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Firm performance after incubation: public incubators and knowledge-intensive entrepreneurial firms

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Abstract

Purpose – Drawing upon theories of knowledge-intensive entrepreneurial firms, we analyze how knowledge specialization within public incubators in terms of industries and founder backgrounds relates to firm performance after incubation. Special attention is given to the direct and indirect contributions of university researchers, who may be well-positioned to apply and recombine advanced knowledge.

Design/methodology/approach – We analyze a longitudinal sample of 852 start-up firms over a period of 15 years which have completed incubation period at one of 37 Swedish public incubators. We categorize knowledge specialization both in terms of founder backgrounds and in terms of the incubators' relative emphasis on an industry-technology. With 80% of firms in the dataset surviving for more than 10 years, our empirical focus is on factors associated with the growth of firms, during the post-incubation period.

Findings – We find that successful firms are founded by individuals from a variety of backgrounds and operate in diverse industries. Firms originating from incubators with more industry specialization have higher growth rates, but this advantage is time limited. Our findings highlight the importance of diverse knowledge specialization in entrepreneurial backgrounds and industries, suggesting that public policy should promote entrepreneurship across various settings and support diverse entrepreneurs.

Originality/value – By covering two dimensions of diversity, including founder backgrounds and integrating registration data from three sources we aim to enhance understanding of how these factors interact within the incubator and if and how these affect firms that have left incubation.

Keywords Firm growth, Firm survival, Incubators, Knowledge-intensive, Knowledge specilization

Paper type Research article

1. Introduction

Entrepreneurship plays a central role in the economy, as new firms experiment with and promote novel ideas that contribute to overall growth (Wennekers and Thurik, 1999). Through a Schumpeterian approach, a long line of literature has been stressing the importance of innovative entrepreneurship to the economy (Klepper, 2016; Van Praag and Versloot, 2007). Malerba *et al.* (2016) and Lindholm-Dahlstrand *et al.* (2019) argue that particularly entrepreneurial firms based upon advanced technologies and knowledge domains can play an

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important entrepreneurial function in promoting entrepreneurial experimentation and causing dynamics. Despite these contributions, limited attention has been paid to how survival relates to firm performance among a larger set of firms emerging from public incubation settings. This paper addresses this gap by analyzing both survival and post-incubation performance of innovative entrepreneurial firms. Specifically, we examine how knowledge specialization during incubation influences firms' subsequent growth and development.

Our theoretical frame of reference is the Schumpeterian conceptualization of knowledge-intensive entrepreneurial (KIE) firms (Malerba and McKelvey, 2019, 2020), which face outlier conditions as compared to conventional entrepreneurs. We adopt the definition of Malerba and McKelvey (2020, p. 508), who define KIE firms as "new learning organizations that use and transform existing knowledge and generate new knowledge in order to innovate within innovation systems".

KIE founders are exposed to fast-moving technologies and industries, while seeking to combine entrepreneurial vision with the commercialization of scientific and technical knowledge across and within sectors (McKelvey and Lassen, 2013). [1] These firms rely heavily on other actors in their innovation ecosystem, in terms of access to resources, contacts and realization of opportunities (Malerba and McKelvey, 2020). Given their dependency upon external knowledge and resources (as well as internal processes), KIE firms that have completed programs and training at public incubators are a relevant setting to examine survival and growth over time.

Entrepreneurs can be supported in their entrepreneurial journey and development. Public business incubators – including those associated with universities – can be understood as policy instruments for stimulating entrepreneurship. The intended mission of incubators is to assist entrepreneurs in translating their ideas into a firm by providing access to different types of resources, network contacts and talent (Klingbeil and Semrau, 2017; Kitagawa and Robertson, 2012; Markman *et al.*, 2008). Identified as a favorable environment for founders that are new to entrepreneurship (Guerrero *et al.*, 2021), incubators help start-ups overcome various entrepreneurial obstacles, including "liability of newness" (Stinchcombe, 1965) and "liability of smallness" (Freeman *et al.*, 1983). From a policy perspective, incubators have been seen as an instrument to stimulate long-term regional development and economic growth via the fostering of technological entrepreneurship and high-tech venture creation (Madaleno *et al.*, 2022; Aerts *et al.*, 2007; Phillips, 2002; Thierstein and Willhelm, 2001; Mian, 1997).

This paper contributes to the literature on incubators by differentiating two dimensions of knowledge specialization– those that relate to (1) founder background and (2) industrial sector. Specifically, we analyze how both dimensions of incubator specialization are related to survival and longer-term performance of incubated firms. We will examine KIE firms which have completed programs at similar public incubators in one country, allowing identification of a population of firms that have all survived to the point of completing incubation. One type of knowledge specialization refers to the background of the founders. Our database contains detailed information on the background of five different types of founders of KIE firms, including but not limited to founders with backgrounds as university researchers. The different founder types represent the previous experience of the founder and are assumed to bring relevant knowledge into the venture. The general importance of founder backgrounds as key determinants of firm capabilities has long been recognized (Helfat and Lieberman, 2002). Another type of knowledge specialization within the incubator refers to the density of other KIE firms within the same industrial sector, as compared to more diverse sets of firms in the incubator setting. Apart from work by Gifford *et al.* (2020), these questions have not been analyzed systematically from a KIE perspective, and particularly in relation to the surviving firms, nor has specialization along founder backgrounds been the focus of prior work on public incubators.

Empirically, we used and further developed our analysis, based upon a 15-year longitudinal dataset of entrepreneurial firms ($n = 852$) that completed incubation between 2005 and 2015

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at Swedish public incubators ($n_k = 37$) [2]. The dataset contains detailed variables at the incubator, firm and founder level, which allows us to measure factors associated with incubator specialization; including industrial sector, founder background, as well as variables that pertain to knowledge exposure during incubation. We then augmented the database with micro-data on survival and firm performance after leaving the incubator. We first explore factors behind firm survival. We find that survival is common, and most firms persist five years post-incubation. We then relate knowledge specialization during the incubation period, to analyze later firm growth in terms of both revenue and employees.

This paper is structured as follows. In the next section we review the literature on the knowledge specialization of public incubators and hypothesize their potential relationships with KIE firm post-incubation survival and performance. Section 3 presents details of our methods and an overview of our dataset, followed by results and conclusions in Sections 4 and 5.

2. Theoretical conceptualization: the relationship between public incubators and knowledge specialization

2.1 KIE firms in public business incubators

Incubators may also help realize the societal potential of individuals taking an entrepreneurial path, as countries appear to have varying numbers of potential "nascent" entrepreneurs (Delmar and Davidsson, 2000). Extant research has addressed the performance of incubators (Lasrado *et al.*, 2016; Lukeš *et al.*, 2019; Schwartz, 2009; Aernoudt, 2004; Sherman and Chappell, 1998) as well as alternative organizational design for effective incubation (Aaboen, 2009; Bergek and Norman, 2008). An extensive stream of literature addresses incubator characteristics. Prior research has shown that efficiency and networking benefits, especially those that pertain to suppliers, customers and partnerships; are associated with larger incubators (Klingbeil and Semrau, 2017; Gerlach and Brem, 2015; Schwartz and Hornych, 2010; Aerts *et al.*, 2007; Allen and McCluskey, 1990). A more recent debate addresses the organizational design of specialized incubators, which suggests that firm performance after incubation may be related to processes during incubation, and in ways that are not yet fully understood (Sohail *et al.*, 2023). Our conceptualization is that incubators, especially publicly funded ones, provide a way to define a set of founders and firms, which are provided institutional support to access internal and external networks of knowledge, as relevant to their business.

