Bridges over troubled water: incubators and start-ups' alliances

Abstract

Innovative start-ups are important drivers for economic development. However, they often suffer from several market imperfections and lack the necessary resources to flourish. Incubators are an important policy mechanism for nurturing the creation and growth of successful entrepreneurial ventures. Specifically, we argue that incubators act as an effective tool in filling start-ups' social capital and in conferring them more legitimacy, so as to ease start-ups' probability to stipulate alliances with key third parties. In this respect, we also theorize that incubators are heterogeneous and these helping functions may vary with their inherent characteristics. We propose that the supposed 'bridging effect' towards start-ups' alliances could depend on the size of the incubator, its affiliation, and the type of alliance (R&D vs. commercial). The hypotheses are tested through a dataset of 1,752 Italian young innovative companies. Results suggest that incubatees are significantly more likely to stipulate alliances with third parties. This bridging role is found not to depend so much on the size of the incubator; conversely, it appears highly contingent on specific matches between the institutional affiliation of the incubator and the type of alliance.

Keywords: start-ups; incubators; R&D alliances; commercial alliances; innovation policy.

1. Introduction

The role that innovative start-ups play for ensuring higher performance in modern economic systems is well-understood (Aghion and Howitt, 1992; 2005; Baumol and Strom, 2007). At the same time, start-ups may be subject to a number of market failures that may severely hamper their flourishing (Peneder, 2008; Grilli, 2014; Audretsch et al., 2020), thus motivating a quest for policy intervention (e.g. Lerner, 2002; Holtz-Eakin and Rosen, 2003; Economidou et al., 2018; Sanders et al., 2020). While the quiver of entrepreneurship policy abounds of possible mechanisms implemented with the aim of stimulating the creation and development of innovative start-ups (see the recent surveys by Audretsch et al., 2020 and Sanders et al., 2020), the *incubator* has historically been one of the most popular instrument. Originated in the United States in the 1950s and spread over Europe in 1970s and 1980s (see Bruneel et al., 2012; Mian et al., 2016), the "business incubator is a shared office space facility that seeks to provide its incubatees with a strategic, value-adding intervention system of monitoring and business assistance" (Hackett and Dilts, 2004, p.57). Throughout the years, this institution has been largely scrutinized so as to investigate its effectiveness as a policy tool (see Mian et al., 2016 for a survey). The quantitative empirical literature investigating the ability of incubators to nurture virtuous entrepreneurial dynamics in innovative sectors has largely relied on a comparison of performance between incubatees and non-incubated ventures, controlling for several possible contextual confounding factors (e.g. Colombo and Delmastro, 2002; Siegel et al., 2003; Stokan et al., 2015; Lukeš et al., 2019). All in all, and taking a global view, the evidence produced is rather fragmented and mixed (e.g. Amezcua et al., 2013; Schwartz, 2013) but generally pointing to a positive impact, possibly depending on not-yet fully-identified contextual factors (Amezcua et al., 2013; Eveleens et al., 2017; Blank, 2021).

In particular, analyses of the chain antecedents of incubatees performance are still lacking. In this domain, the possibility that incubators can help incubatees establish formal alliances with third parties has never been deeply investigated in the literature by the means of large quantitative analyses (see Colombo et al., 2012 for a partial exception focused on academic start-ups). This is surprising for at least two reasons. First, the literature identifies the ability of innovative start-ups to establish (e.g. Stuart, 2000; Hsu, 2006; Lindsey, 2003; 2008) and possibly maintain (Hohberger et al., 2020) alliances with other entities as one of the most crucial factors for their success in markets. As a matter of fact, innovative start-ups have limited access to the pool of resources (whatever their nature) that have to be often combined in order to produce value (Teece, 1986; Mowery et al., 1996; Colombo et al., 2006; Barrett and Tsekouras, 2022). For instance, start-ups' knowledge and skills should often complement those provided by other actors in the ecosystem in order to generate innovation; likewise their products and services usually lack adequate brand endorsement and have to access well-established distribution channels to be profitably launched in the market. Second, we are now in the era of "networked incubators" (e.g. Bøllingtoft and Ulhøi, 2005), where a key function of this new concept of incubator is to increase and enhance the social capital that incubatees may rely upon for their nascent entrepreneurial activities. However, as emphasized among others by Busch and Barkema (2022, p. 887), our knowledge of the role of incubators in facilitating networking capabilities for incubatees is still "severely limited" (see also Eveleens et al., 2017 for the same conclusion).

This study recognizes this important gap in the literature and represents a first attempt to fill it. We focus on a fundamental dimension for the life of a start-up, namely its alliance activity (e.g. Teece, 1986; Gans and Stern, 2003; Colombo et al., 2006) and argue that incubation has a positive effect on the likelihood of incubatees establishing alliances with third-party organizations (e.g., other firms, universities, etc.), but that this positive effect may also be contingent on the specific characteristics of incubators. In particular, we claim that in order to improve their chances to attract external partners, start-ups need both to enlarge their network horizon, i.e. increasing their social capital, and to be legitimate players in the entrepreneurial ecosystem. Incubators can provide a wider network horizon, can legitimate their tenants, but these functions may also strongly depend on their characteristics (Barbero et al., 2012; Klofsten et al., 2020). In other words, incubators are not all the same, and their heterogeneity along given characteristics may play a role on their supposedly positive 'bridging effect'. The literature on business incubator heterogeneity is still scant and mainly focuses on definitional aspects (Al Ayyash et al., 2020; Galbraith et al., 2022), with few exceptions investigating the role of incubator heterogeneity on start-up outcomes (see Barbero et al., 2014). In this respect, we link incubator heterogeneity to their bridging effect by focusing on the size of an incubator, which is likely to be related to the breadth of (internal and external) social ties to which an incubatee may have access, and on the institutional heterogeneity of the incubator, where the different affiliations of an incubator may offer different possibilities in terms of links and exert diverse legitimation strengths, depending also on the nature of the alliance involved. In fact, legitimacy for start-ups may be heavily reliant on the nature of the supporting organization and fit distinctly into the entrepreneurial ecosystem depending on the type of alliance sought for (e.g. Lindsey, 2003; Colombo et al., 2006).

The primary source of data used to conduct the analyses is the "Startup Survey" administered in 2016 to Italian innovative start-ups by the Italian Ministry of Economic Development (MISE) and by the National Institute of Statistics (ISTAT) with the aim of performing an evaluation of the Italian national "Startup Act", enacted in late 2012. Out of the 2,275 start-ups that participated in the survey, we were able to retrieve the variables on firm-level, geographical and entrepreneur-level factors needed to build our dataset on 1,752 incubated and non-incubated ventures.

On average, our findings confirm the bridging function of incubators, i.e. incubation is positively and significantly associated with the likelihood that a start-up will enter into formal agreements with third parties. In our contingency analysis, this effect is found to be rather independent of incubator size, although a moderate advantage can be ascribed to large incubators. However, different incubator affiliations are found to be associated with different probabilities for start-ups to stipulate different types of alliances. In particular, start-ups located in university-affiliated incubators are positively and significantly associated with (only) R&D alliances, while incubators affiliated with public entities show a greater tendency of their incubatees to enter into (only) commercial alliances.

Our study makes two main contributions to the literature. First, it "peels back the layers" of the causal thread between incubation and start-ups performance by focusing on one of the mechanisms through which incubators can benefit their tenants, i.e. by facilitating the creation of alliances with third-party organizations. The supposedly positive bridging function of "networked incubators" (see *infra*, Section 2.2.) has never been tested on a large scale in the literature. Second, it adds to the scant literature on incubators' heterogeneity by investigating how incubator size and affiliation affect the likelihood of incubatees establishing R&D and commercial alliances. Thus, it delves into the *incubation bridging function* by shedding light on its possible contingencies. This analysis offers the possibility of outlining several interesting practical implications for different type of stakeholders. Indeed, the results here exposed identify a specific and well-defined domain in which an incubator may exert a beneficial effect on incubatees, thus showing that the so-called liability of newness or adolescence (Stinchcombe, 1965; Bruderl and Schussler, 1990) can be at least to some extent ameliorated, if not circumvented, by the joint use of appropriate quality signals and network enlarging tools, where the latter can also be put in place by the policy maker. Relatedly, given the recent great emphasis on innovative entrepreneurial ecosystems and ways to trigger and nurture them

(Stam, 2015; Kuckertz, 2019), our analysis, by mapping the existing relationships between incubators, incubatees and third parties, may also offer possible pathways for regulators to nurture the entrepreneurial process by encouraging the creation of (specific) incubators that enhance interactions and collaborations among the various relevant actors.

The paper is organized as follows. In the next Section, the conceptual background is defined and the hypotheses are formulated. The third Section depicts the institutional setting, presents the sample and describes the variables. The fourth Section reports the econometric findings, while the closing Section discusses them to draw final conclusions.

2. Conceptual background and hypotheses development

2.1. The incubator: a general overview

With this study we refer to incubators as organizations, developed on a property-based initiative (Phan et al., 2005), that provide start-ups, i.e. incubatees, with a range of tangible and intangible resources, including: infrastructural capital (Hackett and Dilts, 2004), management and administrative support (Peters et al., 2004; Grimaldi and Grandi, 2005), social environment, technological and organizational inputs (Phan et al., 2005; Bergek and Norrman, 2008; Clarysse et al., 2005; Hansen et al., 2000) with the ultimate goal of transforming an entrepreneurial idea into a viable company. Generally speaking, incubators cater to early stage and embryonic ventures (Aernoudt, 2004; Hackett and Dilts, 2004; Grimaldi and Grandi, 2005), while "science parks" and "technology parks" are commonly intended for relatively more mature ventures (Bergek and Norrman, 2008). They also differ from "accelerators", because incubators generally do not invest equity in the incubatees, especially when considering the European context (see Cohen et al., 2019 for the case of accelerators in the U.S. context).

