LUND UNIVERSITY
School of Economics and Management

Stock Performance Differences in Swedish Life Science Companies with or without Research-based Science Park Affiliation

by

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May 2018

Master's Programme in Accounting and Finance

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Abstract

Title	Stock Performance Differences in Swedish Life Science Companies with or without Research-based Science Park Affiliation
Seminar date	2018-06-01
Course	BUSN 79 Business Administration: Degree Project in Accounting and Finance - Master Level, 15 ECTS
Authors	Eric Isacsson and Liana Trichkova
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Key words	Science park affiliation, university ownership, life science, long-term buy-and-hold-abnormal return, short-term cumulative abnormal return.
Purpose	The purpose of the study is to investigate if there is a difference in the publicly traded stock performance of science park affiliated and non-affiliated life science firms. As well as to assess if university ownership for science park affiliated life science firms influence shareholder returns.
Methodology	A long-term event study analysis (BHAR) is conducted to examine if science park affiliated and non-affiliated life science firms realize different returns. The buy-and-hold abnormal return is used as a dependent variable in a regression analysis which allows to include the variables of interest - science park affiliation and university ownership measures. Additionally, a short-term event study analysis (CAR) is carried out, evaluating the response of the market to an event, joining a science park, as compared to the expected returns provided by the market model.
Theoretical perspective	The study is based on theoretical insights regarding the effects of science parks on affiliated companies in a knowledge intensive environment. The contribution of the thesis comes from studying those effects from the financial markets perspective in Swedish life science firms.
Empirical foundation	170 IPOs of Swedish life science firms out of which 72 are affiliated with science parks and 98 non-affiliated.
Conclusion	The results show that there are no long-term (36-month) abnormal returns from affiliation with a science park. University ownership has no abnormal return effect. A life science company that joins a science park experience a statistically significant positive stock return of 3 % on the day of the announcement.

Acknowledgements

We would like to express our sincere gratitude to the supervisor of this thesis who has provided us with valuable insights and guidance.
Håkan Jankensgård, Associate professor at the Department of Business Administration, Lund University

Special appreciation for the information and time devoted to the interviewees:
Eskil Elmer, CSO, NeuroVive Pharmaceutical
Jan Alenfall, CEO, Follicum
Jonas Söderström, CEO, BioStock
Mikael Lindstam, CEO Aptahem
Per Hillertz, M&A IT Project Manager, Business Analyst, Researcher, AstraZeneca
Per Jansson, CEO, Vicore Pharma

Special appreciation for the information and time devoted to those who provided us with additional information and practical insights:
Frida Lundmark, Programme Director, Health, Vinnova
Göran Marklund, Deputy Director General, Vinnova
Ulrika Ringdahl, Deputy Managing Director, Head of Business Unit - Materials and Life Sciences - Invest in Skåne

List of Abbreviations

AFGX - Affärsvärlden's General Index
AR – Abnormal Return
BHAR - Buy-and-Hold Abnormal Return
BVE - Book Value of Equity
CAR - Cumulative Abnormal Return
EMA - The European Medicines Agency
Et al. - and others
FDA - The Food and Drug Administration
GU - Gothenburg University
IPO - Initial Public Offering
IASP - International Association of Science Parks
KI - Karolinska Institute
LS - Life Science
MVE - Market Value of Equity
NTBF - New Technology Based Firm
OECD - Organization for Economic Cooperation and Development
OLS - Ordinary Least Squares
OMXS - Stockholm Exchange General Index
SP - Science Park
SISP - Swedish Incubators and Science Park Association
R&D - Research and Development
TRI - Total Return Index
UKSPA - United Kingdom Science Park Association

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1. Introduction

The first chapter introduces the context in which this study is conducted and the aim of this research paper. A distinction with previous research papers is made, followed by an explanation of how this research can contribute to the development of the research field. A short overview of the limitations of this study is also outlined. The chapter ends with the structural framework in which the study is conducted.

The Swedish life science (LS) sector is of great importance both in terms of employment but also in terms of the output of innovation and interconnectedness to the larger Swedish universities. All in all, making it a sector with various positive benefits to society both in terms of wealth creation, in terms of research advancements and improving the quality of life for its patients. An important factor in this development has been the strong association between the science parks (SPs) and universities. The Precision Medicine Report from SwedenBIO exemplifies this in their 2018 report stating that 72 % of the commercialised companies are spin-offs from universities, which is a testament to the strength of their research activities and commercial aspirations (SwedenBio, 2018). The continued relationship is also exemplified by the fact that roughly 50 % of these companies are later associated and active within the domains of a SP with a university or municipal affiliation (SwedenBio, 2018). According to the Swedish Organisation for Incubators and Science Parks, there are currently 67 such members across all of Sweden, inhabiting more than 5000 companies overall (SISP, 2018). Out of this larger sample, the more specialised locations pertaining to LS, as detailed in Section 2.1.5, equates to ten SPs. Therefore, this constitutes a great part of the Swedish innovation power and research community as well as it is the recipient of a great deal of funding from government agencies such as Vinnova, municipalities, universities and foundations. In total, Sweden has 30,000+ researchers and scientists engaged in R&D divided amongst 2,130 LS companies, as well as it ranks top ten in Europe in the Global Competitive Index 2015-2016 ranking by the World Economic Forum (World Economic Forum, 2016). However, the commitment and level of research funding is even higher as Sweden ranks second in the world, per capita, when it comes to R&D investments (Business Sweden, 2018).

The level of funding and commitments both from the private and public sector initiatives comes with great responsibilities in terms of assuring prudent spending and efficient allocation of resources in order to maintain the position as a leading nation within LS development. The strength and expertise need to be harnessed and developed effectively in order to ensure a position at the forefront of this sector. As mentioned previously, SPs play an important role as they establish a gateway for research between the universities and private sector with the intent of accelerating and enabling effective research through its collaborative environment and focus on sharing expertise, knowledge and equipment between its hosted companies.

As the literature review in Section 3.1 will show, the effectiveness of SPs have been extensively researched and debated due to the variation in results. The most common way of comparing has been to create two samples of firms with an on- or off-location test, given a certain parameter. The focus area of measurement has on the other hand differed greatly as exemplified by Table 1. For example, Squicciarini (2009) has evaluated the patenting activity in 252 SP firms during the last three decades. Yang et al. (2009) has evaluated whether SP firms are more innovative by measuring the elasticity of R&D with respect to output. Lindelöf and Löfsten have conducted a closely related comparison examining academic and non-academic new technology-based firms in SPs, measuring sales growth and profit margin between the two sets of companies (Lindelöf and Löfsten, 2005). The research community, therefore, have many studies examining operational differences between affiliated SP companies and non-affiliated companies. The general results and perception, as described in Section 3.1, is that they do enforce collaboration and have positive effects of measures such as innovation and sales growth (Lambooy, 2004; Ritala et al. 2015). These are all valid points and each of them provides an interesting measure of possible efficiency enhancements in companies with or without SP affiliation, given their importance and presence within the Swedish LS industry. However, previous studies have observed and measured differences between mostly private companies and no evidence has been found that details the differences between listed companies of these two groups as measured by shareholder return. Given LS companies strong presence in Sweden, coupled with the lack of research on this metric, it is natural to conduct such a comparison.

1.1 Problem Discussion

The measures mentioned in the introduction such as patent activity and sales growth are useful and telling of SP success and of their incorporated firms, however, when able to construct a comparison of listed companies, measuring the relative shareholder performance between the groups (SP affiliated or non-SP affiliated) would constitute a valuable and very comprehensive measurement of their progress and the impact of the SP. As detailed in Section 3.1.2, the productivity increase from SP affiliation is not entirely straightforward and easily diverges into numerous productivity aspects, if observed at all. It appears as if the positive benefits of the collaborative environment of a SP does not materialize equally or similarly across companies and time. The previous measurements used are most likely the result of researchers focusing on the field of organizational behaviour studies such as the effects of networks. Our contribution is, therefore, not to make any assertions or conclusions regarding the particular issues of knowledge management and behavioural studies, but strictly from the perspective of the financial markets to observe shareholder returns with long-term and short-term event studies between the two groups as a comparison of the possible effects observed in previous research. In the context of this study, the authors examine the effects of SP affiliation on stock performance, measured by shareholder returns, BHAR and CAR (refer to Section 4.3 for a detailed explanation of the two measures) as compared to the traditionally used variables, presented in Table 1.