Our focus is on public business incubators – including university incubators – which we conceptualize as a tool for public policy for stimulating KIE firms. Founders of KIE firms require diverse resources and incubators should aim to prioritize these resources at different stages of firm development (Chan and Lau, 2005). A useful starting definition is thus "a support environment for start-up and fledging companies" (Peters *et al.*, 2004, p. 83), even though multiple, overlapping definitions for business incubators exist (Hackett and Dilts, 2004). According to Salvador and Rolfo (2011), incubators identify resource-constrained projects that are deemed to have a high probability in succeeding and assist new firms in overcoming the "liability of newness" and "liability of smallness". Incubators *directly* assist founders with the aim of transforming ideas into firms, along with the relevant resources, routines and capabilities (Breivik-Meyer *et al.*, 2020), but may also provide *indirect* returns such as those that pertain to co-location alongside other KIE firms (McAdam and Marlow, 2008).

A relevant issue is how public incubators promote KIE firm creation. Following Bruneel *et al.* (2012), we distinguish three dimensions of incubator support. The first is *shared infrastructure*, including office space offered at favorable conditions (Bergek and Norman, 2008; Carayannis and Zedtwitz, 2005) which may incorporate ancillary resources such as clerical services, meeting rooms and conference venues (McAdam and McAdam, 2008), as well as specialized premises such as laboratories and specialized equipment (Grimaldi and

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Grandi, 2005). A second dimension is *provision of business support* addressing managerial challenges and skill scarcity. Given the relatively undeveloped firm-specific routines of young firms which requires a gradual process of experimental learning (Dosi *et al.*, 2000), incubators may help with the problem of skill scarcity, offer training and business coaching (Clarysse and Bruneel, 2007) and provide access to specialized services–- especially technical, funding and legal assistance (Bruneel *et al.*, 2012; Grimaldi and Grandi, 2005). The third dimension is *access to networks*, both external and internal networks to the incubator and firms located there. *External* professional networks, which have been identified as a critical factor for incubatee prospects (McAdam and McAdam, 2008; Larson, 1992), serve to connect firms to a range of actors such as investors, suppliers, providers of technology, patent attorneys, consultants, academic institutions and customers (Schwartz and Hornych, 2010; Hansen *et al.*, 2000), as well as multinational corporations and other large enterprises (Vanderstraeten *et al.*, 2016; Bergek and Norman, 2008). Moreover, *internal* networks within incubators, according to McAdam and Marlow (2008), may facilitate the exchange of knowledge between incubating firms (Kitagawa and Robertson, 2012; Witt, 2004), lead to the formation of alliances and the gaining credibility among peers and broker relationships with entities that expedite entrepreneurial goals (Jack, 2005; Witt, 2004).

We conceptualize public business incubators – including university incubators – as providing relevant support for entrepreneurship and the specialized knowledge search processes of KIE firms.

One type of knowledge specialization refers internally to the firm, namely founder background. The composition of tenants in terms of *founder experience* may provide a source of knowledge specialization within incubators. An incubator provides its firms with various possibilities to interact across different types of knowledge bases. We thus consider both direct and indirect roles that *researcher*-led firms play in public incubators in relation to other types of founders: *students*, (non-researcher) *university staff*, *corporate spin-offs* and *independent inventors*. *Researchers* engaging in other engagement activities like collaborative research for example, is far more common than researchers engaging in firm formation (Perkmann *et al.*, 2013). Furthermore, peer influence, role models and the individual's orientation toward commercial science seems to influence this choice (Perkmann *et al.*, 2013; Stuart and Ding, 2006). *Students* in technology and science have been identified as more productive than researchers in starting firms (Åstebro *et al.*, 2012). They have also been identified as having dual roles by both developing their own ideas but also working in incubation projects based on researcher IP (Brunnström *et al.*, 2020; Culkin, 2013). Due to the practice of interpreting inventor ownership legislation in Sweden, *university staff* other than researcher/teachers, are usually awarded the same rights as researchers. Åstebro *et al.* (2019) finds that the likelihood of university employees becoming entrepreneurs was lower than that of non-university employees, but higher in Sweden than in the US. There are good reasons to think that founders starting a *corporate spin-off* would have advantages, not only in firm-formation, but also post-incubation in the marketplace (Dahl and Reichstein, 2007). Their advantages are related to resources such as capital, human capital, knowledge and know-how "inherited" from the mother firm. However, these comparative advantages may diminish with time (Ortín-Ángel and Vendrell-Herrero, 2014). Although not previously analyzed much in relation to public incubators, *independent inventors* are present in our data. Independent inventors refer to individuals who may lack the inherited endowments and resources associated with a corporate spin-off.

The second type of knowledge specialization has to do with the density of more firms in the same industry. Incubators that have higher sector-specific specialization appear to provide better tailored facilities and equipment, as well as specialized services (Schwartz and Hornych, 2008). Within an industry, specialized networks may also enable the transfer of industry-specific knowledge which provide solutions to product and routine development (Giuliani, 2010). However, when examining diversified and specialized business incubators, Schwartz and Hornych (2010) find no association between incubator specialization and an increase in

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inter-firm networks; nor do they find that specialization leads to more emphasis on academic linkages. Hansen *et al.* (2000) argue that specialized incubators represent a new organizational form that promotes scale and scope, entrepreneurial drive and network access, thereby offering benefits previously associated with large established companies and venture capital firms. However, prior work on social network dynamics among entrepreneurs in incubators finds no systematic relationship between networking and the number of venture partners (Ebbers, 2014).

Based on our interpretation of the above theories, we propose three hypotheses. Firstly, the survival after incubation needs to be examined and described in relation to the diversity of founder background, which is an indicator of internal knowledge specialization. Secondly, the firm performance after incubation is related to the density of other founders with similar backgrounds, for example the knowledge specialization as represented by the constituent type of KIE firm. Thirdly, firm performance after incubation is related to the density of other similar KIE firms within the same industry, for example the knowledge specialization as the composition of the set of firms in an incubator. We are assuming that more knowledge specialization promotes firm performance, as conditions in the incubator may provide graduating firms with some critical conditions for knowledge creation and learning and thereby provide a competitive advantage in the marketplace.

H1. Different types of innovative entrepreneurial firms will exhibit different hazard rates for (survival), after the incubation period.

H2. Higher density of founders with similar backgrounds in the incubator improves firm performance, over time.

H3. Better firm performance is more likely for firms from incubators with a higher density of firms from similar sectors, rather than incubators with a lower density of firms from similar sectors.