Incubators are institutional elements that have evolved considerably over time along with the specific characteristics of the context in which they have been called upon to operate. Originating in the United States, Bruneel et al. (2012) identify three distinct generations of business incubators, which differed in the objectives and assets the incubator wanted to offer to incubatees. Starting with the *first generation* incubators (i.e. from early 1960 to all the 1980s), whose main objective was to provide shared office space and physical resources in order to decrease the fixed costs per incubatees, we moved in the 1990s to a *second generation* of incubators that also added the provision of coaching and training supports to start-ups, and finally to the current *third generation* (early 2000s – today), in which incubators often have the additional objective of extending the boundaries of the incubatees' network and increasing their social capital in terms of technological, financial and professional contacts. In a nutshell, like a *Matryoshka* doll, it can be said that, over time, the typical mission of the incubator has increasingly expanded its perimeter to embrace diversified functions and competencies and, thus, increase the range of services offered to incubatees.

2.2. A new incubator archetype: Networked Incubator

Hansen et al. (2000) were among the first to define *networked business incubators* as the new business and organizational model for start-ups' incubation that must offer, in addition to the services typical of the first two generations, access for incubatees to an extended network.

In this respect, a distinction is commonly made (see e.g. Lyons, 2000; Patton and Marlow, 2011; Bruneel et al,. 2012) between internal and external networks. Lyons (2000), in particular, argues that both of them are of equal importance in supporting start-ups and should be properly leveraged by an effective incubator. Thus, the incubator should act as an intermediary with an external pool of potential partners, both in the financial and commercial spheres (Schwartz and Hornych, 2010), but at the same time it should promote the creation of internal networks, as both types of networks are deemed necessary to establish the quality of the new venture and help the start-up gain legitimacy in markets.

The incubator is assumed to build and make available its network of contacts for tenant ventures (Hughes, et al., 2007), as incubatees generally have an underdeveloped network due to their innate lack of experience. In such cases, incubators are supposed to help incubated firms discover their "network horizon" in a way that creates new possibilities for their incubatees' strategic actions (Holmen, et al., 2013). From this perspective, an incubator's ability to nurture such dynamics should take into account start-ups' needs together with the incubator' centrality to the network. However there is a dearth of studies addressing these issues (Eveleens et al., 2017; Busch and Barkema, 2022). The review performed by Eveleens et al. (2017) makes it clear that the literature on networked incubators suffers greatly from the major limitation of looking at the effects of incubation on incubatees ignoring "the network" dimension and focusing on the ultimate performance of start-ups in terms of more generic indicators (e.g. sales performance, employees growth). In their last recommendation on future research directions in this field, the same authors argue (Eveleens et al., 2017, p. 697):

"Finally, further research has the task of developing a finer-grained model of the impact of network-based incubation on start-up performance. This model needs to go beyond the taken-for-granted assumption that the benefits from network-based incubation improve start-up performance in general. It should explain and predict how specific intermediary benefits derived from network-based incubation lead to a change in specific performance dimensions. We call for further research to continue assessing the impact of specific intermediary benefits on start-up performance measures."

Our analysis seeks to provide a first answer to this important call. In exploring the aforementioned issues, we will analyze the enabling role of incubators in terms of the alliance prospects of their incubatees, i.e. their 'bridging effect'. In doing so, we aim at understanding whether this effect may also depend on contingencies related both to the characteristics of incubators and to different types of alliances, focusing on alliances aimed at research and development and technological advancement (Mowery et al., 1996; Gans and Stern, 2003) and commercial alliances, i.e. targeting the market for products (e.g. Teece, 1986; Colombo et al. 2006), both believed to be critical to the success of innovative start-ups.

2.3. Hypotheses development

Our argument on the supposed positive 'bridging effect' of incubators towards their incubatees relies on two main pillars: *social capital* and *legitimacy*. Both of these key theoretical constructs can increase a start-up's concrete possibilities of establishing alliances with third parties (Aldrich and Zimmer, 1986; Gulati, 1995; 1999).[1]

Suffering from the typical liability of newness and adolescence (Stinchcombe, 1965; Bruderl and Schussler, 1990), innovative start-ups struggle to attract the resources needed to exploit the identified entrepreneurial opportunities. Incubators are recognized as a resource-rich environment that can help alleviate a start-up's resource gap also, but not only, through their extensive network of contacts (see e.g. Hansen et al., 2000; Bøllingtoft and Ulhøi, 2005). In this regard, incubation is expected to increase the social capital of incubatees through the expansion of their network horizon due to the addition of new contacts, both internal and external. The former are represented by ties with other incubatees, within the incubator premises, while the latter are represented by external contacts provided by the incubator but also, potentially, by other incubatees, where, as we know since Granovetter (1973), these weak ties are not necessarily of minor importance in establishing relationships that would otherwise remain out-of-reach.

[1] There are multiple definitions across and within different scientific domains of what the two constructs identify. Here we adopt what we gauge are the prevalent views in both the economics and management streams of literature. More specifically, for social capital we intend the array of relationships and ties arising from social structures, networks and memberships which may benefit a given actor (e.g. see Davidsson and Honig 2003, p. 307); while legitimacy "is a generalized perception […] that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions." (see Suchman, 1995, p. 574). Adhering to this view, legitimacy also reflects the congruency between the results and the expectations the social system has towards the outcome of an individual organization (Ashforth and Gibbs, 1990).

However, being a node in a larger network may not suffice for a start-up to be successful in attracting potential partners interested in establishing alliances. As we know since DiMaggio and Powell (1983), organizations seek (and often struggle to obtain) legitimacy, thus to be seen as credible actors in the context in which they operate. In our setting, this means that entering into formal cooperative agreements with third-party organizations requires a start-up also to be considered a legitimate agent (Stuart et al., 1999; Kumar and Das, 2007). Indeed, being selected by an incubator (in case it is renowned) can help reduce the legitimacy gap that start-ups face early in their life cycle. This legitimacy effect may increase the start-up's visibility and appeal in the eyes of third parties, enabling it to build solid partnerships through which it can close its resource gap (Zimmerman and Zeitz, 2002; Bøllingtoft and Ulhøi, 2005).

Summarizing these argumentations about *social capital* and *legitimacy*, we can posit our baseline hypothesis on the 'bridging effect' of incubation:

H1: *Incubated start-ups are more likely to establish alliances with third parties.*

The intensity of both social capital and legitimacy, and thus the strength of the 'bridging effect' for incubatees, may vary with the specific characteristics of an incubator. We initially focus on incubator size and start with the social capital pillar. In this respect, if it is generally true that alliances require trust between the parties (Bierly III and Gallagher, 2007), and that this trust might be facilitated in smaller environments due to more frequent interactions between individuals (Rotter, 1971; Lewicki and Bunker, 1995), we advance the hypothesis that, for what concerns start-up alliances, a network argument should prevail. Larger incubators, in terms of number of incubatees and collaborating partners, automatically increase the internal and external networking opportunities for incubatees and should help the incubated start-up span its boundaries. In all circumstances and events that are to some extent affected by serendipity (Kilduff and Tsai, 2003; Mitsuhashi and Greve, 2009), and whose actual realization implies a match between two distinct entities that may remain episodic and sporadic (see, for instance, Colombo et al., 2006 for the high transaction and administrative costs that start-ups face in managing alliances), an improvement in the pre-conditions that are conducive to the phenomenon at stake should then translate into a greater number of realized matches.

Conversely, we do not expect the legitimacy effect from incubation to depend necessarily and strongly on the size of the incubator. Other characteristics of an incubator, such as its institutional affiliation and prominence may clearly be important in this regard (see *infra*) and be correlated to some extent with size, but we hypothesize that being located in a relatively smaller incubator *per se* should not legitimate a start-up any less than being located in a larger one. Thus, summing up all these lines of reasoning and focusing especially on the enhanced networking function aforementioned, we formulate our second hypothesis:

H2: *Incubated start-ups are particularly likely to establish alliances if their incubator is large.*

We also argue that a different 'bridging effect' could result from the different institutional affiliation of an incubator, that is, the type of main institution that endorses and finances its creation, where we distinguish three categories: academic, governmental and corporate incubators. The label "academic" identifies incubators created by a single university or a group of them, "public" incubators are primarily governmental (at local and/or central level) initiatives and the "corporate" category isolates all incubators that are entrepreneurial initiatives, being them founded by individuals, companies or other privately owned organizations.

In this respect, the literature on alliance formation has extensively documented how start-up legitimacy can be influenced by the support of established organizations (Stuart et al., 1999; Colombo et al., 2006). In particular, since organizational legitimacy is based on community perceptions of an organization's assets and operations (Suchman, 1995; Suddaby et al., 2017), due to the lack (or limitedness) of information about the new venture in the start-up period, these perceptions are likely to be driven by the nature of the sponsoring organization and its fit into the entrepreneurial ecosystem. While this literature has focused primarily on the legitimacy exerted by the nature of direct investors on new ventures as the main form of sponsorship, we extend these lenses of inquiry and include in the analysis the possible legitimacy effects stemming from different types of incubators, beyond and above the effects produced by different types of start-up shareholders.

In doing so, we put forward the idea that both the legitimacy and networking capabilities of incubators may depend on their institutional affiliation but also be contingent on the nature of the alliance under consideration, where, in accordance with other studies (e.g. Colombo et al., 2006), we follow the basic distinction between R&D (explorative, technological) and commercial (exploitative) alliances.

In many institutional contexts, universities are at the forefront of both basic and applied research and, cumulatively, constitute one of the largest contributors to R&D spending. The community at large credits universities as primary institutions for research-based activities (Mansfield and Lee, 1996). As a consequence, start-ups located in an academic incubator are likely to be perceived as endowed with superior resources and capabilities to leverage in the development and implementation of innovative projects (Colombo and Piva, 2012). While the mere academic affiliation as a PhD student or researcher of some founding team members can probably exert only a limited impact vis-à-vis third parties (see Colombo et al., 2012), being located in an university incubator is likely to be perceived as a much more tangible and powerful signal, as it also reveals a high level of commitment to the project on the part of the university. Consequently, potential partners seeking to take advantage of a mutually beneficial R&D-focused agreement should be willing to establish a formal alliance with start-ups supported by an academic incubator to a greater extent, because they would perceive the latter as legitimate R&D players.

