Systema Incubatorae - Classifying the Nests

A Quantitative Study Using a Type-Specific Approach to Business Incubator Assessment

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Abstract
Research on business incubators has focused on various aspects of these organizations. Two of these aspects are the research themes of incubator types and incubator performance. This study examines these two themes together and analyzes what effects incubator types have on the performance outcomes of Swedish incubators. To do this, a sample of 298 firms from 23 different incubators is classified into two groups of generalist and specialist incubators and analyzed using OLS regression and negative binomial regression. The results show that firms from specialist incubators outperform their counterparts from generalists in terms of amount of funding received and the number of patents registered, but do not show any significant differences in terms of revenues and number of employees. These findings are both consistent and contradicting to previous research results and highlight the importance of taking incubator types into account in incubator performance research. As such, the study contributes with a type-specific methodological research approach in incubator performance analysis. The researchers view this approach as a promising way forward in business incubator research because of the way it unifies two major themes in research and its potential ability to consolidate the field of incubator types. From a practical perspective, the results can help entrepreneurs to make more informed decisions about which incubator to enter.

Keywords:
Startups; Business incubator; Incubation; Incubator types; Performance

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Contents

1. Introduction

1.1 Background

Stories about the life of successful organizations are for many people intriguing. Some of the most famous examples are the stories of the tech-giants Apple, Amazon and Google that all started their organizational life in a garage and are today worth hundreds of billions of dollars. Today, the garages in Palo Alto and Seattle are probably home to electric cars and not tech-startups. Many of the startups are instead incubated in safer environments. For a natural scientist, the word "incubation" can have various meanings. For example, it can be referred to as the time between the exposure to an infection and the signs of symptoms or to the activity of egg-incubation performed by egg-hatching animals. For an economics or business scientist in the 21st century, the word has, however, a very different meaning. The phenomenon of business incubation, performed by business incubators, is today widespread. The overall mission of a business incubator is to provide new ventures with a support infrastructure with the intent to help startups survive, scale up, and grow (Mian et al., 2016).

In that respect, business incubators can be seen as a means to mitigate what is referred to as the "liability of newness", which is a concept introduced in 1983 by Michael T. Hannan and John Freeman in their research on the population ecology theory of organizations (Hannan & Freeman, 1983). According to the liability of newness, young firms are exposed to a higher probability of organizational death. In that sense, the comparison to the eggs in the bird nest is perhaps more than just a metaphor and some researchers even refer to incubator companies as "fledgling businesses" (Stokan et al., 2005).

Although incubators have existed in one form or another since the 1950s, it was during the 80s and 90s that the founding rate of incubators increased significantly (Hackett & Dilts, 2004). Today, incubators and accelerator programs are a natural part of business and science communities in multiple economies and amounts to roughly 7000 worldwide according to the International Business Innovation Association (cited in Van Rijnsoever et al., 2017). Despite this significant increase in the number of incubators around the world, the use of the term has been broadly applied to a number of startup-supporting activities (Aernoudt 2004), which has led to a lack of a consistent definition and unified theory in research (Mian et al., 2016). The reason behind this is mainly the diversity among different types of incubators in terms of the needs they aim to satisfy and the goals that they set out to reach (Grimaldi & Grandi 2005; Bergek & Norrman 2008).

As a consequence of this inconclusiveness, the research results on evaluating incubator performance have become rather spread. By only inferring from the recent growth in incubator founding rate (Salido 2013), it is reasonable to think that business incubators constitute effective tools to support startup-firms. The general view within the research community is, however, rather mixed. On the one hand, some findings show that business incubation is positively related to job creation (Stokan et al. 2015) and investment size (Van Rijnsoever et al., 2017). On the other hand, other findings show no relationship between business incubation and variables like growth in profit or sales (Pena, 2004; Lukeš et al., 2018).

One of the most frequently cited explanations behind this spread in research results is the previously mentioned diversity among different types of incubators and their respective objectives (Aernoudt 2004). Aernoudt even argues that "evaluating incubators, or trying to introduce quality standards, has to take these differences into consideration in order to make sense." (2004, p. 129).

Given Aernoudt's argumentation, this study divides up incubators into different classifications based on their respective strategic scopes and objectives. This allows us to investigate if different types of business incubators perform relatively better than other incubator types on different performance measures. To do this, this paper starts off by reviewing the current state of knowledge on incubator classification and incubator performance with the aim of identifying a categorical framework to be used. This framework is then used to categorize a sample of cross-sectional data on 298 startup-firms from 23 Swedish incubators. This yields two contrasting incubator types that are quantitatively analyzed and statistically tested against one another. The performance measures (dependent variables) used are the amount of funding received by an incubator company, the revenues generated by an incubator company, the number of patents registered by each company and the number of employees in each company. The results show that one incubator type outperform the other in terms of amount of funding received and patents registered. In the case of the variables on the generated revenues and on the number of employees, the study is unable to find any statistically significant results.

1.2 Research Question

The purpose of this research paper is to enhance the understanding of the diversity of business incubators by quantitatively analyzing incubator companies' performances with respect to different incubator types. The aim is to shed light on the potential risks, proposed by the existing literature, of applying the same performance measures when analyzing multiple incubator types. The hope is to be able to showcase that different incubators achieve different performance outcomes and thus contribute to the research field on business incubation. Therefore, our research question asks:

What are the effects of different incubator types on the performance outcomes of Swedish incubators?

1.3 Delimitations

This paper tries to answer how the performances of business incubators differ between incubator types by analyzing incubator companies' performances. In that sense, the study will not compare incubator companies to firms that have not been a part of an incubator program. Furthermore, the topic of incubator management is also left out of the research scope since the study only looks at the performance outcomes of the actual incubator companies as means to understand the differences between incubator types.

Moreover, the study is geographically delimited to Sweden mainly due to reasons of data collection. There is no industry-specific focus, as the study does not exclude incubators based on industry-focus. Lastly, the paper does not look at the role of the individual entrepreneurs, as the study is mainly an analysis on an organizational level.

