		(0.034)	(0.029)	(0.062)	(0.039)	(0.028)	(0.034)
α_8	$OtherWorkExp_i$	-0.023*	-0.013	0.018	0.010	0.007	0.008
		(0.013)	(0.014)	(0.022)	(0.018)	(0.016)	(0.016)
α_9	$DManager_i$	0.000	0.059	0.544	0.055	0.088	0.330
		(0.209)	(0.222)	(0.376)	(0.340)	(0.260)	(0.286)
α_{10}	Age_i	0.095*	-0.067	0.111	-0.127	0.133**	0.051
		(0.057)	(0.060)	(0.112)	(0.083)	(0.066)	(0.078)
α_{11}	$SqAge_i$	-0.005**	0.002	-0.003	0.004	-0.005*	-0.001
		(0.002)	(0.002)	(0.004)	(0.003)	(0.003)	(0.003)
α_{12}	$Competition_i$	-0.838*	-0.477	-1.520	-0.960	-1.062*	-0.783
		(0.433)	(0.476)	(1.280)	(0.794)	(0.549)	(0.612)
α_{13}	$TechnoOpportunities_i$	-0.090	-0.016	-0.075	-0.409	0.210	0.198
		(0.238)	(0.268)	(0.393)	(0.400)	(0.268)	(0.280)
α_{14}	$Appropriability_i$	-1.993***	-0.682	-3.111**	-0.755	-0.037	0.926
		(0.760)	(0.808)	(1.554)	(1.364)	(0.902)	(1.041)
α_{15}	$Infrastructures_i$	-0.012***	-0.005	0.014	0.011	0.001	0.005

	(0.004)	(0.005)	(0.010)	(0.007)	(0.005)	(0.005)
α_{16} *HighTechIntensity*$_i$	4.108	-0.258	-5.012	-9.972*	-12.893***	-11.151**
	(3.511)	(3.685)	(7.869)	(5.272)	(4.475)	(4.994)
$\chi2$	40.394(16)***	24.947(16)***	24.192(16)***	43.203(16)***	72.008(16)***	51.176(16)***
No. Observations	551	551	551	551	551	551
Log-likelihood	-353.897	-319.875	-118.450	-156.997	-261.558	-213.195
McFadden's Pseudo-R^2	0.065	0.042	0.072	0.122	0.144	0.125
Wald χ^2 test: $\alpha_1 = \alpha_2$	1.57 (1)	0.15 (1)	0.00 (1)	0.70 (1)	1.27 (1)	0.01 (1)

Legend: *Significance level greater than 10%; **significance level greater than 5%; ***significance level greater than 1%. Robust standard errors and number of restrictions are in parentheses.