In parallel, it is also legitimate to assert that both the internal and external components of the academic incubator network should be formed and largely based on R&D-based ties. Therefore, we posit that academic incubation is not only able to legitimize incubatees in R&D matters but also to enlarge start-ups' social capital in this direction. Following this line of reasoning, we formulate the following research hypothesis:

H3a: *Incubated start-ups will be particularly likely to establish R&D alliances if they are located in an academic incubator.*

Turning to commercial alliances, and looking at the relevance of our two pillars, *social capital* and *legitimacy*, a series of considerations are in order. On the one hand, for the reasons stated above, academic incubators should be at a relative disadvantage compared to other types of incubators. While their mission is often well-exemplified by technology transfer to society, the early stage of development and/or the high-risk profile of many of their incubatees may be less attractive to third parties in terms of immediate commercial use. On the other hand, corporate incubators may not be interested in spurring alliances of their incubatees with third parties, especially if these alliances are not aiming at the pre-competitive stage but are commercially exploitative in nature. In fact, the incubator established by incumbent organizations could be set up to serve the needs of the sponsoring institutions which may not have an interest in dispersing any competitive advantages arising from start-ups located in what they consider "their" incubators. Moreover, start-ups may also have preferential access to complementary assets for the commercial exploitation of their products directly from the sponsoring institutions without the need to stipulate any formal agreement with external third parties. Finally, and looking at the legitimacy side, this type of incubator is a business in its own and, without investing in incubatees (contrarily to what accelerators typically do), they may develop an exploitative attitude towards incubatees rather than a genuine interest in their development, equating incubatees with "clients" which can be (easily) replaced in the marketplace. Therefore, the remaining category of public incubators, provided that their social capital is large enough and their selection procedure is sufficiently competitive, so that the legitimacy effect can actually result from admission, might be in a better position to induce their incubatees to stipulate commercial alliances. In this case, the 'bridging effect' would be highly contingent on the 'certification effect' or 'stamp of approval' that the public actor is able to exert (Lerner, 2002). In a typical context characterized by strong information asymmetries, such as the one here analyzed, in which start-ups possess neither a vested position in markets nor a solid track record of performance on which to rely, being "endorsed" by a reputable institution may represent a powerful signal (Spence, 1973) to third parties of their intrinsic quality and potential profitability (Stuart et al., 1999; Stuart and Sorenson, 2007). Accordingly, these sponsored start-ups may be perceived by potential external partners as more promising players from a market perspective than other types of start-ups (Stuart, 2000; Hsu, 2006; Lindsey, 2003; 2008). Needless to say, the question of whether public managers and civil servants are in a position to exert this signal is far from being obvious, but the circumstance is not deemed implausible in the literature (e.g. Lerner, 2002; Kleer, 2010; Colombo et al., 2013; Guerini and Quas, 2016; Grilli and Murtinu, 2018).[2] Therefore, we advance our final hypothesis:

[2] See Lerner (2002, p. F78) "[…] government officials […] need to be able overcome the many information asymmetries and identify the most promising firms. […] Is it reasonable to assume that government officials can overcome these problems while private sector financiers cannot? Certainly, this possibility is not implausible. For instance, specialists at the National Institute of Health or Department of Defense may have considerable insight into which bio-technology or advanced materials companies are the most promising, while the traditional financial statement analysis undertaken by bankers would be of little value. In general, the certification hypothesis suggests that these signals provided by government awards are likely to be particularly valuable in technology-intensive industries where traditional financial measures are of little use."

H3b: *Incubated start-ups will be particularly likely to establish commercial alliances if they are located in a public incubator.*

3. Institutional setting, sample and variables

3.1. Institutional setting

In the Italian institutional context, incubation is a relatively recent phenomenon. The first incubators emerged in the 1980s as public initiatives aimed at promoting entrepreneurship and economic development mainly in the most disadvantaged areas of the country (Colombo and Delmastro, 2002). Since the late 1980s, still relying on public funds, science and technology parks also started to implement incubation pathways to support innovative entrepreneurship. In the late 1990s, university incubators also began to spread: these organizations usually offer services similar to those offered by other types of incubators, but are more oriented towards the transfer of scientific and technological knowledge from academia. It is only since the 2000s that private incubators have joined public ones, thus enriching the Italian entrepreneurial ecosystem (see Auricchio et al., 2014 for a detailed history of business incubation in Italy).

Being Italy historically marked by a structurally weak innovation system, which has ancient roots that reverberate their effects even today (Nuvolari and Vasta, 2015), including a poor ability to nurture successful start-ups in innovative sectors (Grilli and Murtinu, 2014), at the end of 2012, the Italian Government issued a series of measures (including Law no. 221/2012, modified by further amendments, also known as the *Italian Startup Act*), to sustain the entire Italian innovative start-up segment (see *infra* Section 3.2), and in which the notion of "certified" incubator was also created. Still nowadays, a certified incubator must meet the following requirements established by the Italian Ministry of Economic Development:[3] (i) be able to provide incubates with physical facilities, equipment and systems; (ii) be managed by

[3] In particular, see the Italian legislative acts DL 179/2012 and DM December 22, 2016.

individuals with well-recognized expertise in business and innovation and have a permanent technical and managerial advisory structure available; (iii) have regular collaborative relationships with universities, research centers, public institutions and financial partners carrying out activities and projects related to innovative startups; (iv) have adequate and proven experience in supporting innovative start-ups. This *ad-hoc* reform of the incubation system in Italy was deemed necessary, because, despite the fact that the Italian entrepreneurial ecosystem is more developed and dynamic than it used to be, incubators were still considered to be few in number, with limited resources and geographically fragmented (Social Innovation Monitor, 2021). Moreover, having often been established in the past by public entities to pursue a multiplicity of objectives ranging from job creation to industrial development, from technology transfer to the promotion of entrepreneurship and internationalization, their selection processes were considered much less formal and rigorous than those used in more advanced ecosystems (MISE, 2017). The aforementioned reform thus aimed at encouraging the creation in Italy of more modern, i.e. *networked*, incubators, which also through the social capital and legitimation channels evoked in our theorizing could help innovative start-ups establish alliances with third parties.

3.2. Data collection

Data are based on a survey launched by the National Committee of the Italian Ministry of Economic Development on "Monitoring and Evaluation of National Policies for the Italian Innovative Start-ups Ecosystem" and administered by the Italian National Institute of Statistics (ISTAT) from April to May 2016 . The objective of this survey was to collect information on Italian innovative start-ups along a number of dimensions including their human capital (Section I), financial structure (Section II), innovation strategies (Section III) and subjective evaluation of public policy instruments that had been recently put in place to sustain innovative entrepreneurship in Italy (Section IV).[4]

In fact, in late 2012, the *Italian Startup Act* introduced the possibility for innovative start-ups to (optionally) qualify themselves for a number of benefits. Innovative start-ups would have to meet the following requisites (see Italian Law no. 221/2012): (i) be truly entrepreneurial acts (other existing companies could only hold minority shares); (ii) be less than 5 years old; (iii) operate in high- and medium-technology businesses; (iv) not have distributed dividends and not be publicly traded; (v) have annual revenues of less than 5 million Eur. Furthermore, to qualify for "innovative" status, a start-up must meet one of the following three additional requirements: (i) be the owner or licensee of a patent or a registered software or a generic intellectual right; (ii) have at least one-third of employees with a Ph.D. or research tenure (or at least 66% of employees with an M.Sc. degree); (iii) be able to document yearly investments in R&D accounting for at least 15% of revenues (or operating costs if they exceed revenues).

Innovative start-ups (as identified by the Law) were granted specific incentives, exemptions and access to privileged (and discounted) services. The retroactive nature of the policy also allowed access to these support measures not only to the ventures created after the enactment of the Law, but also to those that existed previously, provided these firms fulfilled the prescribed requirements (including the requirement to be less than 5 years old). The measures spanned over different areas: from hard financial support, in terms of privileged access to state-guaranteed bank loans and tax incentives for external equity investments, to the easing of

[4] The complete version of the questionnaire can be requested to the Italian National Institute of Statistics (ISTAT) at its contact point, and is of course available on request to the authors. The questionnaire was electronically managed by ISTAT though its web-portal specifically dedicated to collect statistical information from firms (namely, 'Statistica & Imprese').

bureaucratic costs and reduction of tax burdens for hiring employees. A complete description of the eligibility criteria and all support measures is provided in Grilli (2019).

The questionnaire targeted the whole population of Italian innovative start-ups, amounting to 5,150 firms as of December 2015. The questionnaire (which included mainly closed questions) was filled out with partial or complete information by 2,275 start-ups, resulting in a considerable 44% response rate. The surveyed sample was ensured to be representative of the population on all dimensions on which ISTAT has information from both sides, i.e. population and sample, including firms' geographic location, industry affiliation, age and legal form (see MISE 2016, for further details).[5] The main questions (related to the alliance activity of the start-up and its incubation status, if any) exploited to operationalize the key variables used in the empirical analyses are shown in Table A1 (see Appendix).

We complement data at the start-up level with information about incubators. At the time of the survey, there were 39 certified incubators in Italy that could have supported through incubation the surveyed innovative start-ups. Specifically, we hand-collected data on incubator size and affiliation by relying on the Italian Business Register maintained by the Italian Chambers of Commerce and incubators' websites, respectively.

3.3. Sample

The final sample used in our empirical exercise is composed by 1,752 innovative start-ups, from which we were able to construct all the variables of interest. The sample consists of 497 incubatees and 1,255 non-incubated start-ups.

Table 1 shows the distribution of incubated and non-incubated start-ups according to the type of established alliance (Panel A), backing at foundation (Panel B) and industry (Panel C). The distributions of the two groups differ along the first two dimensions, as incubated start-

[5] Results of specific tests comparing the surveyed start-ups with the population are available upon request.

ups are more likely to have established alliances (related to both R&D and commercial activities) and to be backed at foundation (with the exclusion of company-backed start-ups). On the contrary, incubated and non-incubated start-ups do not significantly differ in their industry distribution.

[Insert Table 1 about here]

Table 2 shows the distribution of the sampled start-ups according to the type of established alliance across start-ups age.[6] Approximately, 46.6% of the start-ups established an alliance (21.7% an R&D alliance, 13.0% a commercial alliance and the remaining 11.9% both of them). Start-ups that established alliances are more likely to be born earlier. Age stratification indicates that the share of start-ups having established an alliance of any sort increases from 37.7% when they are one year old to 64.1% when they are five years old. The positive trend seems to be substantially driven by R&D alliances, as start-ups that established commercial alliances are more evenly distributed across firm age.