1.4 Intended Research Contribution and Implications

The identified research gap is best illustrated by viewing the established incubator research as consisting of two main areas. While previous research on business incubators has focused on either a.) incubator classification or b.) incubator performance (Mian et al., 2016), there are only a few researchers that have integrated these two topics. This integrated area is where we find a research gap and where we place this research paper in the theoretical context. The intended research contribution is, therefore, to reduce the discrepancy between these two research areas and show the importance of taking both aspects into account in incubator research. Specifically, by using the incubator types as the explanatory variables in evaluating incubator performance, we hope that this research paper will facilitate a better understanding of the spread in previous research results on incubator performance and show the importance of a contingent theoretical approach to research on business incubators. This paper does this through the introduction of a type-specific approach to incubator performance evaluation.

As recent literature has indicated, there are mismatches occurring between startup-firms and incubators for various reasons such as insufficient tailoring of resources by the incubators (Henriques & Ratinho, 2010) and too little knowledge of business challenges by the entrepreneurs (van Weele et al., 2017). As such, the problem of mismatching seems to lie in both ends of the field. However, the understanding that different incubators vary in their ability to achieve certain performance measures is one of the first things for entrepreneurs to be aware of if they consider joining an incubator program. Therefore, the intended practical implication is to help entrepreneurs make more informed decisions on which incubator to join.

2. Previous Literature

2.1. Background

In the special issue on Technology Business Incubation the in journal Technovation, the editors summarize the current state of research on business incubation in the opening article (Mian et al., 2016). In this article, the authors present the research field by theme. Two of the main themes are incubator assessment and incubator model. These themes are the equivalents to what is referred to as incubator performance and incubator types in this paper. This section will review the established literature on both these themes. Lastly, they will be viewed together to theoretically contextualize this paper.

Hackett and Dilts (2004) offer an early systematic review of the research field of business incubators. They define a business incubator as "a shared office-space facility that seeks to provide its incubatees (i.e. "portfolio-" or "client-" or "tenant-companies") with a strategic, value-adding intervention system (i.e. business incubation) of monitoring and business assistance" (Hackett & Dilts, 2004 p. 57). An incubatee is a startup-firm that currently sits in the incubator. Being a relatively early study, Hackett and Dilts published their work during a time when incubators started to also offer more sophisticated services and resources. Today, the Small Business Encyclopedia defines a business incubator as: "An organization designed to accelerate the growth and success of entrepreneurial companies through an array of business support resources and services that could include physical space, capital, coaching, common services, and networking connections" (Entrepreneur Europe, 2019).

Throughout the development of business incubators as tools for fostering young firms, multiple models and configurations on which they are organized have emerged. An early configuration was the distinction between profit- and non-profit incubators. From there on, researchers have identified several other key ways in which incubators have come to differ from one another. Examples include the level of specialization (Schwartz & Hornych, 2008), university involvement (Mian, 1994) and selection criteria (Bergek & Norrman 2008) among others. Aernoudt raised the research problem of this diversity already in 2004 by stressing the importance to "avoid comparing apples to pears" (Aernoudt, 2004 p. 128). Nowadays, the consensus on the importance of understanding the heterogeneous reality of incubators in research has become more accepted in the literature. Consequently, there are now multiple schemes for incubator classification established in the literature.

2.2 Incubator Types

The early research on the topic of incubator types was conducted by Allen and McCluskey (1990). From their research, six archetypes were identified: for-profit property development, not-for-profit development corporation, academic, for-profit seed capital, hybrid and corporate. These classifications are generated based on the sources of value added to the incubatees. As an American study, this classification reflects a view that, at the time, was present in the U.S., which is also the place where the development of incubators originates (Aernoudt, 2004).

From there on, the number of articles per year on business incubation remained relatively low during the 1990s. At the shift of the millennium, however, the number of articles soared and reached its peak in 2005 with 19 articles (Mian et al., 2016). During this time, Aernoudt makes his classification and identifies five distinct incubator archetypes formulated against four variables: main philosophy, main objective, secondary objective and sectors involved (Aernoudt, 2004). At this point, the objectives of different incubators started to emerge as a useful variable in incubator classification in contrast to the previous focus on the sources of value added by incubators. The reason for this switch could be that incubators, at this point in time, had become rather homogenous in terms of the resources that they provided to their incubatees and new ways to separate them were needed.

Nevertheless, the emphasis on the resources added to incubatees still remained a means of classification in the literature because of new needs and expectations from incubatees with an "increasing focus on more intangible and high-value services (access to advanced competencies, learning experiences, knowledge, networking, synergies, etc.)" (Grimaldi & Grandi, 2005 p. 113). These new needs and expectations are met in what Grimaldi and Grandi refer to as "Model 2" (2005 p. 114), which is characterized by high-end financial and social capital. Model 2 is naturally supplemented by Model 1, which is more focused on the provision of tangible assets and market necessities. The types that are identified include Business Innovations Centres (BIC), University Business Incubators (UBI), Independent Private Incubators (IPI) and Corporate Private Incubators (CPI). The authors' illustration of the models is shown below in figure 1, where the UBIs possess characteristics from both models.

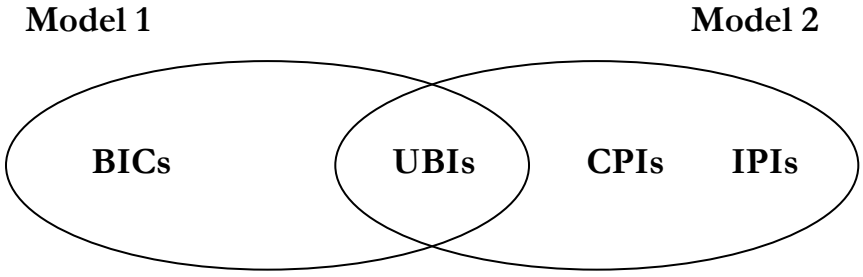

Figure 1
(Grimaldi & Grandi, 2005, p. 114)

Compared to other researchers, Grimaldi and Grandi (2005) use a myriad of variables to generate their incubator types. While we believe that there are strengths in taking many characteristics into account, the high number of variables might also make the classification scheme difficult to apply in practice due to unclarity about which variables to put emphasis on.

