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ORIGINAL PAPER

Do start-ups benefit from coworking spaces? An empirical analysis of accelerators' programs

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Abstract
Open innovation and innovation performance have been widely studied in the literature. However, few studies have examined the impact of openness to different types of external knowledge on start-ups' innovation performance. Moreover, previous literature could be further complemented by additional investigation into how the coworking spaces provided by accelerator programs may engender informal sources of knowledge that enhance the innovation performance of accelerated start-ups. To address this research gap, we investigate whether start-ups participating in accelerator programs can enhance their innovation performance through information transfer from informal networks provided by business accelerator programs. In order to do so, we draw two-stage data collection data from 113 start-ups accelerated by Italian accelerators from 2013 to 2016 and the response data collected in 2018. Our results reveal that coopetitors, educators, and investors are beneficial for different innovation outcomes of accelerated start-ups. These findings contribute to the innovation management literature, the small business management literature, the literature on accelerators and the coworking spaces literature.

Keywords Start-ups · Accelerators · Innovation performance · External knowledge · Informal source of knowledge · Coworking spaces

1 Introduction

Research on the effectiveness and the impact of different open innovation activities on firms' innovative performance is still growing (Helm et al. 2019; Marullo et al. 2022), particularly with regard to start-ups (Parida et al. 2012; Spender et al. 2017). More specifically, existing research has pointed out that forming relationships with external partners may increase the innovation performance of start-ups (Kask and Linton 2013; Teece 2010; Zhou et al. 2019). Start-ups have limited tangible and

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intangible resources; for this reason, the adoption of open innovation practices is crucial for start-ups aiming at overcoming their liabilities (Bogers 2011; Strotmann 2007).

Academic research has thus focused on inbound open innovation activities and identified different knowledge sourcing methods, analyzing different models of inbound-pecuniary and inbound-nonpecuniary options (Dahlander and Gann 2010; Dahlander et al. 2021). In the exploration of such activities, previous research has investigated the effect of the use of external knowledge on a firm's innovative performance (Katila and Ahuja 2002; Laursen and Salter 2006) and on the relationship between a particular knowledge sourcing method and innovative performance (Radic and Pugh 2017). Scholars within this vein agree that through the utilization of external sourcing methods, firms in general and start-ups and SMEs in particular can compensate for the scarcity of internal knowledge and competencies (Parastuty et al. 2015), fostering their innovation performance (Love et al. 2014; Neyens et al. 2010; Parida et al. 2012).

Despite the extensive literature on the topic, we observe three limitations. First, previous literature has focused on the engagement of start-ups in the innovation networks of incumbent firms (Chesbrough and Brunswicker 2014; Chesbrough et al. 2006; Shane 2001; Weiblen and Chesbrough 2015), neglecting to deeply analyze the effect of the adoption of open innovation in start-ups. Second, previous literature analyzing the impact of open innovation practices on the innovation performance of start-ups (Leiponen and Helfat 2010) has considered formal sources of external knowledge (such as collaborations with universities, suppliers, creative individuals, innovation communities, universities, clients, suppliers, and firms from other industries (Radicic et al. 2020; Viljamaa 2011). On the other hand, informal sources of external knowledge (i.e., inbound-non pecuniary option) have been treated as a homogeneous element, without considering the impact of different sources on both the radical and incremental innovation performance of start-ups (Kang and Kang 2009; Parida et al. 2012). Third, only a few studies have considered the context of accelerators and, in general, that of coworking spaces to extend the understanding of open innovation (Pustovrh et al. 2020) despite their growing importance within the innovation ecosystem (Crișan et al. 2019; Del Sarto et al. 2018). With this background in mind, the aim of this paper is to investigate whether startups enhance their innovation performance by participating in specific coworking spaces, such as accelerator programs. Such a study may be important for two reasons. First, such research can shed light on whether and how start-ups can benefit from the adoption of open innovation practices, which implies the use of external knowledge sources to increase their innovation performance. Second, it is important to analyze the role that coworking spaces such as accelerator programs may have in increasing the innovation performance of start-ups hosted by them.

To tackle this research question, we build on the definition of Cohen and Hochberg (2014), who defined an accelerator as "a fixed-term, cohort-based program, including mentorship and educational components, that culminates in a public pitch event or demo-day", and we conceptualize accelerator programs as coworking spaces. Then, we analyze the literature on accelerators and open innovation in coworking spaces to identify three informal networks that interact with start-ups during an acceleration

program: (1) coopetitors (Moritz et al. 2022); (2) educators (Minbaeva et al. 2014); and (3) investors (i.e., venture capitalists and angel investors) (Botelho et al. 2019). We draw on this literature to formulate hypotheses on the impact that each informal source of innovation may have on start-ups' innovation performance, distinguishing between incremental and radical innovation performance (Neyens et al. 2010; Faems et al. 2005).

We tested them by conducting a Tobit analysis on a pooled unique dataset of 113 start-ups that participated in acceleration programs in Italy between 2013 and 2016. Our findings point out the importance of using investors as sources of knowledge to enhance the radical innovation performance of start-ups. In addition, we show that start-ups might enhance their incremental innovation performance by using educators and coopetitors as a source of external knowledge.

Our study contributes to the literature by providing new insights into how different sources of information transfer from informal networks could enhance the radical or incremental innovation performance of start-ups (Chesbrough 2003; Lichtenthaler 2011). Additionally, we also contribute to the small business management literature highlighting how start-ups can benefit from the adoption of inbound open innovation (Spender et al. 2017; Verbano et al. 2015). Moreover, we contribute to the business acceleration literature pointing out the benefits that such programs may have on the innovation performance of accelerated start-ups and last, we contribute to the coworking spaces literature (Bouncken and Reuschl 2018). In addition to theoretical contributions, our study provides interesting insights for chief executive officers (CEOs). In particular, it shows how managers can use start-ups' limited resources for practicing open innovation to increase both radical and/or radical innovation performance.

The rest of the article is organized as follows. We start by building our theoretical arguments by discussing external sources of knowledge in open innovation, introducing coworking spaces in open innovation, and conceptualizing accelerator programs as coworking spaces. In this section, we use the literature on accelerators to develop three hypotheses on informal sources of knowledge. In section three, we describe the methodology, and in section four, we present our results. In the last section, we discuss the results and their implications for theory and practice. Furthermore, we pinpoint the limitations of the study and suggest some avenues for further research.

2 Open innovation and startups' innovative performance

An increasing amount of literature supports the idea that firms' open innovation is favored by different forms of interactions with external sources of knowledge (Madrid-Guijarro et al. 2020; Radicic and Pugh 2017). The relationship between openness to external knowledge and innovation performance is particularly important for start-ups (Spender et al. 2017; Verbano et al. 2015). Existing research, in fact, has pointed out that interacting with external actors has a positive effect on start-ups' innovation performance (Spender et al. 2017; Pangarkar and Wu 2012). Openness to external knowledge sources has been recognized as a crucial factor in the early stages of start-ups' development (Carlsson and Corvello 2011; Chesbrough 2003; Eftekhari

and Bogers 2015). It is essential for start-ups not only because of their limited size but also because they have fewer internal resources and a more restricted competence base, and therefore, sometimes their ability to engage in innovative efforts is compromised (Brem et al. 2017).

A number of studies acknowledge that start-ups may access external knowledge by establishing formal interorganizational relationships with many actors of the open innovation process, such as creative individuals, innovation communities, universities, clients, suppliers, and firms from other industries (Radicic et al. 2020; Viljamaa 2011).