[Insert Table 2 about here]

3.4. Variables and model specification

3.4.1. Dependent variables

Our main dependent variable is *Alliance*, a binary variable set equal to 1 if the start-up has ever settled a formal agreement (i.e. a contract) focusing on R&D and/or commercial activities with third parties and 0 otherwise. In order to test hypotheses H3, since we consider two types of alliances, we built two distinct dependent variables: *R&D Alliance* and *Commercial Alliance*. *R&D Alliance* is a binary variable set equal to 1 if the start-up has ever settled a formal agreement (i.e. a contract) focusing on R&D activities with third parties and 0

[6] At the moment of the survey (April-May 2016) there were 16 (ex-)innovative start-ups that exceeded the law threshold of 5 years (accounting for less than 1% of the sample). All our findings are definitely untouched by the choice of including or excluding them.

otherwise. Likewise, *Commercial Alliance* is a binary variable set equal to 1 if the start-up has ever settled a formal agreement (i.e. a contract) focusing on commercial activities with third parties and 0 otherwise.

3.4.2. *Explanatory variables*

Our main explanatory variable is *Incubation*. It is a dummy variable set equal to 1 if the start-up is or has ever been located in an incubator and 0 otherwise, where this information was directly provided by the surveyed entrepreneurs. This variable was used to test the baseline hypothesis H1. To test the remaining hypotheses, an additional and intensive data hand-collection effort was undertaken, since the survey did not provide the identity of the incubator for the incubated start-up. Thus, each incubated start-up was allocated to the geographically closest incubator based on the Euclidean distance between the start-up's headquarter and those of incubators. In order to verify the reliability of this allocation procedure, we also hand-collect information on tenants in each certified incubator for which characteristics were observable. After this manual data collection effort, triangulation resulted in the identification of 247 ambiguous cases that were excluded from the analysis. As a result, we believe that the risk of misallocation is virtually absent, thus supporting the use of the procedure to link incubatees to their incubators.

To test hypothesis H2, we need to distinguish large and small incubators. In the first instance, we identify as large incubators those that simultaneously meet the following three requirements in 2015: i) have more than 10 employees; ii) have a production value larger than 2 million Eur; iii) have a paid-in capital larger than 1 million Eur. The remaining incubators are identified as small incubators. At this point, we construct the variable *Large Incubator*, a binary variable set equal to 1 if the start-up is or has ever been located in a large incubator and 0 otherwise. Likewise, we construct the variable *Small Incubator*, a binary variable set equal to 1 if the start-up is or has ever been located in a small incubator and 0 otherwise. The baseline category includes start-ups that have never been located in an incubator. In *ad-hoc* robustness checks, we re-operationalize the variables *Large Incubator* and *Small Incubator* by considering the three above mentioned requirements one by one (see Section 4.2.2).

Testing hypotheses H3 requires us to detect start-ups located in academic and public incubators. We identify as academic incubators those having an academic institution among its shareholders (Kolympiris and Klein, 2017). Accordingly, *University Incubator* is a binary variable set equal to 1 if the start-up is or has ever been located in an academic incubator and 0 otherwise. We identify as public incubators those having a public entity (e.g. region, province, etc.) among its shareholders. Accordingly, *Public Incubator* is a binary variable set equal to 1 if the start-up is or has ever been located in a public incubator and 0 otherwise. *Corporate Incubator* is a binary variable set equal to 1 if the start-up is or has ever been located in a corporate incubator which is an entrepreneurial initiative, being it put forward by individuals, companies or other previously existing organizations and 0 otherwise. The baseline category includes start-ups that have never been located in an incubator. Since information obtained through the questionnaire was anchored to December 2015, we made also use of archival web search engines to go back in time and retrieve past information.

3.4.3. Control variables

Our model specification also includes a set of control variables. Basically, these control variables are those commonly used in literature to capture the legitimacy that young innovative start-ups can exert in the eyes of third parties through external or internal resources (Rothaermel, 2002; Li et al., 2008; Lindsey, 2008; Grilli and Murtinu, 2018).

In order to capture the financial structure of start-ups at foundation, entrepreneurs were asked to report the institutional composition of the shareholder base at the foundation year. On this basis, we introduce four binary variables: *University Shareholders at Entry*, *VC Shareholders at Entry*, *BA Shareholders at Entry* and *Corporate Shareholders at Entry*.

University Shareholders at Entry is set equal to 1 if the start-up, at its foundation year, was partly backed by a university or a research center and 0 otherwise. *VC Shareholders at Entry* is set equal to 1 if the start-up, at its foundation year, was partly (i.e. respecting the Law requirement (i) reported in Section 3.2) backed by a venture capitalist and 0 otherwise. *BA Shareholders at Entry* is set equal to 1 if the start-up, at its foundation year, was partly (i.e. respecting the Law requirement (i) reported in Section 3.2) backed by a business angel and 0 otherwise. *Corporate Shareholders at Entry* is set equal to 1 if the start-up, at its foundation year, was partly (i.e. respecting the Law requirement (i) reported in Section 3.2) backed by another company and 0 otherwise.

Regarding legitimacy derived from internal resources, in line with the seminal distinction by Becker (1964) and subsequent operationalizations (e.g. Colombo and Grilli, 2005), we construct two covariates: *Specific Human Capital* and *Generic Human Capital*. *Specific Human Capital* captures the average number of years of experience among co-founders of the same start-up obtained through pre-entry work experience in the same sector of the newly founded firm and previous managerial and entrepreneurial experiences. *Generic Human Capital* is the average experience start-up's founders gained through (university) education and work in sectors different from the one of the focal start-up. By using *Operative Shareholders* we control for the size of the entrepreneurial team, while *Employees* measures the number of employees hired with a long-term contract. Furthermore, given the potential signaling role that intellectual property rights may play in the eyes of complementary assets providers (e.g. Hsu and Ziedonis, 2013), we introduce the variable *Patents* which is set equal to 1 if the start-up is depositary or owner of a patent or software, and 0 otherwise. Lastly, we also include *Firm Age*, which measures the age (in years) of the start-up at the survey time, to control for heterogeneity in the stage of development of sampled firms.

Dependent, explanatory and control variables with the relative sources are summarized in Table A2, which is included in the Appendix.

3.4.4. Model Specification

To test our baseline hypothesis H1, we estimate the following model:

$$Alliance_i = \alpha_0 + \beta_1\, Incubation_i + \gamma X_i + Ind_j + Reg_r + \varepsilon_i \qquad (1)$$

where the *i* subscript denotes the individual sampled start-up, X_i is the vector of firm-level controls, Ind_j are industry fixed effects, Reg_r are region fixed effects and ε_i is the error term. Testing H1 implies to reject the null hypothesis $H_0\colon \beta_1 = 0$.

To test our hypothesis H2, we unpack the incubation dummy to take into account the incubator size and distinguish between start-ups located in large and small incubators. Accordingly, we estimate the following model:

$$Alliance_i = \alpha_0 + \beta_2 Large\ Incubator_i + \beta_3 Small\ Incubator_i +$$
$$+ \gamma X_i + Ind_j + Reg_r + \varepsilon_i \qquad (2)$$

Testing H2 implies to reject the null hypothesis $H_0\colon \beta_2 - \beta_3 = 0$ since our hypothesis H2 implies that start-ups located in larger incubators have a higher probability of establishing alliances than those located in smaller incubators.

Finally, to test our hypotheses H3 (H3a and H3b), we unpack the incubation dummy to take into account the incubator affiliation and distinguish between start-ups located in academic, public and corporate incubators. Accordingly, we estimate the following model:

$$Alliance_{ik} = \alpha_0 + \beta_4 University\ Incubator_i + \beta_5 Public\ Incubator_i +$$
$$\beta_6 Corporate\ Incubator_i + \gamma X_i + Ind_j + Reg_r + \varepsilon_i \qquad (3)$$

where *k* = *R&D Alliance*, *Commercial Alliance* depending on the hypothesis we have to test (we use *R&D Alliance* as a dependent variable to test hypothesis H3a, and switch to *Commercial Alliance* as a dependent variable to test hypothesis H3b). Testing H3a implies to reject the null hypothesis $H_0: \beta_4 = 0$ while testing H3b implies to reject the null hypothesis $H_0: \beta_5 = 0$.

3.5. Summary statistics

Summary statistics for the variables employed in this study are provided in Table 3.

[Insert Table 3 about here]

The correlation matrix is reported in Table 4. It does not show any worrying strong association between independent variables. To further investigate the possible presence of multicollinearity issues, a variance inflation factor (VIF) analysis was run before each regression. Following Belsley et al. (1980), we can exclude any major concern, since the mean VIF is always far below the threshold of 5, while the VIF of each independent variable is always far below the commonly used threshold of 10.

[Insert Table 4 about here]

4. Results

4.1. Main results

4.1.1. Incubation and probability of alliance

Our baseline hypothesis H1 suggests a positive relation between incubation and a start-up's likelihood of establishing an alliance with a third-party organization (centered both on R&D and commercial activities). Methodologically, we have to estimate the change in the probability of establishing an alliance due to incubation. To this purpose, we estimate a probit model based on Equation (1).

Table 5 reports the results of three probit models. In column (1), we include only *Incubation*; in column (2), we add also the four dummy variables accounting for the start-ups' backing at foundation (*University Shareholders at Entry*, *VC Shareholders at Entry*, *BA Shareholders at Entry* and *Corporate Shareholders at Entry*). The remaining controls are included in column

(3) to get the complete specification reported in Equation (1). In every specification, we include also a set of industry and regional dummies. Industry dummies are based on NACE Level 1 codes, whereas regional dummies are based on NUTS 2 territorial units. Moreover, we estimate heteroskedasticity-robust standard errors.

[Insert Table 5 about here]

The marginal effects of the control variables give notable indications. In particular, start-ups backed by academic institutions, business angels and mature companies are more likely to establish alliances. The effect is stronger for the former: being university-backed increases the likelihood of establishing alliances by 23%, whereas the effects go down to 13% and 4% when start-ups are backed by a business angel and a mature company, respectively (the statistical significance of the marginal effects also gets weaker going from 1% when start-ups are university-backed to 5% and 10% when they are backed by business angels and companies, respectively). *Operative Shareholders* is also positive and statistically significant (at the 1% statistical level). Having one more operating shareholder in the start-up increases the likelihood of establishing an alliance by 3% in absolute terms. Since the sample mean value of *Alliance* is 0.47, the effect translates into a 6.4% increase in the probability of establishing an alliance. As initially suggested by the descriptive evidence reported in Table 2, a strong positive effect is also played by *Firm Age*. An additional year of life makes start-ups approximately 10.6% (0.05/0.47) more likely to establish an alliance with third parties. Again, the effect is statistically significant at the 1% level.