A couple of years later, Bergek and Norrman (2008) instead turned to the selection process of incubatees as the driver of incubator classification. These researchers argue that "since most incubators seem to supply more or less the same set of general administrative services" (2008, p. 23), the selection process is a more useful variable in order to distinguish incubators from one another. These researchers distinguish between the idea-focused- and the entrepreneur-focused approach, as well as the "picking-the-winners"- and the "survival-of-the-fittest" approach. By combining all four approaches, four different incubator types are created (Bergek & Norrman 2008). This classification scheme shares many features with another influential categorization

which looks at the spin-out activities used in different incubators (Clarysse et al. 2005). The similarities lie in the selection of incubatees as a critical stage in spin-out processes in incubators. Clarysse et al. identify three incubator archetypes; low selective model, supportive model and incubator model.

By focusing on the selection process in particular, these classification schemes stand in contrast to both the resources added-view and the objectives-view that are both broader and more general. Instead, the selection process-view shares more features with another view on classification that gained popularity in research around the same time. That is the strategy perspective on incubator classification, which applies Porter's strategy models of competitive scope and competitive advantage as tools to distinguish between incubator types. Among the first researchers to highlight this was Schwartz and Hornych (2008) that emphasized the potential advantages of specialization as a strategy for business incubators. A couple of years later Matthyssens and Vanderstraeten (2012) established a more complete classification scheme where selection process is one factor to consider when categorizing incubators together with resource munificence and monitoring and business assistance (Matthyssens & Vanderstraeten, 2012). The incubator types that are generated are generalists and specialists. Generalists host a broad variety of firms from different sectors and technologies and provide general operational business support, whereas specialists attract firms from specific sectors and fields and offer technology-specific services. A simplified version of the researchers' classification scheme is shown below in figure 2.

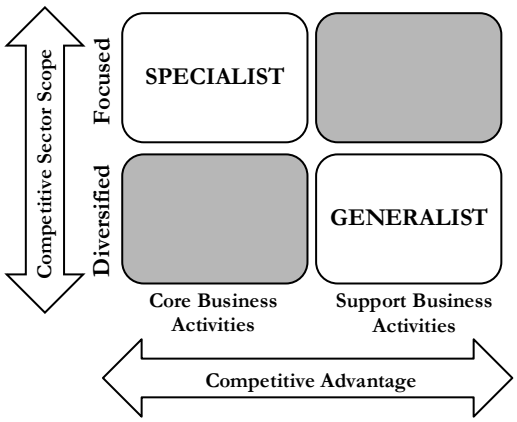

Figure 2
(Matthyssens & Vanderstraeten, 2012, p. 663)

The strength of Matthyssens and Vanderstraeten's framework is that it harmonizes many of the aspects from other classification schemes into a rather simplistic distinction. This makes the classification scheme relatively easier to apply in comparison with for example Grimaldi and Grandi (2005) that uses more variables and several incubator types.

Table 1 summarizes the different classifications, including the variables used in the classification, as well as the classifications identified. Although other classifications exist in the literature, the presented ones are the most used in incubator research and originate from some of the most cited articles in the field (Mian et al., 2016). The structure of this table has been inspired by similar ways of summarizing previous literature in the research field (Barbero et al., 2012).

Table 1 - Incubator Classifications in the Literature

Authors	Variables behind classification	Classifications generated
Allen & McCluskey (1990)	Sources of value added	For-profit property development Non-for-profit development corporation Academic For-profit seed capital Hybrid Corporate
Aernoudt (2004)	Main philosophy Main objective Secondary objective Sector	Mixed incubator Economic development incubator Technology incubator Social incubator Basic research incubator
Clarysse et al. (2005)	Level of complexity of resources and activities View of the incubatees	Low selective model Supportive model Incubator model
Grimaldi & Grandi (2005)	Private/public nature Institutional mission Industrial sector Location Market Origin of ideas Phase of intervention Sources of revenue Services offered Management team	Business innovation centre (BIC) University business incubator (UBI) Independent commercial incubator (IPI) Corporate commercial incubator (CPI)
Bergek & Norrman (2008)	Selection Business support Mediation	Idea-focused approach Entrepreneur-focused approach "Picking-the-winners" approach "Survival-of-the-fittest" approach
Matthyssens & Vanderstraeten (2012)	*Competitive Scope & Competitive Advantage:* Selection process Resource munificence Monitoring and business assistance	Generalists Specialists

As can be seen in table 1, the most common classification schemes in research on incubator types revolve around the objectives of the incubators, the resources they provide, how they choose to specialize and how they select the incubatees. Consistent with the trend in the research field, many articles were published around the year 2005. Although, the classifications may look different on paper, many of them overlap to varying extents. For example, classifying incubators based on objectives may very well yield similar incubator types compared to a classification based on

resources added by incubators because organizations often align objectives and goals to resources and capabilities. As more research on business incubation is conducted, the research field on incubator types may consolidate further and we believe that this paper's type-specific approach is one way of achieving this, which will be illustrated later in this section. To do that, however, we first need to introduce the second theoretical building block - incubator performance.

2.3 Incubator Performance

As a second theme identified within business incubator research, incubator assessment (or incubator performance) uses quantitative studies and comparative analyses to assess performances of incubators (Mian et al., 2016). The topic is of interest for multiple stakeholders. As policymakers on both national and local level have come to view incubators as tools for promoting economic development, innovation and new technology (Bergek & Norrman, 2008), the performance outcomes of incubators are of interest not only to the incubators and the incubatees.

The main cause of encountering the existence of multiple classification schemes in incubator research is, as mentioned earlier, the different objectives and strategies of different incubator types. This diversity of incubator types has been identified as one of the explanatory factors to a lack of academic consensus within incubator performance research (Phan et al., 2005). Other researchers mean that performance is directly connected to objectives, since "the concept of 'performance' usually refers to the goal attainment of an activity or scheme" (Bergek & Norrman, 2008 p. 22). The current literature on incubator performance measures is characterized by a range of complexity with respect to different performance measures, which can be explained by varying research methods and sample sizes (Barbero et al., 2012).

As one of the most prominent researchers on university incubators and science parks, Sarfraz Mian suggests four approaches for university incubator assessment: Goal approach, system resources approach, stakeholder approach and internal process approach. Each approach contains multiple measures (Mian, 1997). Apart from only studying university-based incubators, Mian's framework is complex in the sense that the variables are hard to quantify and is suitable for smaller sample sizes.