Table 1: Commonly Used Variables for SP Affiliation Effects

Author(s)	Innovation	Patent activity	Product development	R&D investment	Employment growth	Revenue growth	Funding opportuntities	Shareholder returns
Albahari et al. (2013)	✓			✓		✓		
Fukugawa (2015)		✓			✓		✓	
Lindelöf and Löfsten (2001)					✓	✓		
Lindelöf and Löfsten (2002)					✓	✓		
Lindelöf and Löfsten (2003)			✓		✓	✓		
Lindelöf and Löfsten (2004)			✓					
Phan at al. (2005)				✓		✓	✓	
Squicciarini (2009)	✓	✓						
Westhead (1997)				✓				
Yang et al. (2009)	✓			✓				
Isacsson and Trichkova (2018)								✓

The authors believe the research to be value adding due to the complex nature of LS and measuring its success. For example, the lead times in developing products are much longer

compared to other sectors (SwedenBIO, 2018). This industry factor would make sales growth to be an incomplete measure of success since advancing between the different stages of research does not generate a positive result on this metric and, thereby, neglects important research results and business development. This would, however, potentially be captured and recognized by the publicly traded capital markets, private equity markets and all SP actors. Another example of previous metrics is that the cash flow is delayed with regards to clinical success due to the earlier explained nature of LS. Research from Phan et al. has exemplified the problems of measuring performance and making the effects concrete and tangible due to the variability of studies as well as the lack of cohesive research structure on the phenomenon of SPs (Phan et al., 2005). However, our aim is instead to synthesize the research by looking at stock returns between the two previously mentioned groups. Measuring this difference could be an indication of the financial markets perspective of the potential effects of SPs.

It is likely that the effects, later detailed in Section 3.1, such as strengthened survival rate (Westhead and Storey, 1995) patent productivity (Link and Scott, 2003; Squicciarini, 2009; Yang et al., 2009) and employment growth (Lindelöf and Löfsten, 2001; Colombo and Delmastro, 2002) as well as other established effects of SPs will also be observable by measuring and comparing the market value of equity (MVE) with benchmarked LS firms without affiliation. We would like to emphasise the fact that previous research has been conducted on high-technological companies and products amongst them LS and not LS exclusively. Nevertheless, there are great similarities such as the required knowledge expertise, regulatory requirements and longer lead times which makes it a suitable comparison. According to Asheim, the company category of LS is greatly dependent on a high level of knowledge base and that not only their own R&D departments will suffice, but that there are interdependencies on universities and other research organizations in their innovation process. The linkage is, therefore, more frequent and more important as compared to lower knowledge base areas of product development. All in all, the knowledge process requires analytical skills such as abstraction, theory building and clinical testing as well as it is exposed to high governmental requirements (Asheim, 2007). Creating a specific need of clinical research experience and potentially making the university affiliation an important role in the success of the SPs.

Previous empirical literature already has shown the possibility of assessing firm-specific technology-related assets and projects by the market value of the firm (Hall, 1999). It more specifically states that the market value is strongly related to its knowledge assets and that patent measures contain information about this value above and beyond that conveyed by the usual R&D measures (Hall, 1999). This serves as an important distinction in making the connection between the increased innovation power of SP affiliation and its effect on shareholder returns.

In conclusion, a great deal of studies has evaluated business specific metrics, however, they should presumably also be observable through a long-term event study as well as within the short-term event study framework. In addition to these methods, interviews have been conducted with leading individuals from both the corporate sector as well as from different SPs and their respective sponsoring organizations in order to gain a deeper understanding of the mechanics. Due to the lack of research previously conducted this will be an important addition to existing research as it closes the gap on the success of SPs through studying the response of the financial markets.

1.2 Aim and Objectives

"Are research-based science parks value creators in life science and is there a difference in the stock performance which can be associated with being or not being a part of a research-based science facility?"

By answering this question, the thesis is of importance for aiding the Swedish LS field and informing government institutions, investors, companies, researchers and scientists of the relevance of research-based SPs. In extension to this, it is a novel way of measuring SP effects.

During the last two decades, there has been a surge of IPOs stemming from the LS sector of Sweden. Our sample consists of 170 listings, where all but 19 took place after the turn of the millennium. This comprehensive list can be divided into two roughly similar sized groups with an important distinction, either with or without SP affiliation. The thesis aims at investigating the value differences by comparing the shareholder returns and thereby estimating from the market's perspective if the collaborative environment of SPs is effective or not in terms of shareholder

returns. To the author's knowledge, no study has been done likewise for Swedish LS companies and their respective market returns. This study will, therefore, investigate how being in collaboration with research-based facility matters for shareholder returns in LS companies.

1.3 Limitations

Our research has a niche focus since it only involves one industry, publicly traded companies, as well as SPs is a quite recent phenomenon. This naturally causes limitations regarding the sample size. Along these lines, there are limitations related to most companies being very recently listed and thereby allowing long-term effects to potentially not fully materialize. One factor the authors were forced to disregard is debated by Phan et al. which emphasizes the different life-cycle phases of SPs as an important success factor (Phan et al., 2005). Due to our limited sample we have not estimated such differences and assumed all SPs to be equally developed and established. Given that the research has industry limitations, the number of SPs diminished to the level that these distinctions could simply not be carried out.

1.4 Research Outline

The thesis is divided into seven main sections: (1) introduction, (2) industry fundamentals, (3) literature review on the value effects and theory of research-based SPs and hypothesis formulation, (4) research methodology, (5) presentation of the empirical results, (6) analysis and discussion and (7) conclusion and recommendation for potential future research.

Chapter one describes the background, the problem discussion, the purpose and the limitations of the study.

Chapter two originates in a definition of all important variables and then progresses from a general view towards the more specific nature of LS research as well as the differences of SPs. Establishing a groundwork concerning the flow of information between companies and outlining the characteristics of each.

Chapter three consists of a literature review in order to overlook previous research of academia's perceived benefits and disbenefits of SP collaboration effects. The qualitative empirical findings serve as the foundation of the hypotheses.

Chapter four presents the research methodology used to evaluate the value effects of SP affiliation. It provides insights into the chosen research process, method and design. It also explains how the data was collected and the reasons behind the sampling. Following, the methodology for testing the hypotheses is presented. In conclusion, we test the reliability and validity of the research methodology.

Chapter five presents all results of both the long-term event study as well as the short-term event study and its descriptive statistics. The appropriate tests are conducted in order to find a suitable regression as well as the results are tested for robustness.

Chapter six ties the results to the existing theories as well as the hypotheses are evaluated based on the findings.

Chapter seven concludes this thesis with presenting ideas for future research and opinions on how to improve and expand on the subject.

2. Industry Fundamentals

The second chapter aims to provide an overview of terminology and definitions concerning the main concepts in this research. A short description of each SP included in our sample is given. The fundamentals and practical framework will be followed by the theories and existing research on the effectiveness of SP collaboration.

The mechanics and structure of SPs and other research facilities are of great importance to the LS sector and the Swedish industry as the following examples will highlight. In the Swedish Drug Discovery and Pipeline Report 2016, produced by The Swedish Life Science Industry Organization and the Swedish Trade and Invest Council, the magnitude and importance are described. At the most fundamental level, the Swedish government has created tax exemptions in order to attract more skilled employees and retain the ones currently active within the field of LS research. Foreign key employees are eligible for a 25 % reduction of taxable income as well as a 10 % payroll tax reduction for all individuals working in R&D, which was introduced in 2014 (Swedish Trade Council, 2016). As an example of the latest success within LS, since the turn of the millennium 70 orphan drug status designations have been granted in total to Swedish companies by the EMA and FDA. On top of this, 2015 has been a record year for Sweden where eight designations and ten orphan designations were granted by FDA and/ or EMA (SwedenBio, 2018). Out of the total 1,391 companies in Sweden within the different main areas of biotechnology, medical technology and pharmaceuticals, slightly over half are associated with SPs. The importance of this sector and the relatedness to SPs is, thereby, of greatest importance. To exemplify the aim of a SP, the Karolinska Institutet (KI) Science Park mission statement will serve as a description as it relates closely to the set-up of other SPs. They state that,

"*KI Science Park, as part of the KI innovation system, supports the commercialization of LS research to apply and benefit healthcare, by creating and operating a business enabling an environment of the highest international quality for the growth of start-ups and established LS companies*" (KI, 2018).

As well as it is stated that "adequate infrastructure and a fruitful interaction between the commercial and the academic world is necessary to ensure that the public will benefit from

research" (KI, 2018). Medicon Village in Lund has a similar aim as they summarize their overarching purpose as:

"*When University, Government and Industry work together it is normally referred to as the 'Triple Helix'. This alliance is essential to the ecosystem we have built up. Players from different disciplines and fields can exchange ideas and work together to create value-add for all involved. Ultimately there is a greater goal – to provide a healthier and better life for many*" [sic] (Medicon, 2018).