Our main explanatory variable, i.e. *Incubation*, has a positive and statistically significant (at the 1% level) marginal effect in every specification. The magnitudes of the effect are comparable across specifications. They range between 0.09 in the specification reported in column (3) to 0.11 in the specification reported in column (1). This suggests that being incubated is associated with an approximately 10% (in absolute terms) increase in the likelihood of establishing alliances with third parties. This result supports our initial baseline hypothesis H1.

4.1.2. Incubator size and probability of alliance

Our hypothesis H2 suggests that start-ups located in larger incubators are particularly likely to establish an alliance with a third-party organization (centered both on R&D and commercial activities). In this case, we have to estimate the change in the probability of establishing an alliance by differentiating between start-ups incubated in large and small incubators. To this purpose, we estimate a probit model based on Equation (2).

Table 6 reports the results of three probit models. In column (1), we include only *Large Incubator* and *Small Incubator*; in column (2), we add also the four dummy variables accounting for the start-ups' backing at foundation. The remaining controls are included in column (3) to get the complete specification reported in Equation (2). In every specification, we include also a set of industry and regional dummies. As before, we estimate heteroskedasticity-robust standard errors.

[Insert Table 6 about here]

The marginal effects of the control variables are similar to those reported in Table 5. Backing at foundation (in particular by academic institutions and other companies) is still positively associated with the probability of establishing alliances. The same applies to the number of operative shareholders and start-up's age. In the full-fledged specification, reported in column (3), also *Patents* turns out to be positive and statistically significant (at the 5% statistical level). Slight different results are conceivably due not only to the unpacking of the variable *Incubation* (which is the only model modification with respect to Table 5), but also to the variation in the sample. In fact, as already mentioned (see Section 3.4.2), we were not able to retrieve information on the incubator where start-ups were or have been located for the entire sub-sample of incubated start-ups: this forced us to drop 247 observations. The robustness of results suggests that losing observations is not a serious concern in our estimations.

Turning to our explanatory variables, *Large Incubator* has a positive and statistically significant (at the 1% level) marginal effect in every specification. The magnitudes of the effect are pretty much the same across specifications and suggest that being located in a large incubator is associated with a 14% (in absolute terms) increase in the probability of establishing an alliance with a third party. On the other hand, *Small Incubator* is positive but not statistically significant at the conventional levels in every specification. We also test that the differences between the coefficients of *Large Incubator* and *Small Incubator* are equal to zero and the null hypothesis is never rejected. These tests seem to indicate that start-ups located in large incubators do not exhibit a significantly higher probability of establishing alliances than start-ups located in small incubators do. Thus, hypothesis H2 is not confirmed, with our findings pointing to only a moderate advantage of start-ups located in larger incubators when it comes to establishing alliances with third-party organizations.

4.1.3. Incubator affiliation and probability of alliance

Our hypotheses H3 suggest that start-ups located in academic incubators are more likely to establish R&D alliances (H3a), whereas those located in public incubators are more likely to establish commercial alliances (H3b). To test the two twin hypotheses, we discriminate between the two types of alliance and estimate the two separated models in Equation (3). In both models, we distinguish between start-ups located in academic (*University Incubator*) and public (*Public Incubator*) incubators from those located in incubators that are entrepreneurial initiatives, being them put forward by individuals, companies or other previously existing organizations (*Corporate Incubator*).

Table 7 reports the results. In columns (1) and (2), we show the estimates relative to two separate probit models having *R&D Alliance* and *Commercial Alliance* as dependent variables; in columns (3) and (4), estimates are obtained using a bivariate probit estimator that jointly models the probability of establishing the two types of alliance. In every specification, we include also a set of industry and regional dummies. As usual, we estimate heteroskedasticity-robust standard errors. Results obtained using the two estimators are almost identical to each other.

[Insert Table 7 about here]

University Incubator has a positive and statistically significant (at the 5% level) marginal effect in both columns (1) and (3). The magnitudes of the effect is 0.13 thus suggesting that being located in an academic incubator is associated with a 13% (in absolute terms) increase in the probability of establishing an R&D alliance with a third party (as compared with non-incubated start-ups). However, the marginal effect of *Corporate Incubator* is also positive and statistically significant at the 5% statistical level in both columns, thus indicating that the probability of establishing R&D alliances does not significantly differ between the two categories of incubated start-ups (as also confirmed by a test on the difference between the two effects). On the contrary, start-ups located in public incubators seem not to benefit at all when it comes to establishing R&D alliances: the marginal effect of *Public Incubator* is not statistically significant at any conventional level. Although academic incubators seem not to be the only ones that facilitate the establishment of an R&D alliance, our hypothesis H3a according to which the academic affiliation is particularly conducive to that kind of alliance proves to be supported.

Public Incubator has a positive and statistically significant (at the 5% level) marginal effect in both columns (2) and (4). The magnitudes of the effect are 0.11 in both columns thus suggesting that being located in a public incubator is associated with a 11% (in absolute terms) increase in the probability of establishing a commercial alliance with a third-party organization (as compared with non-incubated start-ups). Contrary to the case of R&D alliances, when it comes to commercial alliances, the other two categories of incubator (academic and corporate) seem not to exert any positive effect. The marginal effects of *University Incubator* and *Corporate Incubator* are both not statistically significant at the conventional levels in both columns. These results strongly support our hypothesis H3b that start-ups located in public incubators are particularly likely to establish commercial alliances.

Looking at the marginal effects relative to our controls, it seems clear that the number of operative shareholders and the start-up age, which are the most significant controls in the models where *Alliance* is the dependent variable, keep being statistically significant even when the probabilities of establishing R&D and commercial alliances are estimated separately. Interestingly, academic backing at foundation and the number of patents, which are also statistically significant when estimating the probability of alliances of any sort, keep being statistically significant only in the model used to estimate the probability of establishing an R&D alliance.

4.2. Robustness checks

Our analysis does not necessarily claim a causal interpretation on the role of incubation towards the likelihood of incubatees stipulating alliances with third parties. In fact, arguing for a causal effect for our theoretical mechanisms would require a very careful measurement strategy, i.e. measures uncorrelated to other factors, for these mechanisms. Indeed, incubation and alliances (and firm survival) are all liable to be related to a range of factors other than our posited theoretical mechanisms. The cross-sectional nature of our data largely prevents us from a full account of all these possible factors and quite naturally restricts our focus on the not-yet-investigated and still interesting domain of relationships. While our regressions control for many observable variables affecting the outcome of interest, in this section we aim at giving careful consideration to alternative operationalizations of variables, potential sample selection issues, and other unobserved heterogeneity that might still explain the observed patterns (beyond our controls), so as to bring further robustness to our cross-sectional analysis and its highlighted relationships.

4.2.1. Two-stage Least Square and ML recursive bivariate probit estimation

As a first robustness check, we pay particular attention to the endogeneity of *Incubation*. Some start-ups' characteristics may affect both the probability of being incubated and the probability of establishing alliances. For instance, incubators may select promising start-ups that would establish alliances with third-party organizations even without being incubated. If this were true, the positive association between incubation and the probability of incubatees establishing alliances would be misleading.[7] Alternatively, start-ups may self-select into the pool of potential incubatees precisely because they lack a network of potential partners with whom establish alliances (centered both on R&D and commercial activities). In this case, the estimated effect would be downward biased. Although we are well aware that solving the endogeneity issue is a hard challenge, and even more so with our cross-sectional data, we do our best to mitigate it. As we will show below, endogeneity in our case seems to work by downsizing the effect of incubation, consistently with the self-selection mechanism above described. This is comforting as it means that though not able to estimate a fully unbiased relationship between incubation and stat-ups' alliances, we could be confident of providing conservative estimates of it.

[7] We are aware that the same argument can lead to conclude that *University Shareholders at Entry*, *VC Shareholders at Entry*, *BA Shareholders at Entry* and *Corporate Shareholders at Entry* can be endogenous as well. However, we measure backing at foundation, a stage at which the screening ability of investors should be considerably weaker.

We address the endogeneity issue in two different ways. First, we use a standard two-stage least squares (2SLS) estimator; second, we estimate a maximum likelihood (ML) recursive bivariate probit model.

Strictly following Angrist and Pischke (2008), the standard 2SLS procedure requires us to firstly regress, through a linear probability model, the endogenous independent variable, i.e. *Incubation*, against an exclusionary restriction and the remaining independent variables, and then, in the second stage, to estimate our original model by instrumenting the endogenous variable *Incubation* with the fit after the first stage.[8] The incubation equation has the same covariates as in Equation (1) plus an exclusionary restriction, i.e. *Incubator Supply*. This latter measures the number of incubators located in the province (NUTS 3 territorial units) in which the start-up is located at the year the start-up was established. This variable is deemed to be correlated with the probability of incubation, but after regional fixed effects have been absorbed, it should be uncorrelated with the probability of establishing alliances. We test both exogeneity and relevance of our instrument: the first assumption is tested by including the instrument as a regressor in the *Alliance* equation; the second by computing the F statistic after having estimated two *Incubation* equations, one that includes the instrument (*unrestricted*) and the other one that does not include it (*restricted*). Estimates used to test the instrument exogeneity are reported in Table A3, whereas those used to test the instrument relevance are reported in Table A4: both tables are included in the Appendix. Results reported in column (2)

[8] Non-linear models in the first-stage (e.g. probit or logit) should be avoided so not to incur in a "forbidden regression" bias as discussed by Angrist and Pischke (2008, p. 190). More generally, Angrist and Pischke (2008) suggest how it is difficult to ascertain the best estimator in a setting where both the main dependent variable and the variable to be instrumented are represented by binary variables. In this framework, quoting Grilli and Murtinu (2018, p. 1951), "they individuate in linear probability models estimated through a 2SLS estimator a sort of "lesser evil", but of course these models should be corroborated by alternative estimators (see also Angrist, 2001)" as we perform in the present work.

of Table A4 constitute also the first stage estimates.[9] The variable *Incubator Supply* is not statistically significant at the conventional levels in Table A3, thus suggesting that the instrument affects the dependent variable only indirectly, through its correlation with the endogenous variable (*Incubation*); in addition, the F test rejects the exclusion of *Incubator Supply* from the *Incubation* equation, thus supporting the relevance of our instrument (the F statistics is 10.39, thus higher than the conventional threshold of 10).