However, open innovation activities may also favor a relatively high number of informal interactions that could contribute to knowledge breadth (Laursen and Salter 2006). Informal interactions represent a sourcing activity that does not imply any formal agreements or contracts between firms and external knowledge sources (Gronum et al. 2012), thus requiring low maintenance costs (Laursen and Salter 2006). According to Granovetter (1973), informal sources of knowledge may be considered the strength of weak ties or informal interactions between individuals who enhance firms' ability to achieve and implement innovation. Within this vein, Uzzi and Lancaster (2003) pointed out that informal social relationships play a crucial role in interfirm knowledge transfer and learning, suggesting that these ties may be crucial for accessing external knowledge.

Despite the importance of informal sources of knowledge, the literature has been silent about what types of informal sources of knowledge can be accessed through open innovation activities (Ahuja and Katila 2001; Pustovrh et al. 2020).

2.1 The importance of coworking spaces

In the context of open innovation, coworking spaces have become increasingly important (Bouncken and Aslam 2019; Bouncken and Reuschl 2018; Rese et al. 2020). Coworking spaces are shared working environments in which independent knowledge workers gather to create knowledge and benefit from this arrangement, "working alone, together" (Spinuzzi 2012: p. 299). In contrast to rental office spaces, which are organized around worker productivity and functionality (e.g., Davenport and Pearlson 1998), coworking spaces provide both a stable, functional work atmosphere and membership in a social community. According to Bouncken and Reuschl (2018), coworking spaces provide office and social space for temporary or long-term use according to availability (e.g., a cafe) for their users (Capdevila 2013; Spinuzzi 2012), also known as coworkers. 'Coworkers' typically pay a fee for access to an open, collaborative space that includes shared amenities such as open tables, conference rooms, a kitchen, and office supplies, as well as providing community-building activities and a loose social structure (Garrett et al. 2017).

Capdevila (2013) suggested that in coworking spaces, independent professionals work by sharing resources and are open to sharing their knowledge with the rest of the community. Therefore, coworking spaces can be viewed as open innovation environments that favor knowledge exchange between knowledge professionals (Bouncken and Reuschl 2018). Coworking spaces also deal with knowledge transfer and incorporating external knowledge (Bouncken and Aslam 2019; Capdevila 2013;

Parrino 2015; Rese et al. 2020). In shared spaces, coworkers with different levels of professionalism and various talents interact, speak to each other, and create synergies by integrating their skills into a virtuous circle that leads to the development of new ideas, innovation or even new businesses (Bouncken and Reuschl 2018). Recent literature has shown that spatial colocation facilitates stronger and multiple flows of knowledge while unlocking horizons for creativity and innovation (Coradi et al. 2015). According to Coradi et al. (2015), this colocation promotes the interaction between diverse actors, influencing the content of the communication, the frequency of the face-to-face communication, and the duration of the communication (Khazanchi et al. 2018). This sharing of knowledge is facilitated by the socialization process (Chan et al. 2010). It helps to reduce syntactic (language), semantic (meaning), and pragmatic (practice) boundaries, which counteract the knowledge sharing process within organizations (Carlile 2002, 2004; Coradi et al. 2015). Collaborative contexts such as coworking spaces facilitate the opportunities for the growth of individuals and organizations through knowledge exchange because they foster creativity (Bouncken and Reuschl 2018) by enabling "people to meet, explore, experience, learn and teach and share and discuss topics around creative practices in various areas" (Bilandzic and Foth 2013: p. 255).

2.2 Start-up accelerators as coworking spaces

Start-up accelerators are generally defined as "a fixed-term, cohort-based program, including mentorship and educational components, that culminate in a public pitch event or demo-day" (Cohen and Hochberg 2014: p. 4). In this subsection, we build on this definition to argue that accelerator programs can be viewed as coworking spaces that favor knowledge exchange and accelerate the innovation performance of start-ups.

First, accelerators offer immersive education that boosts the learning process of start-ups (Hallen et al. 2020; Hathaway 2016). Such an intense mentoring and training program is usually limited in time (Cohen and Hochberg 2014) and is focused on early-stage start-ups. Start-ups participating in an accelerator program thus share a space for joint work (Cohen 2013). By sharing the same space, start-ups are thus immersed in a highly competitive environment that drives rapid progress (Crișan et al. 2019; Stayton and Mangematin 2019) and favors the production of innovative ideas.

Second, accelerator start-ups are structured into cohorts (Del Sarto et al. 2022). This implies that the acceleration program is focused on small teams that are further involved in start-up classes or groups. Thus, start-ups go through a challenging phase in their development together (Cohen and Hochberg 2014) because they participate in a highly competitive and potentially global application process that accelerates their innovation.

Last, acceleration programs favor the birth of an entrepreneurial ecosystem that supports the initiatives of the founders of start-ups (Fernandes and Ferreira 2021). This occurs primarily through initial investments ($ 10,000– $ 50,000) of accelerators in exchange for capital (5–7%), thus helping start-ups to reduce their costs (Block et al. 2017). Most of the accelerators are in fact for-profit (Isabelle 2013),

and the owners are almost always private individuals with great experience as entrepreneurs or investors (Cohen and Hochberg 2014). The most valuable aspect, however, is the offer of intensive training and consultancy and the numerous networking opportunities with investors, all integrated in a peer-to-peer environment and a supportive entrepreneurial culture (Cohen and Hochberg 2014; Radojevich- Kelley and Hoffman 2012).

Given these characteristics, we can infer that acceleration programs are coworking spaces where start-ups can have access to valuable informal sources of knowledge for innovation. In this regard, many scholars have defined accelerators as an "open environment" (Battistella et al. 2017: p. 89). Indeed, during an acceleration program, start-ups have the opportunity to acquire knowledge from external sources, represented by other start-ups, educators, and the accelerator's network of investors. Previous studies have examined the impact these sources have on different dimensions, such as the acquisition of new knowledge (Battistella et al. 2017; Hallen et al. 2020), the evaluation of start-ups (Kim and Wangman 2014), and the ability to receive subsequent funding (Radojevic-Kelley and Hoffman 2012).

2.3 Hypothesis development

Drawing on the literature on accelerators (Cohen and Hochberg 2014; Clarysse et al. 2015; Hallen et al. 2020; Pauwels et al. 2016; Radojevich-Kelley and Hoffman 2012), we find that, during participation in the program, start-ups have access to different sources of external knowledge that help them to improve their products or services or develop new ideas (Battistella et al. 2017; Jackson and Richter 2017; Richter et al. 2018). Such sources are considered informal (Hansen 1999), as they occur because (a) they arise from informal interactions between individuals Granovetter (1973) and (b) they play a crucial role in external knowledge (Uzzi and Lancaster 2003) that start-ups can access in a coworking space such as an accelerator's program (Cohen and Hochberg 2014).

We identify three main sources of external knowledge that can be classified as informal in coworking spaces, such as accelerator programs (Kang and Kang 2009; Laursen and Salter 2006; Moritz et al. 2022): (1) *coopetitors* (Mention 2011; Moritz et al. 2022); (2) *educators* (Dickson et al. 2008; Simoes et al. 2012); and *investors* (Pinch and Sunley 2009). The identified informal sources of knowledge are likely to affect two types of start-ups' innovation outcomes: incremental and radical innovation performance.