These two examples of mission statements serve as an adequate representation of the overall aim and desire of all included SPs in our sample. A short description of each SP is included in Section 2.1.5.

2.1 Terminology and Definitions in an Industry Context

2.1.1 Choosing Life Science

As previously mentioned, the LS industry is chosen given its importance and forefront position in Sweden as exemplified by the introduction. It is also argued that these complex product developments have the most to benefit from SPs and their collaborative environment. As stated by Henderson and Cockburn the results of research effectiveness within this industry are largely driven by economies of scale arising from sharing fixed costs, economies of scope arising from the opportunity to exploit knowledge across program boundaries within the firm and the enhanced ability to absorb internal and external spillovers (Henderson and Cockburn, 1993). They also make a distinctive remark in their study, examining ten large pharmaceutical companies over a two-decade period, that spillovers between firms may play a major role in increasing the research productivity (Henderson and Cockburn, 1993). These elements above are all highly present and of utmost importance in our examined SPs. As an example, the initial idea that spurred the creation of one of the studied SPs, AZ BioVenture Hub, was the discussion of how to efficiently deal with surplus research facilities and machinery (AZ BioVenture Hub, 2018). Additionally, Henderson and Cockburn also argue that these types of settings and industries are particularly well suited given its extreme research intensity and driving force of firm performance (Henderson and Cockburn, 1993). When fast-forwarding to more recent times,

these dimensions seem to be of ever-increasing importance. Pammolli, Magazzini and Riccaboni (2011) have conducted a drug discovery overview and ascertain a productivity crisis in the pharmaceuticals and the LS industry. They state that although investments in pharmaceutical R&D has increased significantly in recent decades, the lack of corresponding output increases, in term of new drug development, has become more challenging (Pamolli et al., 2011). According to the researchers, the major contributing factor is simply that low hanging fruits are at this point consumed, thereby forcing the research in the direction of unmet therapeutic needs and unexploited biological mechanisms with subsequently a higher risk of failure (Pamolli et al., 2011). This certainly raises the question of how the LS industry will improve its productivity and continue to meet the needs of future therapeutic treatments.

2.1.2 Defining Life Science

The short description of our chosen LS sector is that it is made up of companies dealing with biotechnology, pharmaceuticals and medical technology. As we have retrieved a great deal of data from the Swedish Life Science Industry Organization and their register of members, we have adopted their definition of LS. The three main areas are further defined. Biotechnology is the development of biological material such as cells, proteins, or DNA for medical treatment. Pharmaceuticals deal with both biological molecules as well as chemical molecules. Medical technology includes products aimed at improving the health and the living for patients in need. Companies which develop technologies for diagnostics improvement and interpretations are also included in this category (SISP, 2018).

The definition given by OECD is much too broad as it contains all living organisms, thereby incorporating all fields of botany and agricultural development (OECD, 2018). This is in line with general thesaurus definitions like that of Oxford dictionary, which also incorporate studies such as anthropology and sociology (Oxford, 2018). Here we make an important distinction to only regard the field of medicine and to stay in line with the SISP definition.

2.1.3 Defining Research-based SP

In order to establish some common ground in terms of definitions, we have looked at the two major associations of SPs in order to grasp their meaning and concept. The United Kingdom Science Park Association (UKSPA) defines a SP as:

A business support initiative whose main aim is to encourage and support the start-up and incubation of innovative, high-growth, technology-based businesses through the provision of: infrastructure and support services including collaborative links with economic development agencies; formal and operational links with centers of excellence such as universities, higher education institutes and research establishments; management support actively engaged in the transfer of technology and business skills to small and medium-sized enterprises (UKSPA, 2010).

Another definition, from the International Association of Science Parks (IASP), is not unlike the previously mentioned:

A Science Park is an organisation managed by specialised professionals, whose main aim is to increase the wealth of its community by promoting the culture of innovation and the competitiveness of its associated businesses and knowledge-based institutions. To enable these goals to be met, a Science Park stimulates and manages the flow of knowledge and technology amongst universities, R&D institutions, companies and markets; it facilitates the creation and growth of innovation-based companies through incubation and spin-off processes; and provides other value-added services together with high-quality space and facilities (IASP, 2002).

Different terms are often used interchangeably to the ones given above. Common references with the same definition are for example "*research park", "technology park", "innovation centre"*, however, they all fall within the previously given definitions. A broad way of describing the essence is presented in an early research by Westhead which states that SPs reflect a belief that technological innovation originates from scientific research and that SPs can provide a *catalytic incubator* surrounding for the transformation of strict academic research into production (Westhead, 1997). As earlier mentioned, Sweden has approximately 67 incubators and SPs out of which ten have a more pronounced and highlighted focus of LS research. These are the hosts of our SP affiliated companies and a brief description of each follows. What distinguishes this group from the rest is the area of research/field of interest, as well as their connections and dependence on either university research affiliation or pharmaceutical collaboration.

2.1.4 Determinants of SP Affiliation

A number of studies have been conducted on estimating the determinants of new-technology based firms (NTBF) and their affiliation with a SP. According to Link and Scott, university spin-offs seek older and more established SPs in combination with evaluating the richness of research environment (Link and Scott, 2005). They also state, unsurprisingly, that geographical proximity and focus area of the SP are the major determinants (Link and Scott, 2005). During the same period, Hansson et al. analysed SPs in the UK and Denmark where they reached the conclusion that the main reason for a NTBF to locate in a SP is to acquire social capital and indirectly receive access to links with other companies and university research capabilities (Hansson et al., 2005). These ideas are in line with our interviews conducted with CEOs and CFOs of affiliated companies in order to gain an understanding of their reasons for affiliating themselves with SPs. One CEO described it as being a “stamp of approval” and that it both gave the researchers and investors a sense of security. A recurring theme mentioned by CEOs was described by Westhead and Batstone where significantly more SP than non-affiliated companies suggested that their overall reputation and market image had improved due to their selected location (Westhead and Batstone, 1999). However, a small number of interviewed companies also expressed a hesitant stance on joining the SP based on their possible interference with product development. According to one of the CEOs, the SP more strongly benefits the firm in its early development stage, when the firm needs access to capital, networking, collaboration with scientists and laboratories. The interviewed CEO feared that perhaps the SP management and sponsors would encourage a certain type of research direction not in line with the intended path of current management, researchers or owners. This was described as a potential drawback. Lastly, the general opinion from the interviewed individuals was that the determinants for SP affiliation depend on the degree to which the SP can help the firm achieve milestone completion, which is an essential part of the firms' development. In the context of LS, milestones can be defined as issuance of a patent, clinical trial completion, strategic alliance deal or similar advancements toward a finished product (Onetti and Zucchela, 2014). According to the interviewees, whenever the LS company has just been residing in the SP, the effect on milestone development has been assessed as non-existent, whereas in the cases in which the SP has been value adding for the firm's milestone completion, the same effect was assessed as positive. This in turn reflects the performance of the firms in the stock markets since it creates a positive perception of a firm's

development. The opinion of the interviewees is in line with Onetti and Zucchela who acknowledges that successful milestone completion is the lifeblood of the LS firm and affects positively the shareholder's return (Onetti and Zucchela, 2014).

2.1.5 Swedish Life Science Research-based SPs

Next follows a short description and history of the SPs inhabiting our sample firms.

AZ Bioventure Hub

Founded in 2014 and situated in Gothenburg, the Bioventure Hub differs from the group since it is hosted by the multinational pharmaceutical company AstraZeneca and their headquarters. Nevertheless, their aim is still to give emerging LS companies a unique opportunity to co-locate and interact with a large pharmaceutical company as well as with each other in order to advance the LSs. They currently have 27 companies in the hub (Bioventure Hub, 2018).

GU Ventures

Established in 1995 and situated in Gothenburg it currently hosts 50 companies with a majority within the field of LS. It is owned by the holding company of Gothenburg University as well as it is in collaboration with Sahlgrenska Science Park (GU Ventures, 2018).

Ideon Science Park

Ideon Science Park is divided into four areas of research which are future transportation, smart cities, smart materials and health technology. They host 70 companies within LS. Ideon was constructed in 1988 in direct connection with Lund University as the first SP of its kind in Sweden and northern Europe. The incubator at Lund University, LU Innovation, is represented on the Board of Ideon Science Park and thereby facilitating collaboration and presence (Ideon Science Park, 2018).