2.2 Researchers and university linkages as sources of knowledge specialization

One type of KIE ventures are started by researchers, which we are assuming have skills, knowledge and experience which makes them closer to current science. Researchers and science affect society in many ways.

Founders with a researcher background are expected to have the strongest linkages to a university. Evidence suggests that university linkages are important to firm growth during incubation as well as post-incubation (Lasrado *et al.*, 2016), as well as increased credibility for the firm and many benefits for the university as well (Hassan, 2024). However, Rothaermel and Thursby (2005) also found that stronger university connections (defining founders being researchers) led to projects incubated for longer compared to others. Moreover, Johansson *et al.* (2005), in research on non-incubated spin-offs, found that firms with stronger ties to universities enjoyed higher rates of employee growth. They argued that fewer but more intimate connections would give access to basic research support which Tether (2002) found spin-offs to be reliant on. Within the Swedish context, professors' privilege law (which guarantees the rights to research ownership unless otherwise agreed) has been found to be more effective in generating researcher-led firms compared to, for example, patents and licensing (Färnstrand-Damsgaard and Thursby, 2013). Combined with stronger university ties through employment and personal networks, this in-turn may offer a further incentive for researchers to engage and potentially thrive in entrepreneurial firms.

Researchers establishing KIE firms may also impact *other* types of co-incubated projects. Brunnström *et al.* (2020) found that their presence was correlated with a shorter incubation time of other projects. To our knowledge, prior research has not extended this analysis to the post-incubation stage, and we have few indications of whether and how researchers play a role within public incubators, including those associated with universities.

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Evidence for localized knowledge spillovers from science to industry is pervasive in a variety of contexts and at different levels of aggregation (Salter and Martin, 2001; Jaffe, 1989). Fini *et al.* (2009) describe researchers as seekers of primarily non-market-based rewards. Jensen and Thursby (2001) identify concerns regarding academic reputation, which may compete with other time uses and hinder commercialization of projects. Researchers are highly educated and sought after in the labor market; hence their opportunity costs tend to be higher than for other types of founders. Furthermore, Czarnitzki *et al.* (2014) argue that researchers who migrate from non-profit to for-profit firms incur higher *social* costs. This, they argue, creates a need for a performance premium compared to other startups in knowledge-intensive industries, which is corroborated by their finding of a positive performance premium of researchers and other university employees.

A variety of explanations may be possible. One argument is that researcher knowledge is tacit (Agrawal, 2001), and can only be accessed by those located close to the researcher. Another argument is that researchers may function as brokers, in the sense that they can connect co-located non-researcher-led startups to university researchers outside the incubator (Lissoni, 2010). A further argument is that both direct and indirect linkages to universities may enable firms to keep up to date with recent scientific advances relevant to their firms (Link *et al.*, 2007); including scientific methodology; broad knowledge of the research field, as well as instrumentation. Löfsten (2010), in a study of 131 incubated projects in 16 Swedish university incubators, found no evidence of a relationship between post-incubation performance and an incubator's internal and external networks. However, regarding later-stage firm development, Löfsten (2010) inferred that an incubator's internal network is a potentially important factor for firm growth. Brunnström *et al.* (2020) found that researcher-led projects are less likely to complete incubation compared to projects led by founders from other backgrounds. In our context, public university incubators, by providing shared infrastructure, also provide repeated interactions among different categories of founders, which may help activate knowledge networks between researchers and non-researchers.

H4. Better firm performance is more likely for firms with researchers as founders compared to other types of founder experience in incubators.

H5. Better firm performance is more likely for firms exposed to a higher concentration of projects with founders having researcher backgrounds.

3. Data and methods

We compile our dataset from three sources. Our starting point is a database from the Swedish government agency for innovation (VINNOVA) on all 42 Swedish incubators that received funding from Vinnova and 4,800 associated projects for the 2005–2014 period [3]. This dataset includes variables related to incubator and firm characteristics and founder experience, covering most of the population of public incubators in Sweden.

The initial dataset consisted of 42 incubators. Five incubators were removed as they did not meet the following two conditions: (1) the incubator existed in the dataset over at least five years in the chosen time-period to enable panel data, (2) complete data were available regarding the chosen relevant variables for both the projects, start-up firms and incubators and (3) the incubator could be classified as public. This resulted in a sample of $n_k = 37$ incubators that could be classified as public, leaving us with 3,370 associated projects, of these 852 firms graduated during the period. We link these firm and incubator level data with two types of firm level post-graduation data on the graduated firms, following them until 2020 in terms of survival and 2019 in terms of growth. This end time-period was chosen as we did not want the onset and consequences of the COVID-19 pandemic to potentially influence our results. The second dataset comprises manually collected records of industry classification and operating status for each graduated firm [4] ($n = 852$), compiled from the Swedish Companies Registration Office (Bolagsverket). The third dataset is provided by Statistics Sweden (SCB),

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which lists revenues and employee numbers for each of our graduated 852 firms at graduation and, three- and five-years post-graduation.

We first analyze post-incubation survival rates among graduated firms by employing a non-parametric Kaplan–Meier estimator of the survival function. Our data contain information on exited firms on a monthly interval. Exits via acquisitions are treated as censored. We also carry out a semi-parametric, Cox proportional hazards model to further analyze factors that may be associated with differences in post-incubation firm survival.

Although firms may *persist* in the market, they may not grow or flourish. In addition to survival analysis, we accordingly address firm performance in terms of revenue and employee growth. Our analysis of firm growth uses log-linear OLS regressions for three- and five-year outcomes. Standard errors are clustered at the incubator level to account for incubator-specific effects.

3.1 Variables

Revenue and employee data are categorical, a summary may be found in Table 1. We transform these data to arrive at variables expressed in number of employees for the year of graduation from the incubator program ($EmpYear0_i$) and three and five years of graduation ($EmpYear3_i$, $EmpYear5_i$) by taking the midpoints of each range in each category. Similarly, we take the midpoints for revenue for each year of observation ($RevYear0_i$, $RevYear3_i$ and $RevYear5_i$), expressed in thousands of SEK.

The descriptive statistics in Table 2 reveal that, post-incubation, firms grow in both employees and revenue. Mean revenue displays linear growth, albeit with increasing variability. The mean number of employees on the other hand plateaus after $EmpYear3_i$, yet with a high level of dispersion.

To analyze industrial specialization as addressed in H3, our dataset incorporates two levels of industrial sector categorization, one on a broader level and another on a finer grain level, a list of which may be found in Table 3.

We construct two variables, $SectorSpecL_{ikt}$ and $SectorSpecS_{ikt}$, which measure the share of *other* firms in the same sector classification, at the broader and finer levels respectively, and at the time of entry (t) to the incubator k for firm i [5]. Note that both measures exclude firm i as we are interested in *exposure* to *other* projects during incubation [6].