Another set of performance measures commonly used in research on university incubators/science parks are variables related to R&D. Variables like the gross R&D investment and R&D spending as a percentage of total sales, the number of new products and services introduced and the number of patents registered by a firm are all examples of performance measures used in evaluating university- and technology-based incubators and science parks (Westhead, 1997). Although complex in terms of data collection, these variables are easier to quantify and are more appropriate for larger sample sizes.

Moving away from the relatively complex performance measures that are found in the literature, more common and easier measures are revealed. For example, some researchers have looked at growth figures in sales, profit and employees as well as the number of employees (Peña, 2004; Lukeš et al., 2018). Although, the literature seems to agree on profit growth as an inappropriate variable in incubator research (Barbero et al., 2012). Others have used investment size and

investment source that incubatees receive (Van Rijnsoever et al. 2017), job creation by incubatees (Stokan et al. 2015) and their survival rates (Aernoudt, 2004; Aerts et al., 2007).

Lastly, one performance measure which has been used more extensively in development economics than in management research is cost per job (Markley & McNamara, 1995). Although, the variable is starting to gain popularity in management research as well (Barbero et al., 2012). Viewing incubators as means to create jobs in society, the cost-per-job variable becomes interesting in comparison to other job creation activities, especially for policymakers.

Similar to what was done in the review of incubator classification literature, table 2 summarizes the presented incubator performance measures. This table is also inspired by previous studies within the field (Barbero et al., 2012).

Table 2 - Incubator Performance Measures in the Literature

Authors	Performance measures used
Mian (1997)	Goal approach System resources approach Stakeholder approach Internal process approach
Westhead (1997)	Gross R&D investment as % of sales R&D spending as % of sales Number of new products and services introduced Patents registered by firm
Aernoudt (2004); Aerts et al. (2007)	Survival rate
Peña (2004); Lukeš et al. (2018)	Sales growth Profit growth Employee growth Number of employees
Stokan et al. (2015)	Number of jobs as % of firm age
Barbero et al. (2012)	Cost per job
Van Rijnsoever et al. (2017)	Investment size Investment source (Gov. grants, VC, bank loan etc.)

As previously explained, prior research touches upon various performance measures, many of which are very different from one another. The use of multiple performance measures across studies may not be a problem in itself, however, the problem with multiple performance measures occurs when they are applied on companies from multiple incubator types that all differ in terms of objectives and strategic scope. The problem arises because bundling together incubator companies as a homogenous sample may become misleading when trying to infer conclusions about the performances of incubator companies as a whole. This issue is something that this paper

wants to address and the proposed solution is to adopt an integrated view on incubator performance by combining it with the literature on incubator types.

2.4 Type and Performance - An Integrated View

Although many papers explore the classifications and performance measures separately, the task of quantitatively testing the performance outcomes of different incubator types is still fairly unexplored. Bergek and Norrman (2008) suggested such an approach for future research in their article and some researchers have started to explore this integrated view (Aernoudt, 2004; Barbero et al., 2012). Similar to what this paper is set out to research, Barbero et al. (2012) analyze the performances of four incubator types identified in Andalusia, Spain. Their main variable of classification is incubator objectives and they reach a conclusion that not all incubator types perform satisfactorily. Nevertheless, the authors still see room for "more studies unearthing the differences between characteristics, performance and unique features of incubator types" (Barbero et al., 2012 p. 901).

It is this integrated theoretical view of incubator type performance with which this study will move forward. It is also in this integrated area where we place it in the research context. Although researchers have observed a consolidation of a conceptual understanding and unified theory in the research field, they still see a need for a contingency approach that "addresses varying objectives, organizational forms and context". (Mian et al., 2016 p. 6). With respect to this call for future research, the integrated view of this paper is one way of contributing to the need for more incubator research that analyzes performance contingent upon certain incubator types. There are probably more ways in which this research call can be answered, however, we view the type-specific approach to incubator performance assessment as a promising area of research because of the way it can unify two main themes in the research field and add analytical value. Specifically, it enables researchers to utilize both the extensive literature on incubator types and use the performance measures that are most interesting in the light of the types that are being analyzed.

In regard to this reasoning, this paper contributes with a new and potential promising direction for incubator research and gives one example of how such a study can be methodologically organized and executed. In the next section, the study's method is presented. There we will explain which classifications and performance variables that are used in the study.

3. Method

3.1 Research Design and Strategy

To compare performances between firms that have been a part of different types of incubators, we have conducted a quantitative study with cross-sectional data. In the light of the research question, a cross-sectional study is well-suited because of the multiple companies studied and the research objective of tracking patterns in performance outcomes of being associated with different incubator types. In spite of this clear cross-sectional research design, the study also has elements of a comparative design in the sense that the incubatees in our sample are divided into two main incubator types, which facilitates the analysis by contrasting cases with different traits and objectives against each other (Bryman & Bell, 2015 p. 72). Even though we understand that a cross-sectional design limits our possibility to draw causal inferences as to if the incubator types really are the causes of the effects we measure, the high number of observations yields statistically significant results on important correlations and is therefore in this case a strength.

The study relies on secondary data analysis. This methodological choice allows for an extensive data collection and the use of data from credible databases with less risk of experiencing biases associated with other research methods. Although, it is acknowledged that we lack full control over the collection procedures used by these databases, which can affect data-quality, we believe that the benefits of being able to synthesize large amounts of data from different sources is a justified reason to use secondary data (Bryman & Bell, 2015 p. 239).

This paper takes on an exploratory approach where the existing literature within incubator research lays the foundation for the formulation of the research question and the collection of data. In that sense, this study views the connection between theory and research through a deductive perspective. However, due to the exploratory nature of the research question, there are also elements of induction in this study. An argument for this is that this cross-sectional study draws inferences out of the statistical observations rather than trying to test theory through hypotheses (Bryman & Bell, 2015 p. 632). Nevertheless, the study still uses existing literature to guide the discussion of the results, which further establishes this research as mainly deductive.

The concept of "incubator types" is, as many other concepts in social science, the product of systematic research, observation and measurement of the original concept of business incubators. Although researchers have acknowledged the "arbitrary nature inherent in each category" (Aernoudt, 2004 p. 128), this paper views incubator type as an accurate conceptualization that reflects the reality of the business incubator environment. In that sense, this paper has a positivist epistemological approach to the reality of which the study is set out to analyze, which is necessary in order to draw normative conclusions.