Karolinska Institutet Science Park

Karolinska Science Park is the national centre for molecular biosciences, which is a collaboration between the Karolinska Institute, Royal Institute of Technology and Uppsala University. With the purpose of providing Swedish research with comprehensive and grand analysis of molecular-

biological analysis that which cannot be produced on smaller research facilities. The park was established in 2003 and currently inhabits 60 companies with the main building blocks situated in Solna outside of Stockholm (Karolinska Science Park, 2018).

Lead

Lead is situated in Linköping and founded in 2007 by merging the business incubators of Norrköping and Linköping, LiU Entrepreneurship and Development. It is financed partly by Linköping University as well as the municipalities of Norrköping and Linköping. They currently host 36 companies (Lead, 2018).

Medeon Science Park

Medeon Science Park and Incubator cooperates with the university hospitals of the region as well as Medicon Valley in Malmö in order to create an attractive and innovative environment for companies within LS and health. Medeon is situated in Malmö, it currently hosts 60 companies within LS and it originated from Ideon Lund, however, became independent in 1998 (Medeon Science park, 2018).

Medicon Village

When AstraZeneca announced their closing of research facilities in Lund 2010 the question of utilising the vacant research facilities arose. It resulted in Medicon Village being established in 2012 and currently hosting 120 companies with a distinct focus in LS (Medicon Village, 2018).

Sahlgrenska Science Park

Sahlgrenska Science Park is located in Gothenburg and hosts 91 companies within the LS field. It is jointly owned and operated by Gothenburg University through GU Ventures, Business Region Gothenburg, Chalmers Technical University as well as the municipality of Mölndal (Sahlgrenska Science Park, 2018).

Smile Incubator

Smile Incubator is situated in Medicon Village in Lund and was established in 2014. Smile is funded by the region of Scania, the municipality of Lund, Lund University and Medicon Village. It currently hosts 21 companies (Smile Incubator, 2018).

Uppsala Innovation Centre

Uppsala Innovation Centre hosts 172 companies within the field of LS and was founded in 2003. It has close ties to Uppsala University as well as it is jointly owned by the University and Uppsala Municipality. It is situated in Uppsala with offices in Östhammar and Södertälje (Uppsala Innovation Centre, 2018).

2.2 Costs of SP Affiliation

During the research, several attempts were made at obtaining rental agreements and other proofs of quantitative data regarding the costs of being affiliated with a SP. Just as in other industries there is no free lunch in the LS industry. We have been unable to acquire rental agreements which are often based on confidentiality principles between the companies and the different facilities. Nevertheless, it is clear that a great variety of agreements exists as we have come across examples of both rental fee structures, as well as agreements where rental payments are contingent on successful research results, thereby, creating a potential debt claim between the SP and the LS companies. The issue of affiliation costs has explicitly been discussed with three different CEOs of our sample firms through semi-structured interviews, which will constitute the basis of our assumptions. The interviewees state that the costs outweigh the benefits when the firm is in a SP with a lot of service providers as compared to a facility that has a strong research LS focus. In the context of the interviews, service providers were any firms from unrelated industries or not having a research focus. According to the interviewed CEOs, who claim to have compared different SPs with other facilities, the cost was not a significant factor or issue in making their final decision to join. Indicating that the rental agreements of SPs do not deviate from normal rental agreements as for non-affiliated LS companies. It is clear from the interviews that the choice of location is a multifaceted analysis in which they evaluate the nature of currently residing companies and that an important determinant is looking at how the joining company's research could potentially match and benefit from the existing research in the SP.

3. Literature Review and Hypothesis Formulation

This chapter aims to summarize the current research concerning the productivity of SPs as well as to cover the different performance metrics that have been studied. As this is not an organizational behaviour topic the aim is to summarize metrics focused on enhancing shareholder returns. The chapter is concluded by presenting the hypothesis to be tested.

3.1 Literature Review on Value Effects from a Research-based SP Affiliation

3.1.1 Introduction

The aims of SPs have been laid out and the reasoning for their existence has previously been explained in Section 2.1.3. When reading the vision and mission statement of each individual science park it is easy to get carried away by the superlative phrasing. The collaborative effects and research optimisation procedures are vividly explained and emphasized. For example, the Swedish Incubators and Science Parks organisation has the mission statement to develop the world's most effective innovation ecosystem by adding connectivity between their members and Sweden's leading universities, corporations, public organizations, customers and exit markets (SISP, 2018). The possible effectiveness of SPs is by themselves highlighted a great deal, although, from academia's perspective at times diverging and diffuse, the research indicates that there is a proven record and reason for success. A great deal of research has been conducted to establish their effectiveness and to measure the difference in output that they generate. Some of the most well-known articles, which form the basis of opinion, are summarized below.

Table 2: Summary of the Theoretical Framework

Researcher	Unit	Published	Period	Region	Sample	Model	Result
Felsenstein	Firm	1994	n.a	Israel	73	Log-linear modelling	I , H
Westhead & Storey	Firm	1995	1986-1992	UK	75	Matched pair	S ↑, H ↑
Westhead	Firm	1997	1986-1992	UK	75	Matched pair	S, I
Löfsten & Lindelöf	Firm	2001	1994-1996	Sweden	163	OLS	G ↑, H ↑
Colombo & Delmastro	Firm	2002	2000	Italy	45	Matched pair, Tobit	G ↑, I
Löfsten & Lindelöf	Firm	2003	1999	Sweden	139	Matched pair	I
Link & Scott	University	2003	2001	US	28	Ordered probit	I ↑, R ↓
Siegel et.al	Firm	2003	1992	UK	89	Stochastic frontier estimation	I ↑
Lindelöf & Löfsten	Firm	2004	1999	Sweden	139	Matched pair	I ↑, H ↑
Yang & Motohashi et.al	Firm	2009	1998-2003	Taiwan	247	OLS	I ↑
Diez-Vial Fernandez-Olmos	Firm	2014	2007-2011	Spain	11,201	Tobit dynamic	I ↑, H ↑
Diez-Vial & Montoro	Firm	2015	2012	Spain	78	OLS	I ↑, H ↑

I: innovation, H: higher education institutional linkage, S: survival, G: growth and R: reputational. Arrows indicate increase ↑, or decrease ↓

3.1.2 Earliest Research

Westhead and Storey have conducted some of the earliest research on the subject through a series of articles that continue to have relevance. In -95 they established a positive relationship of increased growth in sales as well as an increase in firm survival in on-site firms by comparing on-and off-site SP firms of comparable size and nature in a matching study (Westhead and Storey, 1995). In a similar manner Lindelöf and Löfsten assessed the performance of SPs by comparing on- and off locations in NTBFs and found a large difference in business strategy related aspects, however, only a slight increase in actual performance (Lindelöf and Löfsten, 2003). More recently, Albahari et al. found a positive relationship of increased strength in innovation, as well as companies in less technologically developed regions, had much to gain from relocating to a SP (Albahari et al., 2013). Thereby emphasizing on the level of development within the industry and its organizational partners could be of significant importance.

Innovation in the form of patent activity and new product offering is a frequent variable measured and arguably one of the most important factors for success within the LS sector, which is very patent-driven, as described in Section 1.1. In the review, there were identified eight studies measuring the variable of innovation effects in the firms located in a SP as compared to an off-location sample. Four have found no significant effect (Westhead and Storey, 1995, 1997; Colombo and Delmastro, 2002; Lindelöf and Löfsten, 2003) whilst four has found a significant positive effect on innovation (Felsenstein, 1994; Link and Scott, 2003; Siegel et al., 2003; Lindelöf and Löfsten, 2004). Besides the most common variables used in order to assess the performance and effect of SPs are employment growth, the collaboration between hosted companies, number of patents and publications, revenue, expenditure on R&D and the amount of funding received.

The LS industry is, as exemplified, earlier characterized by its dependence on patent innovation and protection. Necessary for the industry in order to motivate the long-term investments required for approval and subsequent revenue. Making the likelihood of patent approval variable to arguably be one of the most important for future success and also as a measure of the effectiveness of collaboration and network theory in the SPs (Griliches, 1990). Squicciarini measured exactly this by looking at 252 Finnish firms over a three-decade period. The study was

conducted as a duration analysis specified at the pre and post time after the event, as defined by joining a SP (Squicciarini, 2009). The companies included were originally established outside the SPs only to later relocate to a SP whilst still accounting for firm-specific effects such as age, size and industry. One of Squicciarini's most significant finds is that SPs have an extremely positive effect on the innovative performance of those companies joining at a very young age and that it appears that older companies are at a first mover disadvantage when early joining newly established SPs (Squicciarini, 2009). The author goes on to elaborate on this by estimating different waves of companies joining a SP and concluding that the first wave underperforms the others. Indicating that the SP also evolves and becomes better at caring for their tenants (Squicciarini, 2009). Interestingly enough, researchers have also observed other important effects. Colombo and Delmastro examined 45 Italian SPs and observed the effects that younger firms not unsurprisingly performed better in terms of adopting advanced technologies and establishing collaborative arrangements, especially with universities (Colombo and Delmastro, 2002). The effects of university collaboration are also investigated and show evidence of short-term negative effects on the patenting likelihood, however, with reversed results when extending the time frame (Squicciarini, 2009). The author concludes by summarizing the results as information appears to be flowing from big companies to younger tenants.