2.3.1 Coopetitors

An important informal source of knowledge that affects start-ups' innovation performance during an accelerator program emerges from the collaborative working spaces involving the accelerated start-ups. During the accelerator program, in fact, start-ups are in close contact with other start-ups participating in the program and operating in the same sector (Hallen et al. 2020). By working closely with other start-ups, coopetition dynamics emerge (Brandenburger and Nalebuff 1996). In fact, Moritz et al. (2022) found that during the accelerator program, "start-ups forge specific types

of relationships, including both cooperative and competitive elements, characterizing their early-stage needs. They cooperate through joint projects and exchange and compete on the firm level for internal and external resources and on the individual level for reputation, which makes these relationships overall coopetitive". Hence, start-ups participating in the same accelerator program can be defined as coopetitors. Having clarified this, in the current subsection, we build some theoretical arguments regarding the impact that informal advice from coopetitors could have on the innovation performance of the accelerated start-ups. Drawing on the coopetition literature, it is not so obvious that coopetitors positively impact on start-ups' innovation performance (e.g., Bouncken and Kraus 2013; Ritala and Sainio 2014). However, collaborative and common workspaces, such as those to which start-ups have access during an acceleration program, increase knowledge exchange and information transfer between start-ups accelerated in the same cohort (Bouncken et al. 2017). When start-ups have the same space for joint working, even though they often get together to work privately (Cohen et al. 2019), they also share their visions, ideas, and other types of business information during coffee breaks. Moreover, they also experience similar concerns about the success of their business ideas and approaches to the market, and have similar frustrations about collecting adequate financial resources to sustain their ideas (Cohen and Hochberg 2014). Therefore, direct contact among individuals and teams boosts the conditions for informal knowledge exchange between start-ups and their coopetitors (Bouncken et al. 2020a, b, c). Moreover, some scholars pinpointed that working closely with coopetitors may help start-ups to enlarge their knowledge base (Osarenkhoe 2010) and therefore augment their incremental performance. Because they enable the enlargement of a firm's knowledge base, coopetitors may represent a critical informal source of innovation (Mention 2011) for the other start-ups (Afuah 2000; Moritz et al. 2022) and have an incremental effect on their innovation performance (Quintana-Garcia and Benavides-Velasco 2004).

In parallel, other scholars advocate that coopetitors represent an important informal source of knowledge that affects start-ups' radical innovation performance. Mention (2011), in fact, found that information coming from coopetitors influences the degree of novelty of innovation for firms within the service sector. Within this vein, Czakon et al. (2020) pointed out that a positive relationship exists between knowledge sourcing from competitors and the probability of introducing novel innovation. Building on the RBV of the firm, Chen et al. (2020) found that coopetitors positively affect radical innovation. Ritala and Sainio (2014) reported that technological radicalness is related to coopetition, supporting the evidence that coopetition might be beneficial in the case of radical innovation. According to these authors, in fact, coopetitors seek to differentiate their offerings and therefore inevitably lead to the emergence of radical business-model innovations. On the basis of this evidence, we formulate the following hypotheses:

H1a *The use of coopetitors as informal sources of external knowledge increases start-ups' incremental innovation performance.*

H1b *The use of coopetitors as informal sources of external knowledge increases start-ups' radical innovation performance*.

2.3.2 Educators

A second informal source of knowledge that, during an accelerator's program, affects start-ups' innovation performance originates from interacting with educators (Dickson et al. 2008; Simoes et al. 2012) because of the mentorship-driven nature of the program (Cohen and Hochberg 2014; Radojevich-Kelley and Hoffman 2012). During an accelerator program, most start-up founders likely seek advice on a wide array of topics, including strategy, marketing, finance, and people-management issues such as how to hire, motivate, and best leverage employees. They typically gain this information through informal advice from educators (Lerner and Malmendier 2013; Scott and Shu 2017). The informal advice that start-up founders seek out and receive from educators is typically dispensed via conversations, is unstructured, and is highly dependent on the knowledge and experience of the educator (Vissa and Chacar 2009). In this subsection, we develop some arguments regarding the impact that informal advice from educators could have on the innovation performance of accelerated start-ups.

Some studies highlighted that the informal advice provided by educators in the accelerator training programs has a positive influence on start-ups' incremental innovation performance. Training programs held by educators have been recognized in the literature as one of the main mechanisms through which start-ups can obtain and develop new knowledge (Lepak and Snell 1999; Yang and Watson 2022). During accelerator training programs, start-ups may ask educators for clarifications about the development of business plans, and additional information can be provided in real time (Bergmann and Utikal 2021). Therefore, educators play a crucial role in helping start-ups to regularly refresh their knowledge stock (Kang et al. 2007) and therefore improve their innovation performance (Rosli and Mahmood 2013). According to Dostie (2018), knowledge stock is very important in determining a start-up's ability to innovate, and for this reason, any increase in this stock might lead to more incremental innovation. Moreover, by training their employees, start-ups may update employees' knowledge and improve the human capital within the firm (Rosli and Mahmood 2013). Start-ups characterized by valuable and skilled human resources are more likely to implement new product ideas (Lopez-Cabrales et al. 2006) because employees are one of the most important sources of creativity and innovation (Bontis 1998).

Therefore, this set of arguments suggests that the informal advice that educators dispense to start-ups through accelerator training programs allows them to slightly improve their products or processes and improve their knowledge base. This reasoning, in turn, leads to hypothesis 2a.

Nevertheless, the theoretical arguments developed by other scholars would suggest that the informal advice provided by educators during an accelerator program may also significantly affect start-ups' radical innovation performance (Zhou and Li 2012). As advocated by Freel (2005), start-ups' commitment to the development of human capital, signaled by informal training programs, is likely to be central for the development of radical innovations. This claim has received empirical support from the literature on accelerators. In fact, it has been found that during an acceleration program, training practices provided by educators facilitate internal knowledge gen-

eration and knowledge sharing, which in turn affect radical innovation performance (Zhou and Li 2012). Moreover, most innovative start-ups are those that constantly implement training programs for their employees (Baldwin and Johnson 1996; Chatterji et al. 2019). This, in turn, suggests that the positive influence of educators on start-ups' innovation performance may depend on training intensity (Rampa and Agogué 2021). Taking into consideration the above arguments, we formulate the following hypotheses:

H2a *The use of educators as informal sources of external knowledge increases start-ups' incremental innovation performance.*

H2b *The use of educators as informal sources of external knowledge increases start-ups' radical innovation performance.*

2.3.3 Investors

A further informal source of knowledge that, during an accelerator program, affects start-ups' innovation performance comes from interacting with investors, such as business angels or venture capitalists (Clarysse et al. 2015; Pauwels et al. 2016). It is well known in the literature that the value added by experienced business angels and venture capitalists does not consist exclusively of the "hard" aspect represented by money but also of the "soft" aspect represented by advice and knowledge roles (Pinch and Sunley 2009). In fact, investors such as angel investors and venture capitalists collaborate with the accelerator during the program and for the organization of the demo day (Clarysse et al. 2015; Pauwels et al. 2016). In this subsection, we gain insights into the relationship between investors and start-ups' innovation performance in the context of accelerator programs.

Some scholars have argued that investors positively impact start-ups' incremental innovation performance. This is because start-ups that participate in accelerators programs have the possibility to interact with investors in special events called demo days (Cohen et al. 2019). During demo days, start-ups pitch their ideas to investors to obtain useful advice from them. Investors are considered tacit knowledge brokers who can provide the knowledge gained through personal experience to start-up teams (Botelho et al. 2019). Thus, they can offer informal advice that positively affects start-ups' incremental innovation (Pinch and Sunley 2009). In this regard, González-Uribe (2020) argued that demo-days are ideal contexts for informal knowledge to be transferred between investors and start-ups, and therefore they represent a stimulus for start-ups' incremental innovation. Wright et al. (2016) suggested that the knowledge transferred during demo days to start-up teams becomes incremental when investors possess highly specialized knowledge in technologies that are close to the preexisting knowledge base of the start-ups (González-Uribe 2020).