Elaborating further on incubator type as a concept, the matter of how this study operationalizes this concept in order to assess incubator performance becomes relevant. As incubators are organizations in and of themselves, a natural way of measuring the performances of these organizations is to use the incubators as the unit of analysis. In support to this approach, there are benchmarks for incubator performance developed by the EU (European Union, 2002).

Nevertheless, the most common way of operationalizing the performance of incubators in prior research is to use the companies that are or have been incubated as the unit of analysis. Since the mission of incubators is to help startup-firms to survive and grow, this way of measuring incubator performance makes sense since the performances of the incubator companies become indicators of the performance of the incubators themselves. It is this latter approach that this paper will use in the analysis of incubator performance.

3.2 Incubator Classification

In this study, a classification scheme characterized by incubators strategic scope and sector specialization has been applied on the sample. This classification scheme is inspired by similar schemes in the literature (Schwartz & Hornych, 2008; Matthyssens & Vanderstraeten, 2012) and divides the incubators into generalists and specialists. Due to the geographic scope of this study, other classification schemes found in the literature have not been applied for various reasons. Generally, those reasons are related to differences in culture and complexity of the entrepreneurial infrastructure between countries. The following paragraphs will first explain the reasons for why some classification schemes have not been applied and then explain the chosen classification scheme in more detail.

First of all, the industry organization Swedish Incubators and Science Parks (SISP), from which the sample is drawn, does not include any corporate or solely private incubators (Grimaldi & Grandi, 2005). This could be a consequence of the role that the Swedish government has in promoting entrepreneurship and innovation. Secondly, there are only a few incubators in Sweden that focus solely on social gaps like equality or integration, which is the case in social incubators (Aernoudt, 2004). Lastly, an interesting feature about the Swedish incubator environment is that the vast majority of incubators have, in one way or another, connections to universities. A common way to distinguish incubator types in previous literature is to separate incubators with respect to their university-connections (Allen & McCluskey, 1990; Mian, 1997; Grimaldi & Grandi, 2005). Consequently, this is rather difficult in Sweden.

Other similar studies have used the incubator objectives as the only variable behind classification (Barbero et al., 2012). In the Swedish context, this becomes rather difficult because the government is very often the majority owner of incubators through various government bodies and public research institutions. Thus, the overall objectives are relatively similar across Swedish incubators. Nevertheless, some differences in incubator objectives do exist and these are connected to the level of specialization and technology-focus. In that sense, our scheme of classification is influenced partly by the theory of incubator objectives (Aernoudt, 2004) as a variable of classification, but most importantly on the strategy perspective of generalists and specialists (Matthyssens & Vanderstraeten, 2012). The following paragraphs describe this classification.

Generalists host companies from a variety of industry sectors and look mainly at the personal- and team-characteristics of companies. These incubators are more regionally oriented with the objectives of creating jobs in local communities and cities, as well as fostering entrepreneurship. The resources and services provided are general, such as operational business support and administrative services, which reflect the wide industry scope. Although the industry scope is wide,

there is still an emphasis on innovation, which is the case across incubators in the whole sample. These characteristics share some similarities with Matthyssens and Vanderstraeten's framework in the sense that it considers selection criteria, as well as the incubators' resource munificence (2012, p. 664).

Specialist incubators are specialized in terms of industry sectors and pay more attention to the market possibilities of the companies' products with a focus on new technology and research discoveries. They are usually located in bigger cities in connection to research institutions. Their objectives revolve around commercialization of research and the contribution to a country's success in high-technology sectors. Emphasis is put on providing sector-specific and intangible assets, such as intellectual property-support and scientific/technological knowledge. Tangibles that are provided in the specialist incubators often include technological/lab equipment and more sophisticated assets, besides office space. This description also fits fairly well into Matthyssens and Vanderstraeten's framework (2012, p. 665).

To determine whether an incubator is a generalist or a specialist, information from the incubators' websites and their annual reports were gathered and analyzed. Furthermore, the degree of homogeneity of industry sectors represented by the companies in each incubator also helped to facilitate the classifications. An iterative process was adopted, where the collected information was sorted and categorized in different ways to test the robustness of a classification-decision. The classification process ended when a satisfactory categorization of incubator was reached.

The distinction of generalists and specialists is binary and, therefore, could be viewed as a bit simplified. However, in this case we believe that a binary distinction yields a better result than by applying more than two incubator types. The reason being that by using too many types, the study runs the risk of analyzing categorical variables based on weak factors of distinction between categories. More elaboration on the variables will be presented later in this section.

3.3 Sample of Incubators and Companies

The first step in the data collection was to identify incubators. Due to the geographic scope of the study, the industry organization Swedish Incubators and Science Parks (SISP) was used to identify the incubators. SISP has 65 members that are both incubators and science parks that collectively host over 5000 firms. In the case of science parks, the deciding factor of whether or not such an organization was included in the sample was whether or not the science park in question also hosts an incubator, which is a rather common approach in contemporary research (Weijs-Perrée et al., 2019).

Having identified the incubators, the current incubator companies and the alumni companies from each incubator were plugged into the database crunchbase.com, which collects various data on startup-firms. This yielded a sample of 795 companies from 23 different incubators. Crunchbase is a unique database in the sense that it is a renowned platform that gathers startup-specific data from ventures all around the world, e.g. data on funding rounds, total amount of funding received, number of founders etc. Of the 795 companies in the sample only 298 had values on the amount of funding received, which is a key variable in this study's analysis. Therefore, the sample was

reduced to only include those 298 companies with all 23 incubators still represented by at least one company. In the actual analysis, the sample was further reduced to only include 227 companies in three out of four regressions and 223 companies in one out of four regressions due to missing values on other variables.

3.4 Variables

3.4.1 Dependent Variables

The dependent variables are the performance measures in the study. The study analyzes four dependent variables. These are 1.) the total amount of funding received by a firm in USD, 2.) the revenues generated by a firm in SEK 3.) the number of patents registered by a firm and 4.) the number of employees in a firm. These are chosen in the light of the literature on incubator performance measures and cover different objectives and missions of business incubators (Aerts et al., 2007).