3.1.3 Criticism of Structure

Previously mentioned variables and much of the attempts to measure the effectiveness have been criticized by Phan et al. which claims that SPs and incubators are examined in terms of four levels of analysis 1) the SPs and incubators themselves, 2) the enterprises located upon SPs and incubators, 3) the entrepreneurs and teams of entrepreneurs involved in these enterprises 4) and at the systemic level (Phan et al., 2005). According to the researchers, this level of separation in the analysis has been conducted without a systematic framework and caused a lack of clarity in the findings, failure to understand the dynamics and is the cause for a large variation of results among researchers (Phan et al., 2005). A researcher who early argued along similar lines was Johannisson et al. which stated that there is a substantial debate concerning the appropriate way of assessing the effectiveness of SPs and, therefore, difficult to generalize outcomes of studies which focus on a single or very few SPs (Johannisson et al., 1994). The case study methodology and small sample SP research received further criticism by Siegel et al. who claimed that

assessing outcomes on limited perceptual data suffer from several limitations which would cause sample biasing (Siegel et al., 2003).

3.1.4 Overall Trend and Acceptance

The general effects are, however, positive as described in recent research by Dièz-Vial and Montoro-Sánchez (2015). They summarize it as now being broadly accepted that the different institutions and companies within SPs can provide valuable knowledge and promote innovation through collaboration, network effects and information spillover (Dièz-Vial and Montoro-Sánchez, 2015). Their research, more importantly, emphasized a different perspective which has been incorporated in our research as an extension. According to Dièz-Vial and Montoro-Sánchez the success of each firm depends on the agents with whom they have established a relationship, claiming that knowledge is not a collective good available to all firms without the existence of formal and informal relationships (Dièz-Vial and Montoro-Sánchez, 2015). They find that the level of connectedness with the university host is an explaining factor in how much knowledge and resources the NTBF inside the SP receives. They observed a positive relationship between the knowledge obtained from the university sponsor and the innovations carried out by the firms as also evident in the longer-duration studies by Squicciarini (2009) and Dièz-Vial and Montoro-Sánchez (2015). The basis of these findings and the theory on university and SPs/industry connections claim that NTBF involved in collaboration with a university will receive admittance to novel research and knowledge resulting in a nurtured and heightened competitiveness (Ahuja, 2000; Powell et al., 1996). According to these theories, the NTBF with university ties is able to amass trust from their customer and supplier base as well as it signals that their outputs are constructed on the latest techniques. They further state that the NTBF potentially would obtain a lower production and development cost as well as would have access to labour in times of labour shortage (Ahuja, 2000; Powell et al., 1996).

3.1.5 Literature Insights for Hypotheses Formulation

Based on the results of the presented articles (Dièz-Vial and Montoro-Sánchez, 2015; Squicciarini, 2009; Ahuja, 2000; Powell et al., 1996) this is an interesting feature to evaluate. All sample firms have a connectedness to the sponsoring university since they are all tenants of the sponsored SPs. It is difficult to distinguish them on the surface due to the connectedness, however, we have been able to obtain data regarding university ownership in the SP affiliated

companies and uses that as a proxy for the higher level of connectedness and as constituting a formal relationship. If the LS companies within SPs innovation patterns are in line with the established theories, then there would be an increased innovation likelihood as compared to firms on-or-off SP as well as within affiliated LS companies based on their level of connectedness to the university sponsor.

It is evident from current research that the difference in metrics for measurements, duration, sample selection, as well as the maturity of the SP has caused great diffusion when trying to narrow down the results. As argued by many authors but not pinpointed, when there are spillover effects in a large network system, it is difficult to estimate its final outcome and the timing of that outcome. This certainly poses the question of introducing a performance metric that would better encapsulate these differences. In this research the differences are studied from the financial markets perspective.

3.2 Hypotheses Formulation

By referring to the previously presented theoretical and practical frameworks, the following research hypotheses are developed. The main hypothesis is based on the presented empirical evidence that SP affiliation can positively affect the performance of a company. The supplementary hypothesis is based on the literature insights by Dièz-Vial et al. (2015) stating that university affiliation can be value-adding for a SP affiliated firm and is developed around the value effect that can be observed in a financial market context. The hypotheses are outlined and discussed below.

H1. The relationship between shareholder abnormal returns and research-based science park affiliation in the context of the Swedish life science sector is positive.

The first hypothesis (H1) revolves around the idea that SP affiliation creates positive shareholder abnormal returns (ARs). Based on existing research, positive value effects from SP affiliation can be observed on several performance metrics, among which employment growth (Lindelöf and Löfsten, 2002), survival rate (Ferguson and Olofsson, 2004), average cost per patent (Yang et al., 2009), number of patents (Squicciarini, 2009), etc. Moreover, SP affiliation sends a

positive signal concerning the reputation of the firm as well as its newly gained advantages. Those effects presumably translate into positive shareholder returns for SP affiliated firms as compared to non-affiliated ones. In addition, based on industry insights, the SPs can be value-creators for LS companies whenever the firm's milestone development is supported, which for publicly listed companies translates into higher shareholder return (Onetti and Zucchela, 2014).

H1B. Shareholder abnormal returns are positively related to university ownership for life science companies in research-based science parks

The second hypothesis (H1B) is an extension of the first. As mentioned earlier, the university affiliation creates a formal relationship and ensures easier access to research and resources (Dièz-Vial et al., 2015) and thus creates positive value effects. This could potentially mean that university ownership would signify a positive relationship with shareholder returns as a result of the increased innovation power. With an emphasis on a special case in which SP affiliated firms are partly owned by a university, the supplementary hypothesis is developed.

4. Research Methodology

Chapter four is composed of four parts. Part 4.1 introduces the chosen research framework, by specifying the research process, method and design. 4.2 explains the process of data collection and sampling. 4.3 introduces the methodology to test the hypotheses, which is constituted of a main and supplementary testing method. The first is a long-term event study analysis through which BHAR is derived and regressed to a set of factors, e.g. SP affiliation and university ownership variables. The second is a short-term event study analysis through which it is tested if by joining a SP, a firm realizes ARs. Chapter four is concluded with quality tests of the research methodology.

4.1 Research Framework

4.1.1 Research Process

According to Bryman and Bell there are two opposite processes that describe the possible relation between theory and research. The first one is a deduction, in which the researcher deduces a hypothesis based on existing theoretical evidence (Bryman and Bell, 2011). The theory and hypothesis then lead to a process of data collection, based on which the empirical tests are conducted. Subsequently, the research findings are presented, the hypothesis is confirmed or rejected and the theory is revised (Bryman and Bell, 2011). The second one is induction, in which the researcher considers his or her findings as determinants of theory (Bryman and Bell, 2011). In this specific research, the *deductive method* has been utilized as the methodology and empirical testing is based on existing theoretical insights.

4.1.2 Research Method

Subsequently, the appropriate research method is analysed. The aim of the research method is to determine the type of data that needs to be collected to answer the research question, i.e. data can be qualitative, quantitative or mixed (Muaz, 2013). A *mixed research* is used to empirically investigate the main research questions since multiple interviews have been conducted in complement to the quantitative data. A brief overview of the data collection process is provided in Section 4.2. Respectively, when the research method is used in a systematic pattern to empirically test the hypotheses, the research methodology is constituted (Rajasekar et al., 2013). The research methodology is explained thoroughly in Section 4.3.

4.1.3 Research Design

Finally, the typology of the research design is decided upon. According to Malhotra and Grover depending on the nature of the main research question, the research design may be exploratory or explanatory. The authors claim that a research design is exploratory when the purpose of the research is to better familiarize with a topic. In contrast, the goal of explanatory research would be to find causal relationships among variables (Malhotra and Grover, 1998). In this thesis, the *explanatory research design* is chosen as it aims to explain the relationship between the shareholder returns of LS companies and their affiliation with a research-based SP.

4.2 Sampling and Data Collection

4.2.1 Sampling

In extracting a representative sample the defined population needs to be examined (Bryman and Bell, 2011). Revising the aim of the research, which is to answer the question if there are ARs in listed Swedish LS companies that are affiliated with a research-based facility, the population is defined as all listed Swedish LS companies, thereby excluding the privately held companies based on the studied metric.