Nonetheless, other scholars pointed out that the presence of investors may lead accelerated start-ups to the creation of fundamentally new knowledge during the accelerator program, coming from investors' innovative ideas or from scientific discoveries considered disruptive (Dahlin and Behrens 2005). Therefore, the litera-

ture suggests that investors may also positively affect start-ups' radical innovation performance (Hornuf and Schwienbacher 2016). This occurs, for instance, because business angels or venture capitalists are usually former entrepreneurs (Morrissette 2007); therefore, they may provide the knowledge and expertise they gained in the foundation of a company that have contributed to its growth and development (Wiltbank et al. 2009). Past entrepreneurial experience allows business angels to be skilled in discerning the potential of breakthrough ideas that lead to the production of new knowledge (Croce et al. 2018). Therefore, in the accelerator programs, this type of investor may lead start-ups to think out of the box and guide them to identify knowledge avenues that increase their radical innovation performance. Moreover, investors positively impact start-ups' radical innovation performance because of their network ties. In this regard, Ferrary and Granovetter (2009) highlighted how the presence of venture capitalists in an innovative cluster may create the potential for specific interactions with other agents in the network (universities, large companies, laboratories) that determine a shift in start-ups' innovation performance. By interacting with this type of actor, provided by venture capital, start-ups may produce breakthrough knowledge and patent their innovations (Kortum and Lerner 2000). Similarly, Deffains-Crapsky and Klein (2016) found that business angels may indeed provide useful ties to start-ups' CEOs that can augment their radical innovation performance, especially under highly uncertain conditions. The above lines of arguments allow us to propose the following:

H3a *The use of investors as informal sources of external knowledge increases start-ups' incremental innovation performance.*

H3b *The use of investors as informal sources of external knowledge increases start-ups' radical innovation performance.*

Figure1 provides a simple schematic structure that summarizes the main elements (coopetitors, educators, investors, start-ups' incremental and radical innovation performance) upon which research hypotheses will be built.

3 Research Methods

3.1 Data collection

Data were collected using a survey submitted in the first half of 2018 to start-ups that participated in an Italian acceleration program in the period from 2013 to 2016 and were pooled in a unique dataset. The use of accelerators allows us to examine start-ups from the same empirical context, thereby obtaining a consistent population and avoiding selection bias (Del Sarto et al. 2021). We focused on Italian accelerators for two main reasons. First, since Italy is the fourth largest economy in the European Union and an economy in which innovation plays an increasingly important role, it is quite reasonable to think of collecting data from the Italian context to conduct our study. Second, and consistent with the first reason, the number of accelerators in

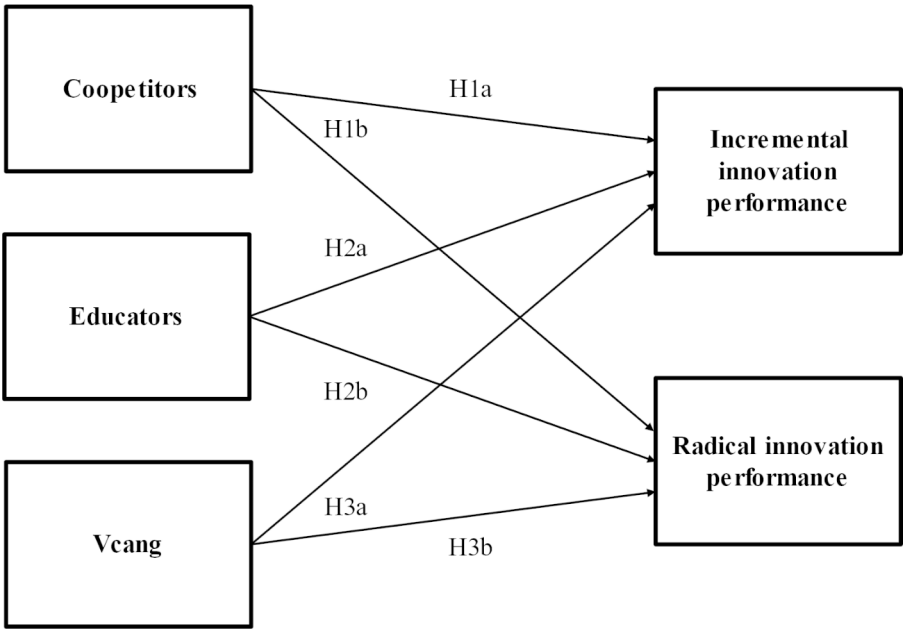

Fig. 1 Theoretical model

Italy is constantly growing. In fact, in the last 5 years, the number of accelerators has increased from 12 (2013) to 27 (2017), confirming the growth trend of this new support program for startups (Del Sarto et al. 2020) and demonstrating the importance of such models of start-ups' assistance in the Italian economy.

In Appendix A, we report the number of accelerators active in Italy from 2013 to 2016 and the number of start-ups that completed our survey for each accelerator along with some features of business accelerator programs. To identify the accelerator programs, we used the definition provided by Cohen and Hochberg (2014). The authors defined an accelerator program as "a fixed-term, cohort-based program, including mentorship and educational components, that culminates in a public pitch event or demo-day" (Cohen and Hochberg 2014: p. 4). This choice enabled us to consider only those programs that are homogeneous in terms of services, financial support, and equity requests offered to accelerated start-ups. Although existing research distinguishes between corporate (Kanbach and Stubner 2016; Kohler 2016) and private accelerators (Clarysse et al. 2015), in our study, we decided to consider both since corporate accelerators are modeled on the basis of private accelerators and offer the same services (Kohler 2016).

An ad hoc survey was developed in January 2018. To validate the questionnaire, we contacted an accelerator manager and three start-up CEOs. Thanks to the feedback received, we improved the questionnaire and submitted it to the overall population of 247 start-ups that participated in accelerator programs between 2013 and 2016. We obtained the list of all these start-ups by accessing accelerator websites and by directly contacting them when such information was missing. Once the list was obtained, we submitted the questionnaire to the entire population of start-ups.

The survey was addressed to each start-up's CEO with a cover letter explaining the purpose of our study. By the end of April 2018, we obtained answers from 113 start-ups, which corresponded to a response rate of 45.7%. As the survey was compiled by start-up CEOs, this rate can be considered satisfactory (Baruch and Holtom 2008). Moreover, the responses obtained are also adequately distributed among each year of the accelerator's program under inquiry: 24 start-ups (21%) were accelerated in 2013, 27 (23%) were accelerated in 2014, 28 (25%) were accelerated in 2015, and 34 (31%) were accelerated in 2016. As the rate can be considered satisfactory and the representativeness of the responses obtained per year of the accelerator program under inquiry, we did not send any reminder to the remaining startups, and we considered the 113 start-ups as the final sample of this study.

To avoid bias due to differences in the acceleration periods, we tested for differences among early accelerated (2013 and 2014) and late accelerated (2015 and 2016) periods with respect to the independent variables. The results of the t test show no differences for COOP [Pr (T!= t) 0.9782], EDUCATORS [Pr (T!= t) 0.2259], and VCANG [Pr (T!= t) 0.4944]. Following Dalecki et al. (1993), we tested for significant differences between early and late respondents and observed no significant differences either in terms of incremental innovation [(Pr (T!= t) 0.6394)] or radical innovation [(Pr (T!= t) 0.6962)].