Funding

Data on the total amount of funding per firm was retrieved from Crunchbase. Crunchbase receives their data from more than 3,700 investment firms that submit monthly reports on funding activities. The reasons for choosing to include this variable in the study are the lack of research on the variable in similar incubator type performance studies and the importance of funding for the survival and success of startups (Kerr et al., 2014). Crunchbase includes most of the funding types, e.g. angel investments, venture capital, government grants, bank loans etc. Far from the only factor that defines startup success, we still believe that the variable will yield interesting insights into how good startups in the incubator types are at attracting funding. In the analysis, the natural logarithm of the total amount of funding is used to compensate for skewness in the dataset as a consequence of outliers in the data.

Revenues

As a second variable that measures startup success, we use the revenues generated by an incubator company. Data on this variable was collected from the database Retriever.com. Retriever is a database that gathers financial data on Scandinavian companies based on information in financial reports. Revenues is a performance indicator that is commonly used to measure a firm's success in incubator research (Peña, 2004; Lukeš et al., 2018). The reason for including revenues as a performance measure is because it represents the commercial performance of the incubator companies. This allows us to not only study firm success in attracting funding, but also how well the assets are utilized in the market and turned into sales. Similar to the variable on the amount of funding, we use the natural logarithm of revenues to compensate for skewness in the data.

Patents

In order to obtain data on the third dependent variable, which is the number of patents registered by a firm, we used the U.S. patent register. The reason behind the choice of using the American patent register is the ease of access, but also the quality stamp that an American patent represents for a Swedish startup-firm. By matching the patent database with the sample yielded 98 patent matches distributed over 26 of the firms in the sample. The major drawback of using the U.S.

patent register is the lack of observations, which can affect the analysis negatively. Commonly used in incubator research (Westhead, 1997; Barbero et al., 2012), this variable represents a performance measure of R&D output by the incubator companies and will allow us to draw conclusions about the result of research and development in generalist- versus specialist incubators.

Number of Employees

The fourth dependent variable measures the number of employees in a firm. Along with the other financial data used in the study, data on the number of employees was collected from Retriever. This variable measure job creation by the incubator companies. It is similar to previously applied variables of job creation such as number of employees divided by the number of years in business (Stokan et al., 2015) or cost per job (Barbero et al., 2012). The reason for this is the fact that the amount of funding per firm, as well as the age of each firm is controlled for in the regression model for the number of employees.

3.4.2 Independent Variables

Incubator Type

The main independent variable is incubator type. It is a conceptually constructed categorical variable that takes on the values of generalist or specialist depending on which incubator type each company's incubator belongs to (Salkind, 2010 p. 124). The strength of using a dichotomous variable is that the incubators represented in the sample can be distinctly separated. Had more categories been used, it would have increased the risk of weakening the distinctions between incubator types in the sample. The drawback of only using two incubator types is that less nuanced conclusions can be inferred from the results. The distribution of companies in each incubator type turned out to be 50 percent in each type.

The rest of the independent variables in the study are control variables. The control variables are chosen based on both logical reasoning of what might affect the dependent variables a priori, e.g. the age of the company, and in the light of what other researchers have used in similar methods within incubator research (Shane & Stuart 2002; Stokan et al., 2015; Van Rijnsoever et al. 2017).

All the variables used in the study can be found in table 3 along with descriptive statistics. Table 4 shows the correlations between all the numerical variables.

Table 3 - Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
Funding	298	13.502	1.744	8.672	18.513
Revenues	278	7.326	2.384	0	13.706
Patents	298	.329	1.555	0	15
Employees	281	7.342	12.599	0	143
Age	298	7.322	5.163	1	35
Founders	244	2.004	1.016	1	6
Activated R&D Costs	298	4.424	4.038	0	11.919

Industry	Freq.	Percent
C. Manufacturing	28	9.79
G. Wholesale and retail trade	24	8.39
J. Information and communication	118	41.26
K. Financial and insurance activities	9	3.15
M. Professional, scientific and technical activities	86	30.07
N. Administrative and support service activities	7	2.45
Q. Human health and social work activities	7	2.45
Other	7	2.45

Incubator Type	Freq.	Percent
Generalists	149	50.00
Specialists	149	50.00

Table 4 - Correlations

Variables	Funding	Revenues	Patents	Employees	Age	Founders	ActRD
Funding	1.000						
Revenues	0.312	1.000					
Patents	0.209	-0.002	1.000				
Employees	0.452	0.457	0.077	1.000			
Age	0.363	0.274	0.298	0.270	1.000		
Founders	0.005	0.016	0.083	0.081	-0.209	1.000	
ActRD	0.223	0.337	-0.053	0.271	0.141	0.022	1.000

Employees

It is reasonable to believe that a higher number of employees should require higher amount of funding for a firm. The reasons being that more employees mean higher salary checks and possibly more extensive operations that need to be funded. In terms of revenues, similar reasonings apply. However, no a priori predictions are made on the impact of the number of employees on the number of patents in a firm.

Age

A more mature firm should have attracted more funding than a less mature one (Van Rijnsoever et al. 2017). Furthermore, the same argumentation applies to the amount of revenues, the number of patents and the number of employees in a firm.

Number of Founders

Assuming that more founders imply a larger social network, research within network theory has shown that a larger social capital endowment can have positive effects on venture capital funding

(Shane & Stuart 2002). Furthermore, the number of founders may positively impact the number of patents per firm through more collective competence, as well as the number of employees.

Activated R&D Costs

As activated R&D costs is a measure of a firm's investments in intangible assets that are close to market introduction, it is reasonable to believe that it exhibits a positive relationship with the number of patents. Similar to the variables for funding and revenue, we use the natural logarithm of activated R&D costs to help mitigate the effects of skewness in the data. The variable name is abbreviated in some of the tables for reasons of space and is called "ActRD".

Funding

The amount of funding per firm is only included as a control variable in the model that predicts the number of employees per firm. The reason for why the amount of funding is controlled for in that model is because we want to isolate the effect that funding may have on the number of employees in each firm.

Industry

Controlling for different industries has been done in other research papers with similar methods (Stokan et al., 2015; Van Rijnsoever et al. 2017). Since different sectors have different regulatory frameworks, staff requirements and investment needs, it makes sense to control for it in the regression models. The letter next to each industry in table 3 is the European NACE-coding. Some industries were only represented by one or two firms and were, therefore, classified together as "Other".