Table 2 shows that $SectorSpecL_{ikt}$ is, on average, higher than $SectorSpecS_{ikt}$, which, due to the former encompassing broader categories, is to be expected. A mean of 0.397 and 0.202 for $SectorSpecL_{ikt}$ and $SectorSpecS_{ikt}$ respectively indicate that incubators are more inclined to foster projects that are industrially similar, as these figures are higher than 0.25 (for $SectorSpecL_{ikt}$) and 0.05 (for $SectorSpecS_{ikt}$), which would represent a perfect distribution of sectors (given the number of industrial categories in each level).

Table 1. Employee and revenue categories

Employees		Revenues	
Class	No. of employees	Class	Revenues (in 1000 SEK)
0	N/A	0	<1
1	0	1	1–499
2	1–4	2	500–999
3	5–9	3	1,000–4 999
4	10–19	4	5,000–9 999
5	20–49	5	10,000–19,999
6	50–99	6	20,000–49,999
7	100–199	7	50,000–99,999
8	200–499	8	100,000–499,999

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Table 2. Descriptive statistics

	N	Min.	Median	Max.	Mean	s.d.
$RevYear0_i$	797	0.00	250.0	25,999.5	1502.3	2213.6
$RevYear3_i$	816	0.00	749.5	200,999.5	2894.3	12,431.3
$RevYear5_i$	787	0.00	749.5	200,999.5	3815.2	16,235.2
$EmpYear0_i$	814	0.00	2.5	74.50	2.910	5.109
$EmpYear3_i$	848	0.00	2.5	149.5	4.336	10.71
$EmpYear5_i$	831	0.00	2.5	149.5	4.975	12.20
$RevGrowth3_i$	772	−8.006	0	12.21	0.391	2.580
$RevGrowth5_i$	743	−8.006	0	9.680	0.376	2.829
$EmpGrowth3_i$	814	−3.541	0	3.395	0.097	0.781
$EmpGrowth5_i$	798	−2.674	0	3.541	0.145	0.918
$SectorSpecL_{ikt}$	838	0.00	0.375	1.00	0.398	0.265
$SectorSpecS_{ikt}$	838	0.00	0.118	1.00	0.202	0.233
$FounderSpec_{ikt}$	838	0.00	0.283	1.00	0.323	0.249
$Backgrounds_{ikt}$	838	0	3	4	2.868	1.213
$Researcher_i$	852	0	0	1	0.170	0.376
$Student_i$	852	0	0	1	0.132	0.338
$UnivEmployee_i$	852	0	0	1	0.105	0.306
$Inventor_i$	852	0	0	1	0.220	0.414
$Spinoff_i$	852	0	0	1	0.374	0.484
$ResExposure_{ik}$	852	0.00	0.175	0.875	0.193	0.159
$Selectivity_{ikt}$	838	0	8.133	124	11.89	15.98
$IncTime_i$	852	1	24	99	26.81	16.72
$IncAge_k$	852	0	12	31	12.91	6.760
$IncEmp_{ik}$	852	0	6.5	20	6.896	3.414
$University_k$	852	0	1	1	0.605	0.489

Table 3. List of industrial sectors

Level 1 category	Level 2 category
Clean technology	Energy
	Environment
ICT	ICT
	Computer games
Manufacturing subsectors	Manufacturing
	Leisure/entertainment
	Media
	Nanotechnology
	Design
	Security
	Material
	Food
	Packaging
	Vehicles
	Agriculture
	Space technology
	Other manufacturing
Life science	Life Science
	Medical technology
	Health

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H2 address the relationship between diversity of founder experience and post-incubation firm performance. The dataset records five founder types: (1) *researchers*, that conduct research or teach at a Swedish university or research institute ($Researcher_i$, 17%); (2) *students*, that are admitted to a course or program at a Swedish university ($Student_i$, 13.2%); (3) *university staff*, both technical and administrative ($UnivEmployee_i$, 10.5%); (4) *independent inventors*, that is individuals unaffiliated with a firm or university $(Inventor_i, 22\%)$ and (5) *corporate spin-offs*, that is projects started by an incumbent firm ($Spinoff_i$, 37.4%).

We define *founder specialization* ($FounderSpec_{ikt}$) as the share of projects with the same background as project *i*, at the time of entry (*t*) to incubator *k*, again excluding focal firm *i* [7]. We also include an additional variable, $Backgrounds_{ikt}$, representing the count of the number of other founder background types hosted by the incubator (i.e. not including the background of the founder of firm *i*) at the time of incubator entry. A mean of 0.323 in Table 2 for $FounderSpec_{ikt}$ indicates that incubators tend to foster projects with founders of similar backgrounds. On average, a firm will accompany projects from 2.868 other backgrounds upon entry to the incubator.

$Researcher_i$, the variable of interest for H4, is a dummy taking on the value of 1 if the founder's background is that of a researcher and 0 otherwise [8]. 17% of founders come from a researcher background. To address the level of exposure of firms to researcher-led projects during incubation as proposed in H5, we construct the researcher exposure index $ResExposure_{ik}$ as described in Equation (1):

$$ResExposure_{ik} = \frac{\sum_{j=1}^{N} \tau_{i,k} \cap \left(\tau_{j,k} \cdot r_{j,k}\right)}{\sum_{j=1}^{N} \tau_{i,k} \cap \tau_{j,k}} \in [0,1], i \neq j \quad (1)$$

where $\tau_{i,k}$ denotes the period of time project *i* spent at incubator *k*, $\tau_{j,k}$ denotes the period of time any other project (apart from *i*) spent at incubator *k* and $r_{j,k}$ takes on the value of 1 if $\tau_{j,k}$ is a researcher-led project and 0 otherwise. Hence, $ResExposure_{ikt}$ represents the percentage of exposure to researcher-led projects as a proportion to the total exposure to all projects during the incubation period. The descriptive statistics in Table 1 indicate that on average, projects are exposed to researcher-led projects 19.3% of their total exposure time during their incubation period, with a considerable level of variation ranging from 0% to 87.5%.

We expect that incubator managers attempt to select the most promising projects from those that apply. The larger the pool of applicants, the more selective they may be. Assuming incubator managers have some ability to predict success, selectivity should relate to performance. We thus define $Selectivity_{ikt}$ as the ratio of the number of projects applying (and evaluated) to the number of projects accepted at incubator *k*. In other words, $Selectivity_{ikt}$ measures the number of applicants for each accepted incubator project. This ratio is compiled for year *t* when firm *i* enters incubation. Thus, higher values of $Selectivity_{ikt}$ indicate a more selective incubator. Table 2 indicates that there is considerable range with this variable, with an average of 11.89 applications to a place.

$IncTime_i$ describes the length of time of incubation for firm *i* measured in months, which, on average, was 24. $IncAge_{ik}$ records the age of incubator *k*, in months, at the time of graduation for firm *i*. The development stage of an incubator can have a direct relationship with the resources it makes available for its tenants (Lalkaka and Abetti, 1999), and younger incubators have limited resources due to the "liability of newness". In our regression specifications, we take the log of both $IncTime_i$ and $IncAge_{ik}$ to account for expected diminishing returns. We also include $IncEmp_{ik}$, which is the number of full-time equivalent employees of incubator *k*, recorded at the time of project *i*'s entry to the incubator. Finally, $University_k$ takes on the value of 1 if the incubator is university-owned and 0 if municipality-owned.