Table 8 reports the results of 2SLS where the second stage is estimated through linear probability model in columns (1-2) and probit in columns (3-4), respectively. *Incubation* is always statistically significant (at the 1% statistical level in the specifications where we do not include start-up-level controls; at the 10% statistical level in the full-fledged specifications). Though these estimates should be handled with caution, the magnitude of the marginal effects suggests that our previous estimates were downward biased, thus indicating that unobservables are negatively correlated with selection into incubation.

[Insert Table 8 about here]

Our second way to deal with endogeneity is to rely on the ML recursive bivariate probit (Greene, 1998), which consistently estimates models where the outcome variable and the potentially endogenous covariate of interest are both binary and the latter is likely to be jointly determined with the former one. The model is a recursive simultaneous equations model that consists of two probit equations (one having *Incubation* and the other *Alliance* as dependent variables) which are estimated simultaneously to control for the potential unobserved heterogeneity between the two equations (Bhattacharya et al., 2006). The outcome equation has the same specification as in Equation (1).

[9] In order to increase the strength of our instruments we also chose to estimate the first stage on a sample with a greater size than our benchmark (1,752), since more information in the database is available on incubation than on alliance activity.

Columns (5-6) of Table 8 report the results of the ML recursive bivariate probit estimations. In both equations, the marginal effect of *Incubation* is statistically significant (at the 1% and 5% statistical level, respectively), thus confirming that incubated start-ups are, on average, more likely to establish alliances with third-party organizations than not-incubated ones. The magnitude of the effect is very much in line with those obtained by using 2SLS when controls are not included in the models, whereas it decreases in the full-fledged model. Cumulatively, these results again support hypothesis H1.

4.2.2. Robustness checks on incubator size and probability of alliance

When measuring incubator size we use an overarching indicator that takes simultaneously into account employees, production value and paid-in capital. In the first three columns of Table 9 we report estimates obtained by using three alternative operationalizations of the two dummies *Large Incubator* and *Small Incubator* that consider each dimension one by one. In column (1), *Large Incubator* is set equal to 1 when the start-up has been located in an incubator having more than 10 employees and 0 otherwise; in column (2), *Large Incubator* is set equal to 1 when the start-up has been located in an incubator having a production value larger than 2 million Eur and 0 otherwise; in column (3), *Large Incubator* is set equal to 1 when the start-up has been located in an incubator having a paid-in capital larger than 1 million Eur and 0 otherwise. In each case, *Small Incubator* is set equal to 1 when the start-up has been located in one of the remaining incubators and 0 otherwise.

[Insert Table 9 about here]

Results show that the marginal effect of *Large Incubator* is always positive and statistically significant. The magnitude ranges between 0.11 (at the 10% statistical level) and 0.17 (at the 1% statistical level). *Small Incubator* is statistically significant in the models in which incubation size is measured by relying on employees and production value (at the 10% and 5%

statistical level, respectively), whereas it is not in the model where it is measured by relying on the paid-in capital. Difference tests keep not rejecting the null hypothesis that the differences between the coefficients of *Large Incubator* and *Small Incubator* are equal to zero, albeit we still prevalently observe a moderate advantage for larger incubators, in line with the main analysis.

In addition, column (4) of Table 9 reports estimates in which the two dummies are replaced by *Incubation* along with the variable *Incubator Partners*, where this latter is a variable retrieved from the incubators' official websites with the use of archival web search engines and indicates the number of institutions (e.g. firms, other incubators, local public entities, etc.) with whom the incubator had established some collaborations up to the survey time. Quite consistently with the previous findings, results show that the number of partners of an incubator does not significantly change the likelihood of incubatees establishing alliances with third-party organizations.

4.2.3. Robustness checks on incubator affiliation and probability of alliance

When measuring incubator affiliation we categorize an incubator as being academic (public) when an academic institution (public entity) is among its shareholders. In Table 10 we report estimates obtained by using an alternative operationalization of the three dummies *University Incubator*, *Public Incubator* and *Corporate Incubator* based on the sole main shareholder of each incubator in which start-ups are located. Accordingly, *University Incubator* is set equal to 1 when the start-up has been located in an incubator whose main shareholder is an academic institution and 0 otherwise; *Public Incubator* is set equal to 1 when the start-up has been located in an incubator whose main shareholder is a public entity and 0 otherwise; *Corporate Incubator* is set equal to 1 when the start-up has been located in an incubator whose main shareholders are individuals, companies or other already existing organizations and 0 otherwise.

[Insert Table 10 about here]

Results show that the marginal effect of *University Incubator* in column (1) is positive but not statistically significant at the conventional levels, whereas *Public Incubator* in column (2) is positive and statistically significant at the 10% statistical level. The magnitudes are similar to those reported in Table 7. A possible reason for the weaker results obtained by using this alternative operationalization is that it ignores the influence potentially exerted by academic institutions and public entities as relevant block-holders even when they are not the main shareholders of an incubator.

5. Conclusions

5.1. Discussion

This study analyzes whether and to what extent incubated start-ups are more prone than non-incubated ones to establish formal contractual alliances with third-party organizations, and if differences emerge depending on the size and affiliation of the incubator in which a start-up has been located and in the content of the partnership, i.e. whether it is focused on R&D activities or it is devoted to commercial exploitation purposes.

Our econometric analyses based on a sample composed by 1,752 incubatees and non-incubatees ventures show that there is a positive relationship between incubation programs and the likelihood of establishing formal alliances. This is an important indication that the network mission declared by the third generation of incubators is actually being realized (Bruneel et al., 2012). We also find that incubator size is not particularly associated with an enhanced probability of incubatees stipulating alliances with third parties as we highlight only a moderate advantage for large incubators in this respect. Conversely, we show that academic incubators are particularly associated with R&D alliances of their tenants, while public incubators significantly correlate with the probability of commercial alliances of their incubatees.

We believe that these findings add interesting insights on the role that incubators can play. As to the extant literature, they respond to the call of Eveleens et al. (2017) of inspecting more closely and deeply the reasons why incubators can positively impact the performance of incubatees. They also contribute to (partly) address a common critique on the growing (especially empirical) literature on entrepreneurial ecosystems (Stam, 2015; Kuckertz, 2019) which "has been relatively silent on the interaction of entrepreneurial ecosystem components […..and] remains too actor-centric and largely neglects interactions and the specific narratives of a specific entrepreneurial ecosystem" (Kuckertz, 2019, p. 2). In doing so, the analysis here performed draws a sort of map of collaborations between incubators, incubatees and the surrounding entrepreneurial ecosystem, which is clearly informative for regulators and (local) policy makers about the types of incubators most likely to lead innovative start-ups to stipulate new partnerships of different nature.

In the same vein, our empirical results enrich the scant literature on incubator heterogeneity by investigating the way in which incubator size and affiliation influence the likelihood of tenants establishing alliances as well as the alliances' purpose.

The analyzed meta-performance dimension of alliances is extremely relevant for innovative start-ups (e.g. Stuart, 2000; Almeida et al., 2003; Hsu, 2006; Lindsey, 2003; 2008; Neyens et al., 2010). In fact, one key stylized fact is that this type of firms is very likely to suffer from several market failures (Peneder, 2008; Grilli, 2014; Audretsch et al., 2020), which make them struggle to attract prominent partners (e.g. Teece, 1986; Colombo et al., 2006) especially when these firms are young and more subjected to the liability of newness and adolescence (Stinchcombe, 1965; Bruderl and Schussler, 1990). All in all, this may translate into the fact that viable (and potentially successful) entrepreneurial ideas can not materialize in markets or start-ups are incapable to fully deploy their potential. Therefore, the enabling network role of incubators (particularly of larger incubators) in endorsing start-ups is an important function, which was never documented in such a large scale before. The fact that this effect may be at work when universities (for R&D alliances) and public entities (for commercial alliances) are shareholders of the incubator is clearly worthwhile to be emphasized and calls for a synergistic action in technology transfer activities between incubators and academic or public entities. Interestingly for policy makers, our study shows that the combination of these instruments under the same umbrella could significantly increase the probability of start-ups establishing alliances, and therefore represents a key factor for ensuring their success in markets. In this respect, our work also adds an interesting insight to the recent stream of literature in entrepreneurship policy that analyzes the joint effectiveness of different measures on innovative start-ups (see Giraudo et al., 2019; Hottenrott and Richstein, 2020).

5.2. Limitations and future research

Needless to say, our study suffers from some limitations which however can open interesting avenues for future research. First, the survey provided information on location in certified business incubators, but did not ask about the use of other increasingly relevant forms of support, like, for example, physical or virtual co-working spaces. Studying whether our results could be transferrable also to this type of measures would improve our understanding of the dynamics here analyzed. Second, while it is true that most of our innovative start-ups were incubated from inception or at an early stage, we are not able to disentangle the exact timing and temporal dynamics of alliances. In other words, we do not have longitudinal information to gauge whether the association between incubation and alliance is immediate or, instead, requires some time to materialize. Third, the data at our disposal do not allow us to distinguish whether the alliance partners for an incubatee are internal or external to the specific incubator considered. We also have been forced to restrict our attention to formal alliances. This is certainly a strength in our (quantitative) framework, since a formal contract implies a serious form of collaboration between the parties which is more solid and robust to measure. Other non-formal modes of collaboration would be looser and more difficult to capture effectively, especially from a quantitative point of view, but this does not imply that they cannot be important for an incubatee. Last but not least, we are not allowed to look at the success of established alliances as well as at the consequences they have in terms of start-ups' medium-term performance (Baum et al., 2000; see also Hohberger et al., 2020 for an account of the negative effects of alliance termination). Clearly, unravelling all these issues, also through qualitative analyses, could enrich our understanding of why some incubators rather than others might help start-ups establish valuable partnerships.