3.2 Variables

3.2.1 The dependent variable: innovation performance

As mentioned earlier, the aim of this paper is to investigate the impact that three informal sources of knowledge, to which start-ups have access during an acceleration program, have on the innovation performance of start-ups. In the literature, there are several ways of measuring innovation performance. In this study, in line with Faems et al. (2005), Neyens et al. (2010) and Nylund et al. (2020), we use the composition of *turnover* as an indicator for innovation performance. Notwithstanding several studies that have used patent activity to measure innovation outcomes (Ahuja 2000; Baum et al. 2000; Wu et al. 2019), in this study, we use the composition of turnover to measure innovation performance, as the propensity to patent is strongly affected by firm-specific variations. Moreover, patents can be considered inputs in the product development process and not outputs (Deeds and Hill 1996) and therefore are not an adequate measure of innovation performance in our study.

The turnover can be the result of (1) technologically new products or services introduced to the market in the two years following the acceleration period; (2) technologically improved products or services introduced to the market within the same period; and (3) unchanged or marginally changed product or services within the same period. A *technologically new product* represents a product whose technological characteristics significantly differ from those of previous products, whereas a new service represents a service whose characteristics significantly differ from those offered by the previous service. These innovations may involve radically new technologies and can be the result of a novel combination of existing technologies in new uses or the exploitation of new knowledge. Such a measure is an indicator of *radical innovation*

performance (RADINN). A *technologically improved product* is a product whose performance has been significantly enhanced or updated, whereas an improved service is a service whose characteristics have been enhanced or updated. A simple product might be improved through the use of higher-performance components or materials, whereas a complex product consisting of a certain number of integrated subsystems might be improved by partially changing a subsystem. Such a measure is regarded as an indicator of *incremental innovation performance (INCRINN)*. Due to the highly skewed distribution of the variables, our analysis includes the natural logarithm of 1 plus the proportion of turnover attributed to new/improved products or services to obtain a normal distribution (Faems et al. 2005).

3.2.2 Independent variables: information transfer from an informal network

The key independent variable in this study represents the intensity of the use of the three external informal sources of knowledge represented by *coopetitors*, *educators* and *business angels and venture capitals*. Based on the study of Tomlinson (2010) and Inauen and Schenker-Wicki (2011), we used three 7-point Likert scale items to measure the three sources of external knowledge identified. First, we measured the source *coopetitors* (COOP) by using three items representing the level of cooperation, exchange of information and interaction with other start-ups accelerated by the accelerator and belonging to the same cohort ($\alpha = 0.823$). Second, we measured the source *educators* with three items representing the level of cooperation, exchange of information and interaction with educators during the acceleration period ($\alpha = 0.842$). Third, we measured the source (VCANG) ($\alpha = 0.737$) with a two-level construct representing the two-factor venture capitals (VC) and business angels (ANG). Each factor is made up of three items representing the cooperation, the exchange of information and interaction that occurred during the acceleration programs with venture capitals and business angels. The results of the CFA are reported in Appendix B. The composite reliability of all constructs was above 0.60 (Bagozzi and Yi 1988), indicating adequate reliability. Moreover, all average variance extracted (AVE) values were above 0.5, indicating sufficient convergent validity (Fornell and Larcker 1981). In addition, the factor loadings of each item are above 0.50, indicating that they belong to the same factor (Stevens 1992).

3.2.3 Control variables

To control for possible confounding effects, we collected through our survey a set of control variables: firm size, R&D intensity, sector of the start-up, level of education, and the presence of users within the innovation process and market. Since the seminal works of Schumpeter (1942), studies exploring the relationship between external knowledge sources and innovation performance have selected the natural log of the number of employees, which is often a proxy of firm size (SIZE), as a control variable (Hwang and Lee 2010; Laursen and Salter 2006). According to these scholars, in fact, larger firms may be likely to have a stronger network that helps them to exploit external knowledge. Within this vein, Lin et al. (2006) identified R&D intensity as a control variable. This variable represents the share of internal/external R&D expen-

diture divided by total sales (R&DINT). Internal R&D intensity, in fact, could be complementary to external knowledge search, improving a firm's learning capacity to search and absorb outside knowledge. A third control variable that may influence innovation performance is the sector (SECTOR) of the start-ups (Veugelers 1997). Following Veugelers (1997), we distinguished among three main sectors, namely, agriculture, industry, and services. In our sample, 63% of the accelerated start-ups belong to the services sector, 32% to the industry sector, and 5% to the agriculture sector. We consider the control variable SECTOR as a dummy variable assuming the value of 1 if the start-up belongs to the considered sector and 0 otherwise. The innovation performance of start-ups may also be influenced by the human capital of the entrepreneurial team represented by the level of education of employees (Lund Vinding 2006). We measured this variable by asking respondents to state the number of employees for each level of education (i.e., high level of education against a low level of education). This control variable (EDLEV) represents the percentages of employees with a Ph.D. or Master's degree. Another control variable included in our study is the effect of users considered as "leads" in innovation (USERS). Previous studies have suggested that the relatedness of lead users in innovation has a significant effect on innovation performance (Von Hippel 1986). The start-ups were asked to indicate, from 1 to 7, the degree to which they use clients or customers as sources of knowledge for innovation activities. The variable takes a value of 1 when the firm indicates a value from 5 to 7 and 0 otherwise. Finally, we included Export (EXPORT) as a control variable because firms that export their products or services are more likely to develop innovative products than those that do not (Berchicci 2013). Table1 reports the description of the variables used in our study.

3.3 Common method bias

We are aware that the application of a Likert scale system taken from the literature and the administration of the questionnaire to each start-up's CEO may cause problems of common method bias. To reduce this threat of common method bias, which could inevitably affect the results, we followed the recommendations of Podsakoff et al. (2003) and Chan et al. (2010) by including the scales and elements used in the analysis in different sections of the broader questionnaire, and we also included several negatively formulated questions to check for any confusing effects in the answers given by the interviewees. In addition to these corrective measures, we also conducted Harman's suggested single factor tests (7% single factor variance) to discover any potential common method bias. The results indicated that there were no single factors, and for this reason, our data did not suffer from the common method bias defect.

3.4 Robustness check

In this subsection, we aimed to test our models by changing the specification of some control variables to verify the robustness of our results. To achieve this aim, we provide an alternative specification of two control variables (i.e., SIZE and EDU). Specifically, for the control variable SIZE, we built a categorical variable starting from

Table 1 Summary of the variables

Variables	Description	Related studies
Dependent variables		
RADINN	The proportion of turnover resulting from technologically new products introduced to the market in the two years following the acceleration period.	Faems et al. (2005), Neyens et al. (2010).
INCRINN	The proportion of turnover resulting from technologically improved products introduced to the market in the two years following the acceleration period.	Faems et al. (2005), Neyens et al. (2010).
Independent variables		
COOPETITORS	Factor representing the degree of interaction with competitors during the acceleration period.	Tomlinson (2010), Inauen and Schenker-Wicki (2011).
EDUCATORS	Factor representing the degree of interaction with educators during the acceleration period.	Tomlinson (2010), Inauen and Schenker-Wicki (2011).
VCANG	Factor representing the degree of interaction with venture capitals and business angels during the acceleration period.	Tomlinson (2010), Inauen and Schenker-Wicki (2011).
Control variables		
SIZE	The log value of the number of employees.	Hwang and Lee (2010).
R&DINT	The share of internal and external R&D expenditure divided by total sales.	Laursen and Salter (2006)
SECTOR	Categorical variable indicating the sector of the startup.	Veugelers (1997)
EDLEV	The share of employees with a high level of education divided by the total number of employees.	Vinding (2006)
USERS	Dummy variable indicating the use of users as the main source of innovation.	Laursen and Salter (2006)
EXPORT	Dummy variable indicating whether a for is exporting or not.	Berchicchi (2013)

the number of employees of each start-up. For the variable EDU, we constructed a dichotomous variable taking the value of 1 if the percentage of employees with a high

level of education was higher than the medium value (i.e., 77%) and 0 if the value was below this value. Appendix C reports the results of the regression with a different operationalization of the control variables. As reported in the appendix, the results of the robustness check are consistent with the results of our model.