To determine the final sample, IPO transactions were collected from LS companies from the following categories - biotechnology, pharmaceuticals and medical technology in line with previously stated SISP definitions in Section 2.1.2. The data for the IPO transactions - transaction type, listing date, listing exchange market - was collected from several sources to ensure data quality (Yin, 2002). The databases of Capital IQ, Thomson Reuters Datastream, BioStock and World Federation of Exchanges made it possible to create a representative sample of 170 IPOs.

To study the shareholder returns of a research-based affiliation on LS companies, from the original 170 observations, two main sub-samples of companies were created – one composed of 72 firms that belong to a research-based SP and another comprised of 98 not belonging to such. To map whether a company belongs or not to a research-based SP, a three-step process was conducted. First, all Swedish LS research-based SPs were identified. To be precise in this identification, the databases of the following institutions were used – the Swedish Innovation

Agency - Vinnova, Scandinavian LSs Database, Sweden Bio and the Swedish Incubators and Science Parks. Second, a selection of companies belonging to those SPs was conducted. To perform this analysis, the publicly disclosed database of each SP was reviewed and subsequently established that 72 firms of the representative sample belonged to one of the already introduced SPs. Lastly, each company identified as belonging to a SP was contacted by email or telephone to confirm or reject the SP affiliation and the period of affiliation.

In addition, two more supplementary samples were created, which enabled (1) a short-term event analysis in order to evaluate whether joining a SP can create positive effects on shareholder returns and (2) a test of H1B, which aims to examine the relationship between university affiliation and the stock performance of SP affiliated companies. The first is composed of 19 LS companies that were listed and successively joined a SP. To access the exact date of affiliation (1) the press release for the change of their location status were reviewed, and/or (2) the date was requested from the LS company. The sources for the press release are provided in Appendix B. The second is composed of 21 LS firms residing in a researched-based SP and being partly owned by a university/SP, which is a proxy for formal university affiliation. Data for the ownership structure of the companies was accessed from the database of Holdings.se. A key-word search by the name of the SP/university was used as a method to detect the firms in the sub-sample as well as university websites of holding companies were reviewed. Ownership data is presented in Appendix B.

4.2.2 Data Collection

The following section outlines the data collected for this study. The currency in which it was collected is the Swedish krona (SEK). Monthly returns have been utilized for the BHAR calculations in order to reduce variation as compared to daily returns in accordance with existing research (Fama, 1976; Brown and Warner 1980, 1985). 36-monthly returns after the listing date were retrieved for all LS companies from the two groups. In both cases, the total return index (TRI), which represents the aggregate returns was employed and, thereby, accounting for splits, dividends and seasoned equity offerings. This data was accessed from Thomson Reuters Datastream. Additionally, information about the listing date of each transaction was accessed through Thomson Reuters Datastream or Capital IQ.

As a next step, data was gathered concerning the age and size of each company. To assess the age of the company as of the first trading day, data was collected for its registration date from Allabolag.se. With regards to the size of the firm, data was downloaded from the Thomson Reuters Datastream database for the MVE. Additionally, information was collected for the ownership structure for all companies from Holdings.se to assess information for university ownership. To construct the control variables, annual data for net income, total assets and cash flow was accessed from Bloomberg.

For the supplementary testing of shareholder CARs, conducted via short-term event study analysis, daily TRI was collected for each of the 19 firms that joined the SP after its listing as well as the TRI of the OMX Stockholm exchange (OMXS TRI). The choice of data is in line with Kothari and Warner (2006) who conclude that daily data has become the prevalent choice for short-term event studies since it mirrors accurately the ARs.

Lastly, six semi-structured interviews have been conducted to gain a deeper understanding of the SP affiliation effects and the LS fundamentals, which served as a supplementary material for the analysis of this thesis. Among the interviewees were people holding key positions at LS firms affiliated with SPs, a specialist from AstraZeneca in the LS field as well as the CEO of BioStock, a firm specialized in analyzing the stock performance of LS firms in Sweden.

4.3 Research Methodology

In this specific research, the aim is to estimate how a research-based SP affiliation affects the stock performance of Swedish LS companies. One way to do this is to conduct a two-step analysis, which observes how a set of factors affect the firm's valuation in case of a specific event (in this case - the IPO) (Skiera et al., 2017). The first step is to conduct a long-run event study analysis, in which the BHARs are derived, whereas the second step is to conduct a regression analysis in which the BHAR as a dependent variable is regressed to a number of firm-, event- and case-specific factors (Skiera et al., 2017), i.e. in this thesis a case-specific factor being the affiliation of SP and/or university ownership.

Another way to examine the effects on stock returns of research-based SPs is to conduct a short-term event study analysis, CAR, in which the effects of affiliation are estimated on shareholder returns. The analysis estimates whether a firm realizes ARs in an event window, when the event effects can be observed, as compared to an estimation period, in which only normal returns can be realized. In this specific scenario, the event is joining a research-based SP. The research methodology is composed of two parts, main and supplementary, that hereby follow.

4.3.1 Main Methodology

4.3.1.1 Long-term Shareholder Returns in an Event Study Framework

The purpose of the main methodology is to analyse the effects of a research-based SP affiliation on stock performance over the long-term. Initially, two important assumptions regarding the event window and the return benchmarks are made. Following, the technical calculation for BHARs is presented.

First, we decide on an appropriate *event window*. According to Kothari and Warner the long-term horizon can be defined as one in which the event window is equal or bigger than one year (Kothari and Warner, 2006). A figure of the event window is presented in Appendix A. The BHARs in this thesis are computed for the period of 12, 24, 36 months, which is in line with the study of Ritter (1991).

Second, the appropriate *return benchmarks* need to be identified since the choice of the benchmark can impact the results of the tests (Fama, 1998). Despite the limitations that the return benchmarks may have, they are essential to control for the stock performance (Kothari and Warner, 1997). Lyon and Barber describe two approaches for estimating return benchmarks for calculating long-term BHARs: (1) the reference portfolio and (2) the control firm approach (Lyon and Barber, 1997).

The reference portfolio approach employs a benchmark index. In this study, two market indexes are considered - OMXS TRI and AFGX TRI. However, according to Lyon and Barber the reference portfolio approach can lead to misspecified t-statistic. Subsequently, this can result in one of the following biases - (i) new listing bias, (ii) rebalancing bias and (iii) skewness bias.

The new listing bias arises when the sampled firms have a long-post event history of returns while firms from the reference portfolio can include firms that start trading close to the event month (Lyon and Barber, 1997). The rebalancing bias relates to the fact that the compound returns of the reference portfolio are calculated assuming periodic rebalancing, while the returns of the sample firms are calculated without rebalancing (Lyon and Barber, 1997). The skewness bias is observed because the long-term ARs can be positively skewed when estimated with a reference portfolio (Lyon and Barber, 1997). Even though, market indexes such as OMXS TRI and AFGX TRI can be suitable reference portfolios, the limitations that this approach encounters, makes it the less preferred choice. Nonetheless, it has been included only as a statistical robustness check of our final BHAR estimations.

Another method that is advocated by several researchers (Fama, 1998; Lyon and Barber, 1997; Lyon et al., 1999) is the control firm approach, which uses the returns of control firms matched by certain characteristics. Loughran and Ritter match based on similarity in the size and the industry (Ritter, 1995). In our sample similarly sized firms within the same industry are matched, whereas size is measured by MVE. Two portfolios are thereby constructed, one comprising of all SP affiliated LS firms and another one consisting of all SP non-affiliated LS firms. Then, a firm from portfolio one is matched with a firm from portfolio two based on similarity in size, measured by the average three-year MVE. Information about the matching can be found in Appendix C. This approach is the better alternative since it controls for the three biases (Lyon and Barber, 1997). The new listing bias is eliminated since all firms are listed during the event. The rebalancing bias is unobservable because the returns of the firms from both portfolios are estimated without rebalancing. Lastly, the skewness bias is minimized since the firms from the two portfolios have an equal chance to have positively skewed returns due to their very similar industry characteristics and size.