Pairwise correlations between all variables are shown in Table 4.

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Table 4. Pair-wise correlation matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
(1) $RevGrowth3_i$	–													
(2) $RevGrowth5_i$	0.69***	–												
(3) $EmpGrowth3_i$	0.21***	0.24***	–											
(4) $EmpGrowth5_i$	0.22***	0.32***	0.76***	–										
(5) $SectorSpecL_{ikt}$	0.01	−0.03	−0.03	0.01	–									
(6) $SectorSpecS_{ikt}$	0.07**	−0.00	0.08**	0.05	0.59***	–								
(7) $FounderSpec_{ikt}$	−0.00	−0.03	0.04	0.04	0.17***	0.18***	–							
(8) $Backgrounds_{ikt}$	0.01	0.06	0.01	−0.04	−0.13***	−0.12***	−0.36***	–						
(9) $Researcher_i$	0.04	0.04	0.07**	0.03	−0.07**	−0.06*	−0.09**	0.04	–					
(10) $ResExposure_{ik}$	0.01	0.02	0.03	0.04	−0.09**	0.00	−0.13***	0.08**	0.24***	–				
(11) $Selectivity_{ikt}$	0.00	0.04	0.08**	0.12***	−0.10***	−0.03	−0.07*	0.02	0.04	0.07**	–			
(12) $lnIncTime_i$	0.00	−0.03	−0.03	−0.06	−0.02	0.04	0.00	−0.09**	0.09***	0.03	0.00	–		
(13) $lnIncAge_k$	0.03	0.07**	0.00	0.04	−0.03	−0.05	−0.02	0.16***	0.03	0.19***	0.16***	0.02	–	
(14) $IncEmp_k$	−0.05	−0.02	−0.04	−0.04	−0.10***	−0.03	0.01	0.20***	0.13***	0.38***	−0.05	0.05	0.25***	–
(15) $University_k$	0.07*	0.06	−0.03	−0.02	−0.15***	−0.02	−0.10***	0.12***	0.14***	0.29***	0.01	−0.00	0.06*	0.15***

Note(s): Pearson correlation coefficient reported. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively

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4. Results

Kaplan–Meier survival curves, partitioned by founder type and estimated by months of post-incubation survival, are shown in Figure 1 (for clarity, both graphs have axis breaks just below 0.70 survival probability).

The apparent initial concavity followed by convexity suggests stronger hazards earlier in the firm's lifetime, followed by stabilization as the firm matures, a "liability of newness". We may observe that, in general, there is little variance in survival probabilities across all firms, with at least 80% of firms surviving after 160 months (>13 years). There is no noticeable variation in patterns of survival rates *across* founder types, contrary to what was predicted in H1. We estimate a Cox regression to check whether there were any major determinants of post-graduation firm survival, the results of which may be seen in Table 5. The size of the incubator, measured by number of employees ($IncEmp_k$) was the only significant estimate in the full model specification (6).

Turning to post-graduation growth performance, we begin by estimating separate models for each of the main explanatory variables ($SectorSpecL_{ikt}$, $SectorSpecS_{ikt}$, $FounderSpec_{ikt}$, $Backgrounds_{ikt}$, $Researcher_i$ and $ResExposure_{ik}$), which are included alongside the control variables. We then estimate a full specification model incorporating all dependent variables. Regression results with respect to 3-year revenue and employee growth are reported in Table 6; results for 5-year growth are reported in Table 7.

Founder experience specialization addressed in H2, with the expectation that $FounderSpec_{ikt}$ and $Backgrounds_{ikt}$ are associated with post-graduation performance. We see no statistical significance for either coefficient, in both the employment and revenue growth models. In the five-year analysis, we likewise do not obtain significant coefficients.

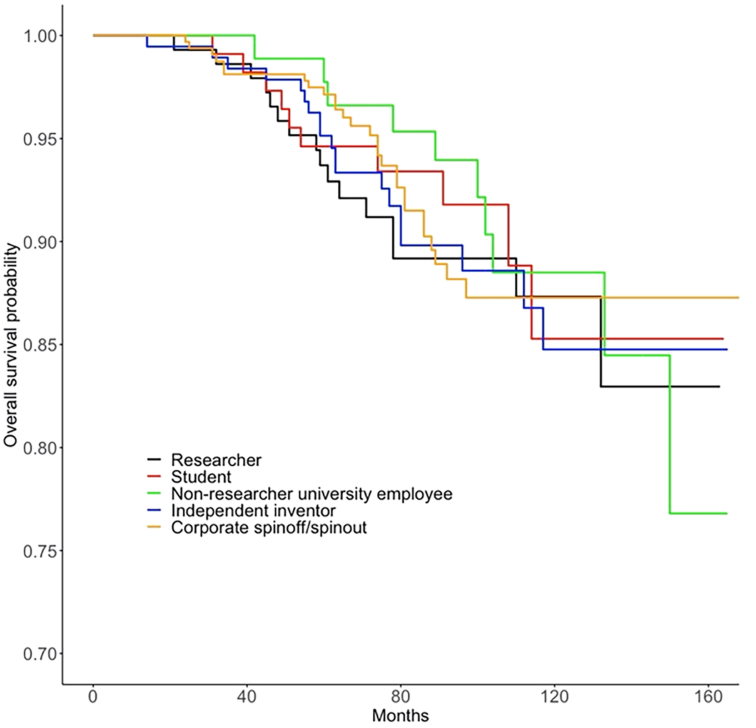

Figure 1. Kaplan–Meier survival curve estimators

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Table 5. Cox survival estimations

	(1)	(2)	(3)	(4)	(5)	(6)
$SectorSpecL_{ikt}$	−0.0133					0.3102
	(0.4174)					(0.5220)
$SectorSpecS_{ikt}$		−0.4347				−0.5688
		(0.5000)				(0.6110)
$FounderSpec_{ikt}$			0.0390			−0.0111
			(0.4906)			(0.4979)
$Backgrounds_{ikt}$			0.1404			0.1261
			(0.1046)			(0.1050)
$Researcher_i$				0.0363		0.0889
				(0.2846)		(0.2916)
$ResExposure_{ik}$					−1.0958	−1.0551
					(0.8180)	(0.8611)
$Selectivity_{ikt}$	−0.0017	−0.0020	−0.0020	−0.0018	−0.0006	−0.0009
	(0.0070)	(0.0071)	(0.0072)	(0.0070)	(0.0070)	(0.0072)
$lnIncTime_i$	0.1880	0.1936	0.2287	0.1866	0.1935	0.2296
	(0.1621)	(0.1626)	(0.1655)	(0.1625)	(0.1639)	(0.1669)
$lnIncAge_k$	0.3287	0.3205	0.3235	0.3284	0.3530*	0.3312
	(0.2150)	(0.2145)	(0.2186)	(0.2151)	(0.2130)	(0.2162)
$IncEmp_k$	0.0521	0.0508	0.0481	0.05184	0.0697**	0.0646*
	(0.0319)	(0.0318)	(0.0328)	(0.0319)	(0.0345)	(0.0356)
$University_k$	0.0588	0.0611	0.0369	(0.0600)	0.1404	0.1295
	(0.2355)	(0.2348)	(0.2363)	(0.2362)	(0.2415)	(0.2462)
N	835					

Note(s): Coefficients reported. Standard errors in parentheses. * and ** denote statistical significance at the 10% and 5% levels respectively

Thus, there is no empirical support for post-incubation performance and diversity of founders in co-incubated firms.