3.5 Data Analysis

In this paper, our dependent variables (RADINN and INCRINN) are censored. To handle such data in the sample, we used a Tobit model. The Tobit model allows the regression of such a variable while censoring it so that regression of a continuous dependent variable can happen. This model allows the researcher to specify a lower and an upper threshold to censor the regression and maintain the assumptions needed for linear regression. Moreover, to address the highly skewed distribution of such dependent variables, we use a log transformation following the works by Faems et al. (2005), Laursen and Salter (2006), and Neyens et al. (2010). The estimation of our study is based on the following two equations:

$$\begin{aligned}\mathrm{RADINN_i} = \beta_0 + \beta_1 \mathrm{COOP} + \beta_2 \mathrm{EDUCATORS} + \beta_3 \mathrm{VCANG} + \beta_4 \mathrm{SIZE} + \beta_5 \mathrm{R\&DINT} + \\ \beta_6 \mathrm{SECTOR} + \beta_7 \mathrm{EDLEV} + \beta_8 \mathrm{USERS} + \beta_9 \mathrm{EXPO} + \mu_i\end{aligned} \tag{1}$$

$$\begin{aligned}\mathrm{INCRINN_i} = \beta_0 + \beta_1 \mathrm{COOP} + \beta_2 \mathrm{EDUCATORS} + \beta_3 \mathrm{VCANG} + \beta_4 \mathrm{SIZE} + \beta_5 \mathrm{R\&DINT} + \\ \beta_6 \mathrm{SECTOR} + \beta_7 \mathrm{EDLEV} + \beta_8 \mathrm{USERS} + \beta_9 \mathrm{EXPO} + \nu_i\end{aligned} \tag{2}$$

where μ_is and ν_is are the error terms.

The two models are designed to examine the influence of the three identified external sources of knowledge on the innovative performance of start-ups. As the values of RADINN and INCRINN range from 0 to 100, a double censored model is used for the estimation.

4 Results

In Table2, we report the correlations and descriptive statistics of our data. As highlighted, we used correlation coefficients to check for multicollinearity (Lööf and Heshmati 2006). As the correlations among independent variables range from −0.01 to 0.35, multicollinearity is not a problem in our analysis.

A summary of the findings of the Tobit analysis is reported in Tables3 and 4. In our analysis, incremental innovation performance and radical innovation performance act as independent variables, whereas the three sources of external knowledge act as independent variables. Moreover, a set of variables are considered control variables. According to the results, all informal sources of external knowledge provided by accelerators have a positive and significant effect on the innovation performance of accelerated start-ups. Turning to the individual hypothesis, H1a receives strong

Table 2 Mean, Standard Deviation, and Correlation Matrix

ID	Variable	Mean	Standard Deviation	Min.	Max.	1	2	3	4	5	6	7	8	9	10	11
1	RADINN	11.73	16.92	0	100	1										
2	INCRINN	15.75	18.12	0	100	-0.01	1									
3	COOP.	11.74	5.52	3	21	0.08	0.35*	1								
4	EDUCATORS	13.29	4.82	3	21	-0.07	0.23*	-0.02	1							
5	VCANG	11.96	4.79	6	42	-0.10	0.15	0.02	0.13	1						
6	SIZE	4.28	1.26	2	9	0.49*	0.08	0.13	-0.08	-0.09	1					
7	R&DINT	19.38	7.68	5	35	0.34*	0.29*	0.23*	0.05	-0.06	0.23*	1				
8	SECTOR	1.42	0.60	1	3	0.09	-0.01	0.01	0.01	-0.01	0.19	0.13	1			
9	EDLEV	13.00	4.79	3	21	-0.04	0.16	0.02	0.12	-0.12	0.05	0.09	0.01	1		
10	USERS	0.36	0.48	0	1	-0.17	0.19	0.08	0.08	0.17	-0.15	0.03	0.11	0.05	1	
11	EXPORT	2.79	0.77	1	4	0.42*	-0.12	-0.16	-0.09	-0.03	0.22*	0.04	0.02	-0.05	-0.17	1
VIF						1.18	1.23	1.26	1.28	1.29	1.24	1.25	1.28	1.27	1.27	1.25

N = 113

Correlations are significant at 0.05 level. Pearson (2 tailed)

support, as informal external source c*oopetitors* are related to incremental innovation performance ($\beta = 0.05$, $p < 0.01$). Hypothesis H1b is not supported by our results, highlighting that the use of *coopetitors* as informal sources of external knowledge does not increase radical innovation performance ($\beta = -0.01$, $p =$ n.s.). Hypothesis H2a receives support as *educators* as external sources of knowledge increase incremental innovation performance ($\beta = 0.12$, $p < 0.01$), whereas this source of external knowledge does not increase radical innovation performance, thereby disconfirming H2b ($\beta = 0.03$, $p =$ n.s.). The last informal source of external knowledge represented by *venture capitalists and business angels* is related to radical innovation performance instead of incremental innovation performance. Hypothesis H3a, in fact, is rejected by the data ($\beta = -0.01$, $p =$ n.s.) However, hypothesis H3b is confirmed ($\beta = 0.11$, $p < 0.01$), highlighting that the exchange of knowledge with *venture capitalists and business angels* has a positive effect on radical innovation performance.

5 Discussion and conclusions

In this study, we examined how different sources of information transfer from the informal networks provided by accelerators impact both the radical and incremental innovation performance of start-ups. The use of external knowledge is recognized as a necessity for entrepreneurial ventures, as they present knowledge deficits that may increase the risk of failure (Gittins et al. 2015). However, previous literature has treated informal sources of external knowledge as a black box, without considering the impact of different sources of knowledge on the innovative performance of start-ups. In our study, we draw from the literature on open innovation and accelerators to fill this gap. Our empirical results have provided support that different sources of information transfer impact both the radical and incremental innovation performance of start-ups differently.

Our results indicate that the three sources, *coopetitors*, *educators* and *investors*, increase the innovation performance of start-ups in different ways. First, our results point out the importance of coopetitors in increasing incremental innovation performance instead of radical innovation performance. On the one hand, during the acceleration program, other start-ups accelerated in the same cohorts are considered a valid source of external tacit and nontacit knowledge, which enlarge the knowledge base of the start-ups (Osarenkhoe 2010) and therefore their incremental innovation performance. This result may be explained by the fact that interaction with *coopetitors* may favor imitation strategies that are positively related to incremental innovation performance (Quintana-Garcia and Benavides-Velasco 2004; Wu et al. 2019). This exchange of knowledge is facilitated by the physical proximity of teams of accelerated start-ups (Kopplin 2020). On the other hand, the knowledge provided by other start-ups does not seem to affect radical innovation performance, thereby confirming the results of Monjon and Waelbroeck (2003), who found that firms collaborating with coopetitors are less likely to introduce new products to the market.