The methodology followed to estimate and test the significance of the BHARs is outlined below. The BHAR for each observation *i* in the three-year event window *t* is estimated as the compounded difference between the firms' stock returns and the benchmarks' returns.

$$BHAR_{i,t} = \prod_{t=1}^{T}(1 + r_{i,t}) - \prod_{t=1}^{T}(1 + r_{b,t}) \quad (1.1)$$

where,

$r_{i,t}$ – a monthly return for observation i in month t

$r_{b,t}$ – a monthly return of benchmark portfolio for observation i in month t

T – the number of months in the event window

To test the significance of the BHARs, t-statistic, p-values and the standard deviation of the mean ARs are estimated. The t-test is performed as shown in Equation 1.2 and signifies that if t_{BHAR} is in the range of 0 and 1, the null hypothesis that there are ARs is rejected.

$$t_{BHAR} = \frac{\overline{BHAR_{i,t}}}{\frac{\sigma(BHAR_{i,t})}{\sqrt{N}}} \quad (1.2)$$

where,

$\overline{BHAR}_{i,t}$ - mean BHAR

$\sigma(BHAR_{i,t})$ - BHAR standard deviation

$\sqrt{N}$ – the square root of the number of firms

4.3.1.2 Regression Analysis on Long-term Shareholder Returns

In order to research the relationship between ARs and SP affiliation, a regression analysis is carried out. In the investigation the ARs signify the dependent variable and are regressed against the independent variables, SP and university affiliation, estimated using Ordinary Least Squares regression (OLS).

Dependent Variable

The dependent variable in the regression is the BHAR winsorized at the 1st and 99th percentile. It is considered an appropriate measure of stock performance since according to Lyon et al. (1999), it is a good representation of shareholder experience.

Independent Variables

Science park affiliation dummy signifies whether the corporation is affiliated or not and has been collected manually from a variety of sources, as described in Section 4.2.1 and available in Appendix B.

University ownership dummy signifies the ownership by a university with data retrieved through the Holdings.se database.

Continuous variable for SP affiliation exemplifies the length of affiliation with a SP in the three-year event window. Thus, each affiliated firm's continuous variable assumes a value smaller or equal to three, where three is the maximum years of the observed event window during which the LS firm affiliation could be observed. Three cut-off points were included in the analysis of the continuous variable - *one* signifies a period up to one year, *two* - up to two years, *three* - up to three years. The variable aims to see if the duration under which the LS firm is related to the SP makes a difference for its stock performance.

Interaction term expresses the relationship between the age of the firm and the SP affiliation. The variable aims to examine whether younger or older firms benefit from SP affiliation and if there is such relationship, whether it is positive or negative.

Control Variables

Firm size is defined as the MVE through multiplying the share price at the time with the undiluted number of shares outstanding, as defined by Thomson Reuters Datastream. The natural logarithm of the average monthly MVE is used.

Firm age is the number of years in existence after being incorporated and registered in the database, Allabolag.se, which directly gathers information from the Swedish tax authorities.

Cash flow – Cash flow divided by the previous year BVE is used and constitutes a common control cash flow variable. Because *cash flow* is utilised the return on equity is not affected by

depreciation or the creation of long-term reserves. It is complimented with the following *earnings* variable since negative values of BVE were observed in our sample.

Earnings – Net income divided by total assets of the previous year and is used as a proxy for earnings efficiency, also commonly known as return on assets. Net income is normalized by total assets to control for size differences within the observations.

Dummies for sector effects – Lastly, three dummies in order to control for sector effects are introduced. As the categorization of SISP is followed, the different dummy signifies belonging to pharmaceuticals, biotechnology, or medical technology sector.

4.3.2 Supplementary Methodology

4.3.2.1 Short-term Shareholder Returns in an Event Study Framework

The aim of this supplementary methodology is to offer an alternative way to assess the impact of research-based SP affiliation on shareholder returns. The test performed examines whether LS companies that join a SP realize ARs. A major limitation of this methodology is the small representative sample. Despite this, the method is considered as a useful tool for assessing the effects of a research-based SP on shareholder returns.

Event Definition and Event Window

In the initial stage of the analysis, the event is defined as a scenario in which publicly listed Swedish LS companies join a research-based SP. Following, the event window is defined as the period under which we expect to observe ARs influenced by the event. According to Benninga, the event window is the period before and after the event date. A common practice for the observed period before the event date is usually two trading days (Benninga, 2008). Kulkarni et al. (2003) claim that the length of the event window varies from research to research, however, the usual event window consists of two days before the event date and several days after the event date. Therefore, the event window is estimated as two trading days before and ten trading days after the event.

Normal and Abnormal Returns

The next step is to appraise the impact of the event, for which the AR needs to be calculated. The $AR_{i,t}$ is estimated as the difference between actual return ($R_{i,t}$) and the expected normal return $E(R_{i,t})$, taking into consideration the conditioning information of the normal performance model (X_t) (MacKinlay, 1997).

$$AR_{i,t} = R_{i,t} - E(R_{i,t}|X_t) \quad (2.1)$$

For estimating $E(R_{i,t})$, we consider the performance model's estimation parameters, α and β**,** using a subset of data, called estimation window.

Estimation Procedure

The duration of the estimation window constitutes the period before the start of the event window (Benninga, 2008). According to the author, to observe robust results at least 126 observations in the estimation window is required (Benninga, 2008). Armitage (1995) acknowledges that an estimation window of 100 days or more is sufficient for accurately estimating α and β, therefore, the estimation window is defined as 130 days prior to the event window.

Subsequently, the expected normal returns are estimated $E(R_{i,t})$ using the *market model* since it is advocated as efficient by a number of researchers (Brown and Warner, 1980, 1985; MacKinlay, 1997; Fama and French, 1996). The market model is presented in Equation 2.2, where the observed daily return for each observation *i* in the estimation window is denoted by $R_{i,t}$. $R_{m,t}$ is the return of the market portfolio. Because most of the companies are listed on NASDAQ OMX Stockholm and consisting of various size, it is predicted that the OMX Stockholm TRI would be the most suitable choice for return of the market portfolio. The $\varepsilon_{i,t}$ is the zero-mean disturbance term and α, β are the market model parameters for estimating the expected normal returns (MacKinlay, 1997).

$$R_{i,t} = \alpha_i + \beta_i * R_{m,t} + \varepsilon_{i,t} \quad (2.2)$$

Next, the market model estimation parameters are used to estimate the expected normal returns. The OLS regression used to calculate $E(R_{i,t})$, is outlined below and shows the relationship between the stock returns and the return of a market portfolio taking into consideration the extent to which the stock responds to the market volatility factor β (MacKinlay, 1997).

$$E(R_{i,t}|X_t) = \hat{\alpha}_i + \hat{\beta}_i * R_{m,t} + \varepsilon_{i,t} \quad (2.3)$$

$E(R_{i\tau})$ is the expected normal daily stock return for a firm *i* at time *t*. $R_{m,t}$ is the daily return on a stock market index *m* at time *t* during the event window (MacKinlay, 1997). The market model parameters for estimating the normal returns, α and β, are derived from Equation 2.2.

Testing Procedure

Lastly, it is tested whether the firms have been realizing ARs under the influence of the event. P-values, standard deviation and t-statistic are observed to test the significance of the CARs. To derive to the CARs, first, the ARs for each event day and observation *i* are calculated.

$$AR_{i,t} = R_{i,t} - E(R_{i,t}|X_t) = R_{i,t} - (\hat{\alpha}_i + \hat{\beta}_i * R_{m,t}) \quad (2.4)$$

where,

$AR_{i,t}$ - abnormal return

$R_{i,t}$- actual return

$E(R_{i,t}|X_t)$ - expected normal return

$R_{m,t}$ – return on market portfolio

$\hat{\alpha}_i, \hat{\beta}_i$ – estimation parameters

Subsequently, the CARs for each observation in several different event windows are estimated with Equation 2.5 and the mean CARs with Equation 2.6.

$$CAR_i = \sum_{i=1}^{N} AR_{i,t} \quad (2.5)$$

$$\overline{CAR_i} = \frac{1}{N}\sum_{i=1}^{N} CAR_i \tag{2.6}$$

where,

CAR_i – cumulative abnormal return

$AR_{i,t}$ – abnormal return

$\overline{CAR_i}$– mean cumulative abnormal return

N – number of observations

Finally, inferences about the CARs are drawn by testing the null hypothesis Ho that CARs are zero under the assumption that the daily expected normal returns are normally distributed. The null hypothesis can be tested with the formula in Equation 2.7. The CARs are significant if the null hypothesis can be rejected.

$$t_{CAR} = \frac{\overline{CAR_{i,t}}}{\frac{\sigma(CAR_{i,t})}{\sqrt{N}}} \tag{2.7}$$

where,

$\overline{CAR}_{i,t}$- mean CAR

$\sigma(CAR_{i,t})$ - CAR standard deviation

$\sqrt{N}$ – the square root of the number of firms

4.4 Tests Verifying the Quality of the Research Methodology

According to Yin, four tests are widely accepted to test the quality of any empirical research methodology (Yin, 2002).