Despite the unavoidable limits, we believe that our findings could deliver interesting implications for policy makers and incubators' managers who aim at creating and stimulating virtuous dynamics in an innovative entrepreneurial ecosystem. As a matter of fact, the capability of start-ups to stipulate vital alliances with third-party organizations appears to strongly depend on the contemporaneous interplay of different actors, in a complementary rather than substitutive fashion. Thus, from a policy perspective, simply supplementing "one piece" with "another piece" that is only vaguely reputed to perform the same function is likely to lead to an incomplete puzzle.

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Tables

Table 1. Sample distribution by incubation, alliances, backing at foundation and industry

	Incubated		Non-incubated		Total
	No	%	No	%	No
Panel A - Alliances					
R&D	126	25.35	255	20.32	381
Commercial	77	15.49	150	11.95	227
R&D and Commercial	70	14.08	139	11.08	209
No Alliances	224	45.07	711	56.65	935
Total	497	100.00	1,255	100.00	1,752
Panel B - Backing at foundation					
UNI-backed	13	2.62	18	1.43	31
VC-backed	19	3.82	22	1.75	41
BA-backed	9	1.81	7	0.56	16
COM-backed	169	34.00	519	41.34	688
Multi-backed	73	14.69	80	6.37	153
Non-backed	214	43.06	609	48.53	823
Total	497	100.00	1,255	100.00	1,752
Panel C - Industry					
Manufacturing	85	17.10	227	18.09	312
Wholesale and retail trade	17	3.42	44	3.51	61
Information and communication	208	41.85	536	42.71	744
Professional, scientific and technical activities	157	31.59	361	28.76	518
Administrative and support service activities	9	1.81	37	2.95	46
Others	21	4.22	50	3.98	71
Total	497	100.00	1,255	100.00	1,752

Legend. The table reports the sample distribution by incubation and alliances (Panel A), backing at foundation (Panel B), industry (Panel C). UNI-backed, VC-backed, BA-backed and COM-backed identify start-ups backed by universities, venture capitalists, business angels and mature companies, respectively. Industries are classified based on NACE Level 1 codes.

Table 2. Distribution of alliances by start-up age

		Alliances				
		R&D	Commercial	R&D and Commercial	No Alliances	Total
Age						
0	No	12	1	5	18	36
	%	33.33	2.78	13.89	50.00	100.00
1	No	87	71	42	330	530
	%	16.42	13.40	7.92	62.26	100.00
2	No	122	78	58	328	586
	%	20.82	12.75	13.31	55.97	100.00
3	No	74	43	52	142	311
	%	23.79	13.83	16.72	45.66	100.00
4	No	45	19	32	74	170
	%	26.47	11.18	18.82	43.53	100.00
5	No	35	14	17	37	103
	%	33.98	13.59	16.50	35.92	100.00
6	No	6	1	3	6	16
	%	37.50	6.25	18.75	37.50	100.00
Total		381	227	209	935	1,752

Table 3. Summary statistics

Variable	Obs.	Mean	Median	Sd
Alliance	1,752	0.47	0.00	0.50
R&D Alliance	1,752	0.34	0.00	0.47
Commercial Alliance	1,752	0.25	0.00	0.43
Incubation	1,752	0.28	0.00	0.45
Large Incubator	1,503	0.09	0.00	0.29
Small Incubator	1,505	0.07	0.00	0.26
University Incubator	1,505	0.06	0.00	0.23
Public Incubator	1,505	0.06	0.00	0.24
Corporate Incubator	1,505	0.07	0.00	0.26
University Shareholders at Entry	1,752	0.04	0.00	0.19
VC Shareholders at Entry	1,752	0.09	0.00	0.28
BA Shareholders at Entry	1,752	0.04	0.00	0.19
Corporate Shareholders at Entry	1,752	0.46	0.00	0.50
Specific Human Capital	1,752	9.17	6.38	8.14
Generic Human Capital	1,752	10.48	7.58	10.86
Operative Shareholders	1,752	2.38	2.00	1.55
Employees	1,752	0.17	0.00	0.85
Patents	1,752	0.35	0.00	0.48
Firm Age	1,752	2.24	2.00	1.25

Table 4. Correlation matrix

	Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
(1)	*Alliance*	1.00																		
(2)	*R&D Alliance*	0.77	1.00																	
(3)	*Commercial Alliance*	0.61	0.18	1.00																
(4)	*Incubation*	0.09	0.08	0.04	1.00															
(5)	*Large Incubator*	0.06	0.03	0.06	0.71	1.00														
(6)	*Small Incubator*	0.06	0.07	-0.01	0.64	-0.09	1.00													
(7)	*University Incubator*	0.05	0.05	0.01	0.55	0.32	0.44	1.00												
(8)	*Public Incubator*	0.06	0.02	0.08	0.58	0.63	0.14	0.35	1.00											
(9)	*Corporate Incubator*	0.06	0.09	0.01	0.61	0.25	0.59	-0.06	-0.07	1.00										
(10)	*University Shareholders at Entry*	0.11	0.15	-0.02	0.05	-0.01	0.08	0.08	0.03	0.02	1.00									
(11)	*VC Shareholders at Entry*	-0.00	-0.01	0.03	0.09	0.08	0.04	0.02	0.07	0.05	-0.04	1.00								
(12)	*BA Shareholders at Entry*	0.02	0.01	0.04	0.09	0.09	0.02	0.11	0.05	0.01	-0.03	0.34	1.00							
(13)	*Corporate Shareholders at Entry*	0.04	0.03	0.01	0.02	0.01	0.02	0.01	0.02	0.02	0.01	0.06	-0.05	1.00						
(14)	*Specific Human Capital*	0.01	0.03	-0.02	0.01	0.00	0.02	0.05	0.00	-0.01	0.02	-0.02	-0.04	0.01	1.00					
(15)	*Generic Human Capital*	-0.03	-0.02	-0.03	-0.06	-0.04	-0.04	-0.06	-0.04	-0.01	-0.04	-0.02	0.03	0.08	-0.48	1.00				
(16)	*Operative Shareholders*	0.16	0.14	0.08	0.07	0.03	0.06	0.07	0.03	0.04	0.22	-0.01	0.02	0.06	0.07	-0.08	1.00			
(17)	*Employees*	0.06	0.07	0.03	-0.03	-0.03	-0.00	-0.02	-0.04	-0.00	-0.01	-0.01	-0.00	0.02	0.04	-0.02	0.04	1.00		
(18)	*Patents*	0.06	0.06	0.02	0.01	0.01	0.01	0.02	-0.01	0.01	-0.01	0.10	0.06	-0.01	-0.00	0.10	-0.02	0.03	1.00	
(19)	*Firm Age*	0.15	0.15	0.08	-0.03	-0.03	-0.00	-0.06	-0.03	0.02	0.06	-0.02	-0.02	-0.01	-0.02	-0.03	-0.00	0.08	0.11	1.00

Table 5. Incubation and probability of alliance

Dependent variable: *Alliance*	(1)	(2)	(3)
Incubation	0.11***	0.10***	0.09***
	(0.03)	(0.03)	(0.03)
University Shareholders at Entry		0.31***	0.23***
		(0.07)	(0.07)
VC Shareholders at Entry		-0.00	-0.01
		(0.04)	(0.04)
BA Shareholders at Entry		0.13**	0.13**
		(0.07)	(0.06)
Corporate Shareholders at Entry		0.04	0.04*
		(0.02)	(0.02)
Specific Human Capital			-0.00
			(0.00)
Generic Human Capital			-0.00
			(0.00)
Operative Shareholders			0.03***
			(0.01)
Employees			0.03
			(0.02)
Patents			0.04
			(0.02)
Firm Age			0.05***
			(0.01)
Industry dummies	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes
Observations	1,752	1,752	1,752

Legend. The table reports the estimated marginal effects after probit models. The dependent variable is *Alliance*. Industry and regional dummies are used to stratify the probability functions. Standard errors are in parentheses. * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

Table 6. Incubator size and probability of alliance

Dependent variable: *Alliance*			
	(1)	(2)	(3)
Large Incubator	0.14***	0.14***	0.14***
	(0.05)	(0.05)	(0.05)
Small Incubator	0.07	0.07	0.06
	(0.05)	(0.05)	(0.05)
University Shareholders at Entry		0.27***	0.18**
		(0.08)	(0.08)
VC Shareholders at Entry		-0.03	-0.03
		(0.05)	(0.05)
BA Shareholders at Entry		0.13*	0.12
		(0.08)	(0.07)
Corporate Shareholders at Entry		0.05*	0.04*
		(0.03)	(0.03)
Specific Human Capital			-0.00
			(0.00)
Generic Human Capital			-0.00
			(0.00)
Operative Shareholders			0.04***
			(0.01)
Employees			0.03
			(0.02)
Patents			0.06**
			(0.03)
Firm Age			0.05***
			(0.01)
Industry dummies	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes
Observations	1,503	1,503	1,503

Legend. The table reports the estimated marginal effects after probit models. The dependent variable is *Alliance*. Industry and regional dummies are used to stratify the probability functions. Standard errors are in parentheses. * $p < 0.10$; ** $p< 0.05$; *** $p< 0.01$.

Table 7. Incubator institutional affiliation and probability of alliance

	Probit		Bivariate probit	
	R&D Alliance	*Commercial Alliance*	*R&D Alliance*	*Commercial Alliance*
	(1)	(2)	(3)	(4)
University Incubator	0.13**	0.00	0.13**	0.00
	(0.06)	(0.06)	(0.06)	(0.06)
Public Incubator	-0.01	0.11**	-0.01	0.11**
	(0.06)	(0.05)	(0.06)	(0.05)
Corporate Incubator	0.10**	-0.00	0.10**	-0.00
	(0.05)	(0.05)	(0.05)	(0.05)
University Shareholders at Entry	0.24***	-0.10	0.24***	-0.10
	(0.07)	(0.06)	(0.07)	(0.06)
VC Shareholders at Entry	-0.04	0.02	-0.04	0.02
	(0.05)	(0.04)	(0.05)	(0.04)
BA Shareholders at Entry	0.11	0.07	0.11	0.07
	(0.07)	(0.06)	(0.07)	(0.06)
Corporate Shareholders at Entry	0.03	0.01	0.03	0.01
	(0.02)	(0.02)	(0.02)	(0.02)
Specific Human Capital	0.00	-0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Generic Human Capital	0.00	-0.00	0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Operative Shareholders	0.03***	0.02***	0.03***	0.02***
	(0.01)	(0.01)	(0.01)	(0.01)
Employees	0.03**	0.01	0.03**	0.01
	(0.02)	(0.01)	(0.01)	(0.01)
Patents	0.05*	0.02	0.05*	0.02
	(0.02)	(0.02)	(0.02)	(0.02)
Firm Age	0.05***	0.03***	0.05***	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)
Industry dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Rho			0.31*** (0.04)	
Observations	1,505	1,503	1,505	1,505

Legend. The table reports the estimated marginal effects after separate probit estimations in columns (1-2) and after bivariate probit estimation in columns (3-4). The dependent variables are *R&D Alliance* in columns (1) and (3) and *Commercial Alliance* in columns (2) and (4). Industry and regional dummies are used to stratify the probability functions. Standard errors are in parentheses. * $p < 0.10$; ** $p< 0.05$; *** $p< 0.01$.