3.5 Regression Models

This study uses regression models to analyze the data. In the case of the models that predict the dependent variables of funding, revenues and employees, regular OLS regression is used. These variables are numerical and do not display any characteristics that would motivate the use of more sophisticated regression models. In the case of the model for the number of patents, however, we fit a negative binomial regression model. The reason for using a negative binomial regression model in the case of patents is because it is a count variable that exhibits overdispersion. For count variables of this kind, it is inappropriate to use linear regression models according to literature (Long et al., 2006 p. 4). Furthermore, these authors also suggest that for overdispersed count variables, a negative binomial regression is the best model to apply (2006, p. 266). The drawback of using negative binomial regression is the difficulty of interpreting the results. To make it easier for the reader to follow the regression outputs in the next section, the interpretation of the negative binomial regression model is:

$$\Delta y = exp(x\widehat{\beta})$$

where y is the number of patents in a firm, $\hat{\beta}$ is the logs of expected counts in the the number of patents and x is the dichotomous variable that takes the value of 0 for generalist and 1 for specialist.

The first step of each model only enters the control variables. The second step adds the main independent variable of incubator type. For all models, the log likelihood is included to assess if each step improves the overall model. Furthermore, R-square figures are also included for each step of the models to see if the performance of the models increase with each step.

3.6 Limitations and Reflexive Considerations

Despite our belief that the methodological choices that have been taken are justified, we do acknowledge the influence of our subjectivity in all stages of the research process. However, we identify some critical areas that might be relatively more sensitive to interpretations and subjectivity of us as researchers.

An area in which this becomes evident is the classification process through which the incubators in the sample are categorized. Although established classification schemes were used to guide the generalist/specialist distinction, the arbitrary nature of different categories inevitably leads to the need for making interpretations. Interpretations become difficult when the incubator in question possesses characteristics of multiple incubator types. Thus, the ambiguity of the classification procedure is an issue that affects the inter-observer consistency of this paper and may damage the reliability of the study (Bryman & Bell, 2015 p. 169). To address this risk, we have let the classification process take its time and thoroughly discussed the decision-making in this process to ensure a mutual understanding of our impact as researchers on the incubator types that were generated.

Another reflexive aspect relates to the geographic scope of this study. As the researchers have connections to Sweden and its business environment, the familiarity with the organizational context that the incubators are a part of may have affected the sampling and incubator classification. Acknowledging our inherent bias and our probable inclination to conduct research in a familiar context, we have actively reflected on what implications this have had throughout the process. As we strive to retain the external validity of this study, the country-specific customization of the incubator classification has been kept to a minimum viable level.

These are the areas in which we believe the method is subject to limitations and where reflexive considerations are especially needed. The next section contains the presentation of the study's results, followed by discussions and conclusion.

4. Results

Table 5 presents the results from the OLS regression and the negative binomial regression that predict amount of funding received, revenues generated, number of patents and number of employees based on incubator types. The p-values are shown in parentheses below each coefficient. The R-square and McFadden pseudo R-square range between 0.15 and 0.33, which shows satisfactory model fits. Furthermore, the additions of the variable of incubator type result in model improvements in all models.

The model for amount of funding shows that being a part of, or having been a part of, a specialist incubator type has a positive effect on the amount of funding received by an incubator company relative to companies belonging to generalist incubator types. Specifically, if an incubator company belongs to a specialist incubator type it receives on average 65.5% more funding than that of a company belonging to a generalist. In contrast, the second model, which predicts the amount of revenue, does not show any significant results between incubator types. As with the model for funding, being a part of, or having been a part of, a specialist incubator type, has a positive effect on the number of patents registered by an incubator company relative to companies belonging to generalist incubator types. As can be seen in table 5, the value of the coefficient for specialist incubator companies is 2.389, which predicts that incubator companies from specialist incubators have, on average, roughly 11 more patents than that of companies from generalist incubators. Lastly, the fourth regression model shows no significant effect on the number of employees in a company with respect to incubator type.

Table 5 - Regression Results (Industry variable is left out of the table due to reasons of space)

		Funding		Revenues		Patents		Employees	
		Step 1	Step 2	Step 1	Step 2	Step 1	Step 2	Step 1	Step 2
Control Variables	Employees	0.060***	0.060***	0.073***	0.073***	0.067	0.104+		
		(0.000)	(0.000)	(0.000)	(0.000)	(0.191)	(0.071)		
	Age	0.112***	0.098***	0.085*	0.079*	0.390***	0.385***	0.271+	0.291+
		(0.000)	(0.000)	(0.015)	(0.025)	(0.000)	(0.000)	(0.076)	(0.059)
	Founders	0.092	0.119	0.020	0.029	0.199	0.067	0.803	0.733
		(0.368)	(0.237)	(0.884)	(0.831)	(0.573)	(0.869)	(0.165)	(0.207)
	ActRD	0.041	0.039	0.142***	0.142***	-0.092	-0.115	0.578***	0.575***
		(0.133)	(0.142)	(0.000)	(0.000)	(0.353)	(0.252)	(0.000)	(0.000)
	Funding							1.914***	1.991***
								(0.000)	(0.000)
Incubator Type	Generalists		ref.		ref.		ref.		ref.
	Specialists		0.655**		0.244		2.389*		-1.374
			(0.003)		(0.404)		(0.023)		(0.276)
	N	227	227	223	223	227	227	227	227
	R-sq	0.293	0.323	0.292	0.294			0.331	0.334
	pseudo R-sq					0.152	0.185		
	Log lik.	-404.647	-399.817	-459.124	-458.753	-88.647	-85.132	-797.582	-796.952

p-values in parentheses +p<0.1 * p<0.05 **p<0.01 *** p<0.001

The control variables that measure the number of employees in a firm and the age of a firm are both positively related to the amount of funding, the amount of revenue and the number of patents. In addition, age is also positively associated with the number of employees in a firm in the fourth regression model. These results are all in line with the a priori predictions. The control variable that measures the number of founders in a firm has no significant effect on any dependent variables in the analysis. Activated R&D costs show no significant effect related to the number of patents in a firm, nor to the amount of funding. However, it exhibits positive relationships with the amount of revenue, as well as the number of employees in a firm. These findings are noteworthy in the light of the stated prediction that activated R&D costs should exhibit a positive relationship with the number of patents. One explanation could be that since the activated R&D costs are measured as the absolute size of the R&D investments, it may biases companies with large revenues and high number of employees that do not necessarily have higher number of patents. Finally, the amount of funding as a control variable in the fourth regression is positively associated with the number of employees in a firm. This is also the case for the wholesale and retail industry, but this is not visible in table 5.