Hypothesis 3 addresses how industrial specialization, as measured by $SectorSpecL_{ikt}$ and $SectorSpecS_{ikt}$, is related to post-graduation firm performance. $SectorSpecL_{ikt}$, which measures industrial specialization when measured in a *broader* way, is not statistically significantly associated with revenue or employee growth. In contrast, we obtain significantly positive estimates for the narrower definition of specialization, $SectorSpecS_{ikt}$, both for revenue ($p < 0.10$) and employee growth ($p < 0.01$). These results indicate that projects benefit from *close* cognitive proximity, providing a post-graduation performance premium via the sharing of tacit information between co-incubatees, in-turn facilitating learning and innovation as well as post-graduation linkages. Five-year results (Table 7) suggest that these benefits may attenuate over time.

Furthermore, following on from H4, firms emerging from researcher-led projects (as measured by $Researcher_i$), exhibit significantly higher employment growth ($p < 0.01$) in their first three years. However, no significant association is found for revenue growth. This may suggest that firms founded by researchers tend to have complex products and services that necessitate an abundance of skilled labor, and/or that, following the reasoning of Jensen and Thursby (2001), their products and services are still in the development phase and not market-ready, therefore requiring additional employees to finalize. Note also that the stronger employee growth of researcher-led firms is limited to the three-year analysis.

Finally, exposure to researcher-led projects during incubation, as measured by $ResExposure_{ik}$, has no statistically significant association with either revenue or employment growth, counter to the prediction of H5. Thus, one may infer that *co-incubation with* researcher-led startups is insufficient to boost firms' post-incubation performance. Co-incubation may not be sufficient to access researchers' tacit knowledge, or

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Table 6. 3-year revenue and employee growth

	Dependent variable: $RevGrowth3_i$						Dependent variable: $EmpGrowth3_i$					
	(1)	(2)	(3)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
$SectorSpecL_{ikt}$	0.1467					−0.3896	−0.0061					−0.2360
	(0.4004)					(0.4885)	(0.1179)					(0.1506)
$SectorSpecS_{ikt}$		0.7715*				1.0874*		0.2808***				0.4432***
		(0.4350)				(0.5427)		(0.1009)				(0.1226)
$FounderSpec_{ikt}$			0.0800			0.0281			0.1446			0.1520
			(0.2983)			(0.3197)			(0.1289)			(0.1381)
$Backgrounds_{ikt}$			0.0490			0.0594			0.0249			0.0285
			(0.0817)			(0.0799)			(0.0246)			(0.0238)
$Researcher_i$				0.2635		0.2782				0.1867**		0.1964**
				(0.3991)		(0.4022)				(0.0748)		(0.0745)
$ResExposure_{ik}$					0.4229	0.2910					0.2196	0.1462
					(0.6984)	(0.7571)					(0.1990)	(0.2002)
$Selectivity_{ikt}$	−0.0034	−0.0034	−0.0036	−0.0039	−0.0039	−0.0044	0.0033**	0.0034**	0.0035**	0.0031**	0.0032**	0.0030**
	(0.0040)	(0.0037)	(0.0040)	(0.0042)	(0.0042)	(0.0043)	(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0013)	(0.0012)
$lnIncTime_i$	0.0193	0.0047	0.0251	0.0031	0.0173	−0.0118	−0.0278	−0.0321	−0.0235	−0.0371	−0.0285	−0.0406
	(0.1255)	(0.1325)	(0.1198)	(0.1301)	(0.1228)	(0.1291)	(0.0408)	(0.0400)	(0.0405)	(0.0422)	(0.0403)	(0.0406)
$lnIncAge_k$	0.2393	0.2533	0.2279	0.2362	0.2313	0.2352	−0.0198	−0.0155	−0.0251	−0.0222	−0.0245	−0.0237
	(0.1518)	(0.1559)	(0.1566)	(0.1517)	(0.1523)	(0.1580)	(0.0584)	(0.0542)	(0.0633)	(0.0578)	(0.0580)	(0.0585)
$IncEmp_k$	−0.0523**	−0.0513**	−0.0562**	−0.0562**	−0.0600**	−0.0642*	−0.0057	−0.0052	−0.0072	−0.0076	−0.0091	−0.0125
	(0.0234)	(0.0239)	(0.0253)	(0.0241)	(0.0267)	(0.0322)	(0.0101)	(0.0096)	(0.0101)	(0.0098)	(0.0110)	(0.0093)
$University_k$	0.4478*	0.4394*	0.4316*	0.4137*	0.4066	0.3557	−0.0405	−0.0381	−0.0379	−0.0566	−0.0553	−0.0804
	(0.2257)	(0.2300)	(0.2224)	(0.2286)	(0.2499)	(0.2618)	(0.0698)	(0.0683)	(0.0761)	(0.0697)	(0.0683)	(0.0646)
Constant	−0.2043	−0.2924	−0.2631	−0.0790	−0.1188	−0.2367	0.2632	0.2014	0.1494	0.2895	0.2661	0.1986
	(0.6106)	(0.5645)	(0.5260)	(0.5573)	(0.5346)	(0.5896)	(0.1854)	(0.1820)	(0.1970)	(0.1767)	(0.1748)	(0.1995)
N	759						797					

Note(s): Clustered robust standard errors (clustered on incubators) in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively

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Table 7. 5-year revenue and employee growth