Table 8. 2SLS and ML recursive bivariate probit estimates

Dependent variable: *Alliance*	LPM		Probit		ML recursive bivariate probit	
	(1)	(2)	(3)	(4)	(5)	(6)
Incubation	0.47***	0.59*	0.47***	0.60*	0.49***	0.33**
	(0.12)	(0.35)	(0.12)	(0.34)	(0.03)	(0.16)
Firm controls	No	Yes	No	Yes	No	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1,752	1,752	1,752	1,752	1,752	1,752

Legend. The table reports the estimated marginal effects after two different implementations of the 2SLS model and ML recursive bivariate probit. Columns (1-2) report 2SLS results obtained using OLS in the second stage (i.e. a linear probability model, LPM), columns (3-4) report 2SLS results using probit in the second stage, whereas columns (5-6) report results using the ML recursive bivariate probit model. The dependent variable is *Alliance*. *Incubation* is treated as endogenous and instrumented by *Incubation Supply*. Industry and regional dummies are used to stratify the probability functions. Standard errors are in parentheses. * p < 0.10; ** p< 0.05; *** p< 0.01.

Table 9. Alternative operationalizations of incubator size

Dependent variable: *Alliance*	Employees (1)	Production value (2)	Paid-in capital (3)	Partners (4)
Large Incubator	0.14***	0.11*	0.17***	
	(0.05)	(0.06)	(0.05)	
Small Incubator	0.09*	0.11**	0.06	
	(0.05)	(0.04)	(0.05)	
Incubation				0.08*
				(0.05)
Incubator Partners				0.00
				(0.00)
Firm controls	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes
Observations	1,505	1,505	1,503	1,505

Legend. The table reports estimated marginal effects after probit using alternative operationalizations of incubator size. The dependent variable is *Alliance*. Industry and regional dummies are used to stratify the probability functions. Standard errors are in parentheses. * p < 0.10; ** p< 0.05; *** p< 0.01.

Table 10. Alternative operationalizations of incubator affiliation

	R&D Alliance (1)	*Commercial Alliance* (2)
University Incubator	0.11	0.01
	(0.08)	(0.07)
Public Incubator	0.07	0.10*
	(0.06)	(0.06)
Corporate Incubator	0.08**	-0.00
	(0.04)	(0.04)
Firm controls	Yes	Yes
Industry dummies	Yes	Yes
Regional dummies	Yes	Yes
Observations	1,505	1,507

Legend. The table reports estimated marginal effects after probit using the sole main shareholder to operationalize the incubator affiliation. The dependent variables are *R&D Alliance* in column (1) and *Commercial Alliance* in column (2). Industry and regional dummies are used to stratify the probability functions. Standard errors are in parentheses. * $p < 0.10$; ** $p < 0.05$.

Appendix

Table A1. Main Start-up Survey questions for key measures

Alliance's activity
Has the start-up ever made formal cooperation agreements with third parties (universities, businesses)? [*Yes/No*] If yes, of what kind? • Technology Agreements (Research and Development). [*Check the box*] • Production/commercial Agreements [*Check the box*]
Incubation
Is the start-up currently located or was it previously located at a certified incubator? [*Currently located/Previously located/Not located, either now or in the past*]

Legend. Author's own elaboration of Start-up Survey.

Table A2. Variable description

Dependent Variables	**Operationalization**
Alliance	Dummy variable equal to 1 if the start-up has ever settled a formal alliance (i.e. a contract) with third parties for R&D and/or commercial purposes, 0 otherwise. *Source*: Start-up Survey.
R&D Alliance	Dummy variable equal to 1 if the start-up has ever settled a formal alliance (i.e. a contract) with third parties for R&D purposes, 0 otherwise. *Source*: Start-up Survey.
Commercial Alliance	Dummy variable equal to 1 if the start-up has ever settled a formal alliance (i.e. a contract) with third parties for commercial purposes, 0 otherwise. *Source*: Start-up Survey.
Explanatory Variables	
Incubation	Dummy variable equal to 1 if the start-up has been belonging or belongs to an incubation program, 0 otherwise. *Source*: Start-up Survey.
Large Incubator	Dummy variable equal to 1 if the start-up has been belonging or belongs to an incubation program and the incubator is large, 0 otherwise. *Source*: Italian Business Register.
Small Incubator	Dummy variable equal to 1 if the start-up has been belonging or belongs to an incubation program and the incubator is small, 0 otherwise. *Source*: Italian Business Register.
University Incubator	Dummy variable equal to 1 if the start-up has been belonging or belongs to an incubation program and the incubator is affiliated to a University, 0 otherwise. *Source*: Data collected by the authors.
Public Incubator	Dummy variable equal to 1 if the start-up has been belonging or belongs to an incubation program and the incubator is affiliated to a public entity, 0 otherwise. *Source*: Data collected by the authors.
Corporate Incubator	Dummy variable equal to 1 if the start-up has been belonging or belongs to an incubation program and the incubator is an entrepreneurial initiative, being put forward by individuals, companies or other already existing organizations, 0 otherwise. *Source*: Data collected by the authors.
Controls	
University Shareholders at Entry	Dummy variable equal to 1 if the start-up, at its foundation year, was backed, with any percentage of shares, by a university, 0 otherwise. *Source*: Start-up Survey.
VC Shareholders at Entry	Dummy variable equal to 1 if the start-up, at its foundation year, was backed, with any percentage of shares, by a VC, 0 otherwise. *Source*: Start-up Survey.
BA Shareholders at Entry	Dummy variable equal to 1 if the start-up, at its foundation year, was backed, with any percentage of shares, by a business angel, 0 otherwise. *Source*: Start-up Survey.
Corporate Shareholders at Entry	Dummy variable equal to 1 if the start-up, at its foundation year, was backed, with any percentage of shares, by a mature company, 0 otherwise. *Source*: Start-up Survey.
Specific Human Capital	Average number of years of experience among cofounders of the same firm gained through work experience in the same sector of the start-up before firm's foundation and previous managerial and entrepreneurial experiences. *Source*: Start-up Survey.
Generic Human Capital	Average number of years of experience among cofounders of the same firm gained through (university) education and work in sectors different from the one of the start-up, before firm's foundation. *Source*: Start-up Survey.
Operative Shareholders	Number of operative shareholders in the start-up. *Source*: Start-up Survey.
Employees	Number of employees hired with full time contracts. *Source*: Start-up Survey.
Patents	Dummy variable equal to 1 if the start-up is patent holder or software proprietary, 0 otherwise. *Source*: Start-up Survey.

Firm Age	Difference, expressed in year, between the 31/12/2015 and the year of subscription to the special section of young innovative companies in the register for start-ups. *Source*: Start-up Survey.

Table A3. Instrument exogeneity

	Alliance (1)
Incubator Supply	0.05
	(0.03)
Incubation	0.09***
	(0.03)
University Shareholders at Entry	0.20***
	(0.05)
VC Shareholders at Entry	-0.02
	(0.04)
BA Shareholders at Entry	0.13**
	(0.05)
Corporate Shareholders at Entry	0.04*
	(0.02)
Specific Human Capital	-0.00
	(0.00)
Generic Human Capital	-0.00
	(0.00)
Operative Shareholders	0.03***
	(0.01)
Employees	0.03
	(0.02)
Patents	0.04
	(0.02)
Firm Age	0.05
	(0.01)
Industry dummies	Yes
Regional dummies	Yes
Observations	1,752

Legend. The table reports the estimated coefficients of linear probability models (LPMs). The dependent variable is *Alliance*. Industry and regional dummies are used to stratify the probability functions. Standard errors are in parentheses. * $p < 0.10$; ** $p< 0.05$; *** $p< 0.01$.

Table A4. Instrument relevance

	Incubation	
	(1)	(2)
Incubator Supply		0.09***
		(0.03)
University Shareholders at Entry	0.14**	0.14**
	(0.06)	(0.06)
VC Shareholders at Entry	0.21***	0.21***
	(0.04)	(0.04)
BA Shareholders at Entry	0.12*	0.12*
	(0.07)	(0.07)
Corporate Shareholders at Entry	-0.03	-0.00
	(0.02)	(0.02)
Specific Human Capital	-0.00**	-0.00**
	(0.00)	(0.00)
Generic Human Capital	-0.00***	-0.00***
	(0.00)	(0.00)
Operative Shareholders	0.01*	0.01*
	(0.01)	(0.01)
Employees	-0.01	-0.01
	(0.01)	(0.01)
Patents	0.02	0.02
	(0.02)	(0.02)
Firm Age	-0.01	-0.01
	(0.01)	(0.01)
Industry dummies	Yes	Yes
Regional dummies	Yes	Yes
Observations	1,801	1,801

Legend. The table reports the estimated coefficients of linear probability models (LPMs). The dependent variable is *Incubation*. Industry and regional dummies are used to stratify the probability functions. Column 1 reports the estimates of the restricted model, whereas column 2 reports the estimates of the unrestricted one; the latter one is actually used in our 2SLS estimations. Estimations are run on a greater sample size than our benchmark (1,752) since more information in the database is available on incubation than alliance activity, so as to increase the strength of our instruments. Standard errors are in parentheses. * $p < 0.10$; ** $p< 0.05$; *** $p< 0.01$.