5. Discussion

This study examines what effects different incubator types have on the performance outcomes of Swedish incubators by analyzing the performance of their respective incubator companies. Our results show that incubator companies that belong to specialist incubators, on average, receive more funding and register more patents than that of companies in generalist incubators. However, the study is unable to show any significant results on the variables that predict the amount of revenue and the number of employees. In addition, the study also introduces a type-specific approach to incubator performance evaluation.

5.1 Results and Implications

We interpret these results to indicate that there are differences in performance outcomes between incubator types. Specifically, the effects that are observed relate to funding and patents. Our result on the number of patents stands in contrast to previous findings in research that did not observe any significant results between incubator types in terms of patents (Barbero et al., 2012). One explanation for this could be the different classification scheme that these researchers apply, which does not distinguish incubators based on sector-specialization. Their classification based on the objectives of the incubators might overlook important aspects in recognizing the ability to generate patents, which a focus on sector-specialization might encompass in a more accurate way. In terms of the observed differences in funding received by the incubator companies, there are no similar studies to compare our results to. Although, Matthyssens and Vanderstraeten provide some support for our results by indicating that specialists possess capabilities and knowledge of the specific financing needs for their incubatees (2012 p. 665).

In terms of job creation, previous studies find no significant differences between incubator types on employment generation cost (Barbero et al., 2012). This is consistent with our findings on number of employees, which show that the ability to create jobs is not different between incubator types. Furthermore, our usage of a different classification scheme adds significant weight to the collective findings that job creation does not seem to differ between incubator types. Although the incubator companies from specialists attract more funding than their counterparts from generalists, this is not translated into significant effects of higher revenues. However, as previously mentioned, we do find that incubator companies from the specialists have more patents on average. This could be an indication that the funding that incubator companies from specialists receive, is to a larger extent directed towards innovation.

As an answer to the call for future research that studies incubator performance contingent upon incubator type (Mian et al., 2016), the results of this paper show that a type-specific approach to performance assessment generates significant differences in performances between incubator types. These results emphasize the importance of comprehending the diversity in the business incubator environment and present a way of understanding how types of incubators differ in their performance outcomes. This understanding is the result of combining the literature on both incubator types and incubator performance in research and resembles what we refer to as the integrated view.

The theoretical implications of this paper's results mean that the previous literature that stresses the importance of viewing incubators according to different archetypes (Aernoudt, 2004; Bergek & Norrman, 2008) can be quantitatively validated. In other words, this paper's results further support the proposition that it is not fruitful to conduct incubator performance research without taking incubator types into account, which is the case in many of the previous studies within the field that have resulted in a spread of research findings (Pena, 2004; Stokan et al., 2015; Van Rijnsoever et al., 2017; Lukeš et al., 2018). Nevertheless, we still acknowledge that there are different ways of classifying incubators that can influence the results to large extents. For example, an interesting remark is that Barbero et al. (2012) also use a type-specific approach but generate insignificant results when it comes to patents. This stands in contrast to our findings and puts emphasis on the role of classification when analyzing how incubators perform across different types.

From the perspective of startup-firms, results that unearth quantitatively measured differences between different incubator types have the potential to serve as useful grounds for early-life decisions in these firms. As was mentioned in the introduction of this paper, there are mismatches occurring between startup-firms and incubators (Henriques & Ratinho, 2010; van Weele et al., 2017). In that sense, a practical implication of our results is to allow startup-firms to get access to more tangible results on what certain types of incubators actually achieve and thereby help to mitigate the mismatches that occur. However, to achieve this to a larger extent, more precise performance measures than the ones used in this paper may be needed. A second implication applies to incubator management that benefits from comparative results on the performance outcomes of different incubator types, which may help to set industry benchmarks.

5.2 Limitations and Future Research

It is acknowledged that the study is subject to limitations with respect to various assumptions and procedures. One important shortcoming relates to the incubator classification that is used. Even though we view the classification of incubators based on the distinction between generalists and specialists as appropriate in this study, the classification procedure is still a rather arbitrary process, and by adopting a dichotomous classification will inevitably simplify the heterogeneity of these organizations.

Another limitation is connected to the methodological choice of secondary data collection. The quality of the data that was collected from various databases is likely higher than if we had collected the data by ourselves. However, we still acknowledge the lack of control over the data quality associated with this method. This consideration is especially important in relation to the data on the amount of funding received by startup-firms, as more than half of the original sample of incubator companies had to be left out of the analysis due to missing values on this variable. This raises questions about why the companies that remained in the sample had data on amount of funding and why the other companies had not. Either the companies had not received funding at the point of the data collection, or it could be an indication that the database might not be adequately complete. In that sense, the incompleteness of the databases may influence the sampling in the study, which raises the risk of a biased sample of firms.

By going deeper into this type-specific area the results will allow the incubator community, both in academia and in practice, to untangle what different incubator types achieve in practice and thereby establishing classification schemes that are both qualitatively and quantitatively grounded. In the light of our findings and the limitations, we encourage future studies to apply different classification schemes that are established in the literature to see if similar performance patterns can be distinguished. This would not only explore the research field of incubator type performance further, but eventually reveal what incubator classification schemes that can be validated through quantitative studies and thereby consolidating the view on what classification schemes that are most appropriate both in theory and in practice. As this field of research is fairly unexplored, we also see room for similar studies that look at other performance measures than the ones used in this paper.

6. Conclusion

The driving issue of this paper has been the identified research gap between the two major research themes in business incubator research. This gap came to be known as the integrated area in this paper, since it integrates both themes in the analysis. These research themes are incubator types and incubator performance, which are two blocks in the literature that traditionally have been kept rather separated. The findings of this study show that there are differences in performance outcomes related to the amount of funding received and patents registered across incubator types. To some extents, these results quantitatively validate the established classification scheme that distinguishes incubators as generalists and specialists and shed light on the importance of a type-specific research approach when studying incubator performance. We believe that future research on incubator type performance can further consolidate the literature on incubator classification and potentially drive the research field on business incubation forward.

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