	Dependent variable: *RevGrowth5*$_i$						Dependent variable: *EmpGrowth5*$_i$					
	(1)	(3)	(2)	(4)	(5)	(6)	(1)	(2)	(3)	(4)	(5)	(6)
SectorSpecL$_{ikt}$	−0.1745					−0.2034	0.0403					−0.1277
	(0.4409)					(0.5343)	(0.1147)					(0.1420)
SectorSpecS$_{ikt}$		−0.0215				0.2361		0.2218*				0.2786**
		(0.4354)				(0.5442)		(0.1135)				(0.1324)
FounderSpec$_{ikt}$			−0.1454			−0.1062			0.1015			0.1178
			(0.4135)			(0.4166)			(0.1757)			(0.1827)
Backgrounds$_{ikt}$			0.1192			0.1215			−0.0237			−0.0187
			(0.1071)			(0.1046)			(0.0213)			(0.0212)
Researcher$_i$				0.2810		0.2707				0.1015		0.0957
				(0.3172)		(0.3446)				(0.0946)		(0.0924)
ResExposure$_{ik}$					0.1755	0.0873					0.3606	0.3144
					(0.7398)	(0.7790)					(0.2508)	(0.2588)
Selectivity$_{ikt}$	0.0023	0.0026	0.0022	0.0023	0.0025	0.0018	0.0062***	0.0062***	0.0063***	0.0060***	0.0058**	0.0059***
	(0.0048)	(0.0048)	(0.0049)	(0.0048)	(0.0050)	(0.0051)	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0022)	(0.0021)
lnIncTime$_i$	−0.1113	−0.1096	−0.0912	−0.1250	−0.1104	−0.1107	−0.0695*	−0.0728*	−0.0734*	−0.0747*	−0.0708*	−0.0828**
	(0.1227)	(0.1222)	(0.1091)	(0.1285)	(0.1203)	(0.1190)	(0.0369)	(0.0360)	(0.0380)	(0.0389)	(0.0358)	(0.0379)
lnIncAge$_k$	0.4055**	0.4041**	0.3701*	0.3987**	0.4002**	0.3671*	0.0323	0.0358	0.0404	0.0308	0.0246	0.0354
	(0.1871)	(0.1901)	(0.1985)	(0.1889)	(0.1902)	(0.1986)	(0.0662)	(0.0636)	(0.0635)	(0.0657)	(0.0657)	(0.0595)
IncEmp$_k$	−0.0410*	−0.0398	−0.0460	−0.0430*	−0.0425	−0.0515*	−0.0092	−0.0090	−0.0084	−0.0106	−0.0151	−0.0149
	(0.0241)	(0.0242)	(0.0274)	(0.0254)	(0.0255)	(0.0285)	(0.0122)	(0.0117)	(0.0122)	(0.0116)	(0.0126)	(0.0118)
University$_k$	0.3973*	0.4100*	0.3750*	0.3813*	0.3968	0.3284	−0.0391	−0.0408	−0.0308	−0.0515	−0.0675	−0.0699
	(0.2201)	(0.2190)	(0.2141)	(0.2146)	(0.2380)	(0.2315)	(0.0792)	(0.0778)	(0.0834)	(0.0814)	(0.0792)	(0.0762)
Constant	−0.1856	−0.2716	−0.4773	−0.2202	−0.2703	−0.3874	0.2843	0.2567	0.3169	0.3224*	0.3152*	0.3297
	(0.7501)	(0.6550)	(0.6126)	(0.6649)	(0.6342)	(0.7381)	(0.1833)	(0.1787)	(0.2161)	(0.1797)	(0.1759)	(0.2210)
N	730						781					

Note(s): Clustered robust standard errors (clustered on incubators) in parentheses. *, ** and *** denote statistical significance at the 10%, 5% and 1% levels respectively

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access to this tacit knowledge may not have a strong impact on firm performance. This finding diverges from those obtained by Brunnström *et al.* (2020), who report that projects exposed to higher shares of researchers were more likely to complete incubation and doing so in less time than other projects. These contrasting outcomes may be due to the form of the exchange between project founders (e.g. advice and mentorship) rather than a more permanent transfer of knowledge. Thus, the returns from researcher exposure may be seen at the incubation stage only.

Regarding our control variables on revenue growth, $lnIncAge_k$ is statistically insignificant for the first three years. $IncEmp_k$, on the other hand, is *negative* and significant for the first three years of revenue growth. This may be explained by a potential "coddling" effect of incubation, leading to firm difficulties once exposed to the marketplace. This adds to the arguments put forward by prior research that the liability of newness of firms takes effect *after* graduation and that incubation may, in some regards, exacerbate this liability by providing *over* support during incubation (Schwartz, 2013; Feldman and Pentland, 2003; Levitt and March, 1988). $University_k$ remains positive and significant for growth in terms of revenues in both the three-year as well as the five-year models (up to *model 5* in both), however for the employee-growth models $University_k$ have negative and insignificant values throughout. A possible explanation of these results could be the presumably stronger linkages to universities of firms being incubated at university incubators may be linked to stronger growth patterns as suggested by Rothaermel and Thursby (2005) and Lasrado *et al.*'s (2016) studies. Although, these growth patterns are only visible for growth in terms of revenues.

For further analysis to ensure robustness, we manually scrutinized the top 1% of all firms by employee count and revenue five years post-incubation (Table 8). No discernible pattern could be found in terms of industrial sector, the incubators that hosted them or the origins of the respective businesses. Top performers came from different incubators, and their founders had diverse backgrounds. Even though industry spin-offs and independent inventors were the most common founder background, others, such as researchers and (non-researcher) university employees, were present among the top performers.

5. Discussion and conclusions

Despite policy makers' interest in incubator performance, a challenging issue remains regarding how to measure and explain the relationship between incubator performance and the performance of highly innovative entrepreneurial (KIE) firms. In this paper, we proposed to differentiate knowledge specialization within public incubators along two dimensions: specialization by industries of the firms incubated, and specialization by founder backgrounds.

Contrary to our predictions, the post-incubation (hazard of) survival of KIE firms founded by different founder types did not differ, but instead our results suggest most firms persist in the market. This result may seem contra-intuitive as researchers, for example, tend to have more embryonic ideas (Jensen and Thursby, 2001) in need of more resources and time to survive and grow than others. Given the endowments of corporate spin-offs, these should have an advantage (Dahl and Reichstein, 2007), but our results suggest otherwise.

However, in line with our predictions, we obtained some evidence suggesting that industry specialization may be associated with higher growth rates post-incubation. This association appears to be short-lived, suggesting that inter-firm networks may pay off in the short run but not in the long run, thereby complementing Schwartz and Hornych's (2010) findings of no association between incubator specialization and inter-firm networks. Although specialization may be linked to higher short-run post-incubation growth, this should not be taken as evidence of durable network effects. Instead, the positive association that we found may reflect other explanations, such as temporary sector-specific support (Hansen *et al.*, 2000), legitimacy after completing incubation (Guerrero *et al.*, 2021) and/or due to the composition of firms and industries (Giuliani, 2010).