Second, according to our results, the source of external knowledge represented by *educators* affects only incremental innovation performance. The interaction with educators, in fact, may increase the social capital (Teixeira and Forte 2017) and human

Table 3 Results of Tobit analysis, dependent variable: Incremental innovation performance

	Coefficient	Standard error	T	p>|t|
Const.	-0.01	0.01	-0.69	
Independent Variables				
COOP	0.05	0.01	3.77	0.000
EDUCATORS	0.12	0.02	7.46	0.000
VCANG	-0.01	0.01	-0.69	0.494
Control Variables				
SIZE	0.67	0.05	1.25	0.215
R&DINT	0.01	0.01	3.56	0.001
SECTOR				
Industry	0.01	0.03	0.34	0.732
Services	-0.07	0.06	-1.20	0.234
EDLEV	0.01	0.01	0.86	0.392
USERS	0.07	0.03	2.41	0.018
EXPORT	0.01	0.02	0.39	0.698

Note: n = 113. Left censored obs: 46, uncensored obs: 66. Right censored obs: 1

Pseudo $R^2 = 1.45$, Log likelihood = 15.65

Table 4 Results of Tobit analysis, dependent variable: Radical innovation performance

	Coefficient	Standard error	T	p>|t|
Const.	-0.53	0.17	-3.06	0.003
Independent Variables				
COOP	-0.01	0.02	-0.35	0.726
EDUCATORS	0.03	0.02	1.65	0.101
VCANG	0.11	0.02	5.56	0.000
Control variables				
SIZE	0.18	0.07	2.67	0.009
R&DINT	0.01	0.01	2.21	0.029
SECTOR				
Industry	0.01	0.04	0.27	0.790
Services	-0.04	0.07	0.56	0.579
EDLEV	0.01	0.01	0.35	0.725
USERS	-0.01	0.04	-2.23	0.028
EXPORT	-0.05	0.02	2.61	0.010

Note: n = 113. Left censored obs: 59, uncensored obs: 53. Right censored obs: 1

Pseudo $R^2 = 0.97$, Log likelihood = -9.38

capital (Rosli and Mahmood 2013) of firms, which in turn has a positive effect on the innovation performance of entrepreneurial ventures (Hughes et al. 2014). Moreover, as highlighted by Hughes et al. (2014), the effect of educators on firms' innovation performance through social capital is mediated by absorptive capacity (Cohen and Levinthal 1990), which helps firms filter out information and knowledge of little relevance (Lane and Lubatkin 1998). In addition, interaction with educators increases the professional skills and expertise of teams, which in turn may boost the innovation performance of start-ups through an increase in social capital (Grimpe et al.

2019; Minbaeva et al. 2014). Furthermore, a high level of social capital is essential for leveraging strategy focused on innovation (Pucci et al. 2020), especially for the introduction of new products (Lau and Ngo 2004).

Third, our results point out the importance of the external source of knowledge *investors* (i.e., venture capitals and business angels) in increasing radical innovation performance. According to previous literature, venture capitalists and business angels provide not only investment but also advice and knowledge, which may increase the innovation performance of start-ups (Botelho et al. 2019), providing them access to a wide network of actors (Ferrary and Granovetter 2009). Moreover, the specialization of venture capitalists and business angel in a specific technological field is more effective in transferring knowledge to start-up teams (Clarysse et al. 2015). Furthermore, professional investments drive innovation performance by acting on managerial aspirations (Colombo et al. 2016).

Finally, the empirical evidence outlined in this study shows that all three informal sources of external knowledge originate in a coworking space and increase the innovation performance of start-ups. The ability of start-ups to build an effective network and interact is essential for them, as it helps entrepreneurial firms build high-quality ties that enable the transfer and building of new knowledge (Yli-Renko et al. 2001). Moreover, the access to knowledge provided by informal networks unlocks opportunities for growth (Ketchen et al. 2007). In a coworking space such as an accelerator program, start-ups interact with different sources of external knowledge to achieve the advantages of newness (Autio et al. 2000).

5.1 Implications for theory

Based on the above findings, this article offers four theoretical contributions. First, our article contributes to the literature on small business management, highlighting how start-ups can benefit from adopting open innovation (Spender et al. 2017; Verbano, Crema and Venturini 2015). According to our results, the external knowledge provided by the three informal sources, coopetitors, educators and investors, enhances the innovation performance of start-ups acting on the size of their knowledge base (Ahuja and Katila 2001). By enlarging the internal knowledge base with external knowledge provided by external partners, start-ups may overcome resource liability (Neyens et al. 2010; Spender et al. 2017; Wang and Fang 2012) and process external knowledge to increase their innovation performance (Quintana-Garcia and Benavides-Velasco 2004). Moreover, during the acceleration period, start-up teams belonging to the same cohort are proximate to each other. This proximity acts on cognitive and social proximity, which in turn favors the process of knowledge acquisition and exploitation (Bouncken and Reuschl 2018). In line with Crespo et al. (2014), we found that the proximity among start-up teams activates horizontal knowledge spillovers, which are beneficial for start-ups' innovative performance and, in particular, for radical and incremental innovation performance.

Second, our article contributes to the innovation management literature by pointing out how different sources of external knowledge, classified as "informal" (Hwang and Lee 2010; Laursen and Salter 2006; Kang and Kang 2009), increase the innovation performance of start-ups. Our results highlight that the source of knowledge

venture capitals and business angels can be classified as distant knowledge sources (Katila and Ahuja 2002) since it increases radical innovation performance, whereas coopetitors and educators can be considered proximate knowledge sources (Fleming 2004). Previous studies, in fact, have argued that combining more distant knowledge domains is riskier but may result in fundamental breakthroughs of immense value (Ahuja and Lampert 2001; Fleming 2001), whereas any recombination involving proximate knowledge is likely to yield incremental improvements (Kotha, George & Srikanth, 2013). Thanks to our results, we contribute to this burgeoning literature pointing out that the informal source of external knowledge provided by venture capitalists and business angels can be classified as distant knowledge, which increases radical innovation performance, whereas the informal source of external knowledge provided by coopetitors and educators can be classified as proximate knowledge, which increases incremental innovation performance.

Third, we contribute to the business accelerator literature by viewing accelerators as coworking spaces and disentangling the informal networks provided by accelerators and their impact on both the radical and incremental innovation performance of accelerated start-ups. In particular, our contribution mainly relies on investigating the preliminary results of Stayton and Mangematin (2019), which found that "accelerators supply preexisting networks and connections for inexperienced entrepreneurs" (Stayton and Mangematin 2019: p. 1181). Our study contributes to this work by disentangling the impact of accelerators' networks on start-ups' innovative performance, thus adding granularity to the understanding of informal networks provided by accelerators (Crișan et al. 2019).

Finally, our article contributes to the emerging literature on coworking spaces (Bouncken et al. 2020b; Bouncken and Reuschl 2018; Rese et al. 2020). In particular, the common spaces provided by accelerators to start-ups accelerated in the same cohort favor the interaction between actors located in the same space and the flow of knowledge among them, thus improving the circulation of knowledge (Bouncken et al. 2020a, b, c; Coradi et al. 2015) and the creativity of individuals (Rese et al. 2022). Such a circulation is enhanced by informal communication among individuals (Garrett et al. 2017; Khazanchi et al. 2018; Kraus et al. 2022; Spinuzzi et al. 2019), represented by coopetitors, educators, venture capitals, and business angels. In line with Orel et al. (2022), our study shows that coworking spaces may act as local environments that provide support for firms' innovative knowledge. Within cohorts of accelerated start-ups, in fact, proximity among individuals boosts knowledge sharing and generation, thereby favoring the achievement of radical or incremental innovation (Bouncken and Aslam 2019; Capdevila 2013; Parrino 2015).