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Table 8. Top 1% of firms 5 years post-incubation terms of revenue and employees respectively

Firm	Activities	Founder type	Incubation (months)	Graduation year	Employees[a]	Revenue (million SEK)[a]	Incubator	Incubator founding year
Alpha	Manufacturer of plastic and plastic products	Independent inventor	16	2011	10–15	20–25	East 1	2007
Beta	IT developer and platform provider	Independent inventor	37	2009	10–15	100–200	South 1	1983
Gamma	Parking app developer	Spinoff	25	2014	20–35	100–200	South 1	1983
Delta	Vehicle developer and consultant	Spinoff	34	2014	50–75	100–200	West 1	1997
Epsilon	Hybrid and electric driving systems	Spinoff	19	2011	50–75	100–200	West 1	1997
Zeta	Vehicle engine developer	Spinoff	21	2011	20–35	20–25	West 1	1997
Eta	Staffing and recruiting company	Researcher	17	2013	100–150	10–15	West 2	2008
Theta	Forestry, organized hunting and related activities	Independent inventor	12	2014	100–150	20–25	West 3	2000
Iota	Personal assistance for disabled people	Independent inventor	3	2007	100–150	20–25	Central 1	1987
Kappa	Software developer in the recruitment sector	University employee	7	2007	50–75	10–15	East 2	1999
Lambda	Wave and wind power developer and retailer	Spinoff	23	2012	5–10	100–200	East 3	1999
Mu	Healthcare company	Spinoff	13	2014	50–75	10–15	East 3	1999

Note(s) [a]5-year employee and revenue estimates given as a range, starting with the minimum and ending with median

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Knowledge specialization along with founder backgrounds appeared to be unrelated to firm-level outcomes. Such evidence suggests that knowledge sharing among founders of similar background has minimal influence on subsequent firm success. Furthermore, our results show limited support for the proposition that incubated firms benefit from co-located founders with dissimilar, but related, backgrounds.

In addition, we did not obtain strong results suggesting a special role for researcher-led firms in public incubators. Stronger employee growth of researcher-led firms was limited to the first three post-incubation years. However, it is of note that we did not see any signs of researcher-led firms performing worse than the other founder types. This is surprising given that researcher's ideas tend to be embryonic and in need of time and resources (Jensen and Thursby, 2001). Given that researcher-led firms performed as well as firms founded by other types of founders, a possible interpretation may be that the incubation period does provide them with relevant resources to develop an idea into a venture.

Further, we found no support for the hypothesis that exposure to more researcher-led firms is beneficial for co-incubatees with other types of founder backgrounds. The returns from researcher exposure, as suggested by Lissoni (2010) and Brunnström *et al*. (2020), may be of a temporary nature and may not develop into longer-term relationships that benefit the firm. The brokering role of researchers would thus also be temporary and the benefit of this relationship, that is the connection to other researchers and the university does not continue after the co-incubated time together is over.

The general pattern emerging from our analysis, that is that no single characteristic is strongly predictive of post-incubation performance, is consistent with our additional analysis of top performers in our sample. At the same time, our findings attest to the overall economic significance of startups emerging from incubator facilities. Five years after incubation, the top performers in the sample were what may be considered successful, that is with revenues in the hundreds of millions of SEK and up to 150 employees. While it was not the purpose of our study to identify the causal effect of incubation on firm performance, nor to establish the cost-effectiveness of public incubation, these top performers show that firms emerging from public incubators may create non-negligible numbers of jobs and contribute in meaningful ways to the Schumpeterian innovation ecosystem in which they are embedded.

5.1 Implications for public policy

Public business incubators are widely used policy instruments aimed at fostering knowledge-intensive entrepreneurship and supporting long-term economic growth (Ejermo, 2018). However, designing effective policies in this area remains challenging, as entrepreneurial processes are inherently uncertain, decentralized and difficult to predict (Henrekson and Sanandaji, 2020). In such contexts, policymakers operate under conditions of incomplete information regarding both entrepreneurial opportunities and market needs (McKelvey and Saemundsson, 2018; Metcalfe, 1998).

Our findings provide several implications for the design of public incubation programs. First, the absence of strong performance differences across founder types suggests that targeting specific groups may not be sufficient to improve overall outcomes. Instead, policies that support a broad range of entrepreneurial backgrounds may be more effective in fostering diverse and resilient entrepreneurial ecosystems.

Second, although our findings do not suggest differences between founder types, this also hints at researcher-led firms benefitting more from incubation. Moreover, assuming that firms founded by researchers are more likely to introduce change in industries and societies (as suggested by, e.g. Stephan, 2014), our findings suggest researchers having access to public incubators is of utmost importance.

Third, the limited and short-lived effects of industrial specialization indicate that while sector-specific support may generate short-term growth advantages, it does not necessarily

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lead to sustained performance differences. This suggests that policymakers should be cautious in overemphasizing specialization strategies at the expense of broader knowledge diversity.

Fourth, the overall pattern of results highlights that no single organizational design for incubators appears to dominate in terms of performance outcomes. Rather, multiple configurations may be effective in supporting knowledge-intensive firms. This aligns with an evolutionary perspective on innovation systems, where variety, experimentation and multiple pathways are essential components of economic development.

Taken together, these findings suggest that policy efforts should focus less on optimizing specific incubator characteristics and more on enabling a diverse and flexible environment for knowledge-based entrepreneurship across industries and founder backgrounds.

5.2 Limitations and future research

This study has several limitations that should be considered when interpreting the results. First, our empirical design focuses exclusively on firms that have completed incubation within public incubators. While this allows us to analyze a relatively homogeneous population of supported firms, over a long time-period, it does not enable direct comparisons with non-incubated firms (as some previous studies do, e.g. Lasrado *et al.*, 2016; Schwartz, 2013). As a result, we cannot draw causal conclusions regarding the effectiveness of incubation itself.

Second, we also recognize the debate about the efficiency of different types of incubators, but instead we focused on examining our population of firms kept constant over a long time-period, in one country, and all from public incubators. Our choice to include incubator variables as control variables was to try to tease out the possible impacts of incubator differentiation on long-term performance.

These limitations, together with our findings, point to several avenues for future research. This study suggests post-incubation performance and survival cannot be predicted by what the firm is exposed to while incubated. We therefore propose that future research may do well by focusing on: (1) challenging what the definition of success is for KIE firms, and (2) using the quantity of new firms as a measurement of success for incubators. Building on this study's conclusion that incubated firms persist in the market, a compelling argument can be made that firms persisting are able to compete and thereby contribute to economic growth.

Notes

1. This specific form of entrepreneurship is closely related to concepts related to previous literature including young innovative firms, technology start-ups, academic spin-offs and Schumpeterian firms.
2. Measuring growth (in employees and revenues respectively) up until 2019 and survival up until 2020.
3. Vinnova DNR: 2017–03360.
4. These data were collected by two of the authors independently and then combined to avoid manual input errors.
5. Formally, these may be expressed as $SectorSpecL_{ikt} = \frac{N_{j,p}}{N_j}$ and $SectorSpecS_{ikt} = \frac{N_{j,q}}{N_j} \in [0, 1], i \neq j$, where $N_{j,p}$ $N_{j,q}$ represent the number of other incubated projects in the broad (p) and narrow (q) industrial sector category, and N_j denotes the total number of incubated projects at the time of entry.
6. These two measures are somewhat simpler versions of *related* and *unrelated variety* as originally proposed by Frenken *et al.* (2007), which considers all sectors within its entropic measurement. However, as we wish to study the effects of co-incubated firms in the *same* industry as firm *i*, we consider simpler share measures instead.
7. Formally, $FounderSpec_i = \frac{N_{j,b}}{N_j} \in [0, 1], i \neq j$, where $N_{j,b}$ denotes the number of projects with the same background as the founder of firm i into the incubator and N_j denotes the total number of incubated projects at the time of entry.
8. The data used only record the background of the "idea provider", meaning we do not have access to potential team composition.

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