5.2 Implications for practice

Our research has implications for practitioners such as start-ups' CEOs. In particular, we highlight that participation in an acceleration program can help start-ups increase innovation performance, which is fundamental for small firms that are at the beginning of their lifecycle. More specifically, we highlight the need to strengthen the ties with different actors during acceleration programs, depending on whether they are interested in increasing their radical or incremental innovation performance on the

basis of the product/service they are offering to the market. Moreover, our results pointed out that informal sources of external knowledge allow start-up managers to make up for the lack of resources and knowledge that are provided by external partners thanks to the adoption of open innovation activities. On this basis, start-ups' CEOs must overcome the well-known "not invented here" syndrome, especially at the beginning of the start-up's lifecycle, and dedicate their resources to the relationship with the external environment, even if not formalized and based on a pecuniary basis. Our research may also be useful for policy makers. In particular, we have shown that, in addition to facilitating specific structural elements of entrepreneurial ecosystems, policy makers need to support interactions among different actors to facilitate business model experimentation and horizontal knowledge spillovers.

5.3 Limitations and future research

As with all research, this study presents some limitations that provide avenues for future research. The first limitation refers to methodological issues. In particular, the study may suffer from measurement subjectivity due to the use of a survey. Respondents could have misunderstood some questions or interpreted them subjectively. Moreover, the sampling technique adopted and the research context represented by Italian accelerators may influence our results. Our results could only apply to these open environment circumstances, and the effect could not be the same in other start-ups operating in different institutional environments, such as China. Future research should consider the selection of larger samples from other geographical regions to verify how geography may impact start-ups' innovation performance. Within this vein, scholars should consider the different impacts of different accelerators on start-ups' innovation performance, dividing them according to the sector in which they operate.

Moreover, in this study, we have considered coopetitors, educators, and investors (venture capitalists and business angels) as informal sources of knowledge. However, we have not considered whether cooperation partners (in our case, i.e., start-ups accelerated in the same cohort program but operating in different industries) favored the innovation performance of the start-ups (Van Aken and Weggeman 2000). We recognize that this is a limitation of our study. Scholars interested in tackling this issue may study what makes cooperation partners different from coopetitors in affecting start-ups' innovation performance in coworking spaces. In addition, future scholars should consider different dependent variables, such as start-up growth or, in general, different types of performance, and select control group samples to explore the efficacy of accelerators by comparing them to nonaccelerated start-ups.

Finally, by enlarging the sample and considering accelerators from different countries, scholars should compare the different impacts of participation in acceleration programs on start-ups' innovative performance, helping make the results of our study more generalizable. In addition, an increase in the sample size may strengthen the internal consistency of the variable VCANG, which is slightly outside the tolerance range.

Beyond its limitations, the paper also offers a few avenues for further research. First, a key insight of this article is that accelerator's programs can be seen as

coworking spaces. It would be interesting to deepen the internal dynamics that take place in this particular type of coworking space. Future research may explore which mechanisms that belong to the accelerator's programs may help startups increase their innovation performance. Second, future scholars should investigate such emerging coworking spaces through the use of qualitative research, which would permit a more granular comprehension of the phenomenon and the development of new theories based on the results.

6 Appendix A

List of Italian accelerators compliant with the definition provided by Cohen and Hochberg (2014)

Name	Foundation year	Seed ($)	Equity	Duration (month)	Cohort Size	Industrial sectors of program focus	Respondent Startups
42 Accelerator	2015	10-80k	10–80%	6–12	7	Generic	0
Alimenta	2014	50k	5%	9	7	Specific (agrofood startups)	4
Barcamper Garage	2015	25k	8%	3	20	Generic	3
Bioupper	2015	180k	10%	9	20	Specific (Biotech)	5
BiovelocITA	2015	100k	8%	9	10	Specific (Biotech)	2
b-Venture	2013	25k	10%	6	5	Generic	6
Cesenalab	2015	20k	5%	9	10	Specific (IT startups)	0
Fashion Technology	2013	100k	10%	8	9	Specific (Fashion startups)	4
H-Farm	2013	50k	10%	6	8	Specific (Web startups)	6
Industrio	2013	50k	15%	6	10	Specific (Hardware startups)	6
Make a Cube	2014	20k	5%	6	8	Specific (Social startups)	4
Nana Bianca	2012	10-80k	10–80%	6–12	7	Specific (Web startups	5
Nuvolab	2013	50k	10%	6	10	Specific (Web startups	8
Pi Campus	2014	25k	5%	6	8	Specific (Web startups)	5
SeedLab	2013	20k	10%	2	5	Specific (IT startups)	0
Seedup	2015	30k	10%	5	7	Generalist	3
Sellalab	2013	50k	15%	6	8	Generalist	5
SpeedmiUp	2015	30k	8%	9	10	Generalist	6
Startup bootcamp	2016	50k	10%	8	15	Generalist	8
The Hive	2014	20k	5%	9	10	Generalist	7
TIM#Wcap	2011	30k	5%	6	10	Specific (Web startups)	6
Vodafone Xone	2016	25k	10%	5	10	Specific (mobile startups)	7
iStarter	2012	20k	5%	6	3	Generic	6
Luiss Enlabs	2012	80k	9%	5	3	Generic	7

7 Appendix B

Questionnaire

Welcome to the online questionnaire "Types of openness for innovation within accelerator programs". With this survey we aim to investigate if external sources of knowledge provided by accelerator programs increase innovation performance of accelerated startups. For this purpose, we have scrutinized the literature on accelerators and we identified the external source of knowledge which interact with startups during the acceleration program. As a result, we have identified three external sources of knowledge: (1) Coopetitors; (2) Educators; (3) venture capitals and business angels. For each question an explanatory box is provided and accessible by clicking on the appropriate link.

7.1 Innovative performance

Please indicate the composition of the turnover of the startup two years after the participation to the acceleration program for what concern:

1. Technologically new product or services introduced to the market.
2. Technologically improved product or services introduced to the market.
3. Unchanged product or services.

7.2 Coopetitors as a source of knowledge (likert scale 0–7)

- To what extent did you rely on coopetitors as a source of exchange of information provided by the accelerator program?
- To what extent did you rely on coopetitors as a source of exchange of experiences provided by the accelerator program?
- What was the cooperation intensity with coopetitors provided by the accelerator program?

7.3 Mentors as a source of knowledge (likert scale 0–7)

- To what extent did you rely on mentors as a source of exchange of information provided by the accelerator program?
- To what extent did you rely on mentors as a source of exchange of experiences provided by the accelerator program?
- What was the cooperation intensity with mentors provided by accelerator program?

7.4 Educators as a source of knowledge (likert scale 0–7)

- To what extent did you rely on educators as a source of exchange of information provided by the accelerator program?
- To what extent did you rely on educators as a source of exchange of experiences provided by the accelerator program?
- What was the cooperation intensity with educators provided by accelerator program?

7.5 Investors as a source of knowledge (likert scale 0–7)

- To what extent did you rely on investors as a source of exchange of information provided by the accelerator program?
- To what extent did you rely on investors as a source of exchange of experiences provided by the accelerator program?
- What was the cooperation intensity with investors provided by accelerator program?

8 Appendix C

Construct details and factor loading

Construct	Items	Factor loading			
		1	2	3	4
COOP	Source of information 1		0.830		
COOP	Source of experience 1		0.921		
COOP	Cooperation 1		0.826		
EDUCATORS	Source of information 2	0.915			
EDUCATORS	Source of experience 2	0.932			
EDUCATORS	Cooperation 2	0.769			
VC	Source of information 3			0.731	
VC	Source of experience 3			0.840	
VC	Cooperation 3			0.767	
BUSANG	Source of information 4				0.783
BUSANG	Source of experience 4				0.835
BUSANG	Cooperation 4				0.751

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