4.4.1 Construct Validity

Construct validity aims to establish that the right measures for answering the research questions are employed. In this thesis, each measurement is argued by finding a literature reference for its appropriateness and made compatible with the context of this research. In addition, multiple

sources of evidence are used to ensure the quality of data as well as establishing a "chain of evidence" (Yin, 2002). The chain of evidence concerns the ability of an external observer to be able to trace back the steps of the researchers in making the conclusions for the specific research (Yin, 2002). It is ensured by referencing every source of information and explaining in detail the steps to conduct the empirical investigation.

4.4.2 Internal Validity and External Validity

Campbell and Stanley explain the internal validity, as the "basic minimum" without which the main research question cannot be answered (Campbell and Stanley, 1966). One potential limitation, for which we could not control is the categorization of SP affiliation which may be interpreted in various ways by different stakeholders. For example, a SP itself assumes that a company is part of its research-based facility by simply having the company residing there. A company affiliated with a research-based SP can potentially associate itself with a SP only if it has an R&D activity within this park. In our categorization, data has been collected from the databases of all observed SPs and then contacted each firm separately to request information about their formal affiliation. Although significant attempts have been made in ensuring the quality of this categorization, the internal validity may be infringed because of different perceptions about categorizing as having an affiliation with a SP.

The external validity appears when the findings of the research can be generalized for any similar observations (Campbell and Stanley, 1966). Lewis et al. assert that the problem of generalizing for the whole population may evolve from the inappropriateness of the sample (Lewis et al., 2009). The population consists of all publicly listed Swedish LS firms, whereas the sample under observation is composed of 170 publicly listed firms, which accurately mirror the population and, therefore, confirm the external validity.

To ensure the correctness of the research methodology, several tests have been performed. First, the dependent, independent and control variables are examined for normality of their distribution with histograms and Jarque-Bera testing. Whenever skewness was identified, appropriate transformations were applied as detailed in Section 5.1.1. Second, a multicollinearity test was performed to check if the regression variables are correlated. Whenever such a relationship was

detected assumptions for excluding those variables from the analysis were later conducted. Subsequently, the time series data was tested for heteroskedasticity and autocorrelation. The HAC Consistent Covariance (Newey-West) test was conducted to fix for those data biases. The problem of endogeneity, a correlation between the independent variables and the error term was also considered (Roberts and Whited, 2013). In this thesis, the omitted variable bias has been accounted for to some extent.

As previously mentioned, the matched firm approach is based on the framework of Loughran and Ritter (1995). However, this approach have received some criticism based on the fact that it disregards the findings of price-to-book values being related to subsequent returns, in particular for small firms (Fama and French, 1992). The criticism is based on the fact that a high multiple of price-to-book for smaller companies on average will yield a long-term loser effect (Fama and French, 1992). The authors of this thesis recognise that price-to-book values would be a telling complimentary perspective in constructing the matched sample. Such a matching was attempted in this research, unfortunately, due to the lack of comparable size observations in certain ranges of price-to-book values this became unpractical and arbitrary in assigning different comparing companies under certain circumstances. The authors of this thesis, thereby, concluded that a larger sample would be required in order to mechanically construct this in a fair and consistent manner. The research, therefore, proceeded with matching based on natural logarithmic three-year average values only. As previously stated, an initially high price-to-book multiple for a small company indicates weaker long-term performance in a matched portfolio, which needs to be dealt with in some aspect (Fama and French, 1992). This was accounted for and calculated as a means of comparison and testing between our two sub-samples. It was concluded that the non-affiliated firms on average were much similar to its comparing sample, thereby, eliminating a potential bias towards our results and hypotheses conclusion. If contradicting results would have been received it would have caused concerns when interpreting our BHAR. The authors of this thesis also conclude that since the matching is performed as a same industry comparison, the authors hope to avoid a lot of noise and interferences from unexpected events that affect the performance of entire industries and the dynamics between them as related to variables such as interest rates, exchange rates and other industry specific determinants. Besides, two auxiliary models were supplemented to control for the endogenous reason for the BHAR development.

One accounting for the age differences between SP affiliated and non-affiliated LS firms. The other testing if the duration of SP affiliation instead of the affiliation by itself affects the BHARs.

4.4.3 Reliability

To ensure reliability, Yin (2002) recommends a detailed description of the followed research steps in an accurate manner. In order to reach this, we have established that there is relevance between the literature review and the chosen research methodology. Second, there has been diligence in the data collection process and description of the research methodology which serves as the foundation of empirical investigation in the research. Lastly, the researchers have done multiple sample and calculation controls in order to exclude possible mistakes or misspecifications.

5. Empirical Results

The fifth chapter provides the empirical results of the conducted research. Thorough analyses of the BHAR measure and the regressions are presented. Descriptive statistics and tests for normality and multicollinearity of all regression variables are shown. Following, the model is tested for robustness. Finally, the results from the supplementary methodology are presented.

5.1 Main Methodology

5.1.1 Long-term Event Study Results

5.1.1.1 BHAR Measure and Adjustment for Outliers

The results for long-term post IPO performance of LS firms affiliated and non-affiliated with SPs are presented in Table 3. The BHARs results estimated with the two different return benchmark models - reference portfolio and control firm approach are shown. The BHAR mean shows the average difference between the compounded firm returns and benchmark returns over the 36-monthly period. The results for the standard deviation, t-statistic and p-values for the average BHARs show the statistical significance of the ARs at 10 %, 5 % and 1 % level.

Table 3: Parametric T-test of BHAR

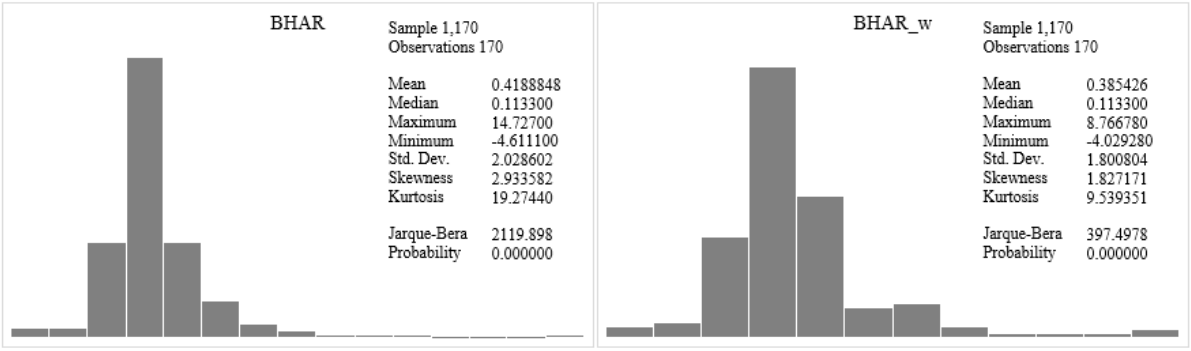
	Model for return benchmark	BHAR mean	T-statistic	Standard deviation	P-value	Significance level
SP affiliated and non-affiliated LS firms	Control firm approach	0.42	2.69	2.03	0.008	***
	AFGX TRI	0.42	2.47	2.23	0.015	**
	OMXS TRI	0.45	2.66	2.21	0.009	***

The significance level is divided into three different levels, t-statistic for a two-tailed test with 169 degrees of freedom at *10%, ** 5%, *** 1% significance level.

The BHARs for the total sample of 170 firms are significant at the 1 % level calculated with the control firm approach and the OMXS TRI. The BHARs estimated with the AFGX TRI are significant at 5 % level. The control firm approach yields the most well-specified test statistic (p-value of 0.008) as compared to the reference portfolio method, which is in line with the findings of Lyon and Barber (1997). Since the BHAR estimated with this return benchmark results is the most significant, the rest of the analysis is based on this measure.

An important consideration for the BHARs regards the normal distribution of the returns. The presence of extreme outliers results in the positive skewness of the BHAR distribution, meaning that a transformation of BHAR is required. To control for this deviation from the BHAR's mean, winsorizing at the 1st and 99th percentile is applied, as shown in Figure 1. The Jarque-Bera test yields better results for the normality of the distribution of BHAR_w (397.49) as compared to the non-transformed variable (2119.89), therefore, the rest of the analysis is based on the winsorized estimate.

Figure 1: Skewness Test of BHAR and BHAR_w



5.1.1.2 Analysis of the BHARs of SP Affiliated and Non-affiliated LS Firms

In the following section, the stock performance of the two main comparative groups are examined. First, a parametric t-test of the winsorized BHAR measure is performed to test the main hypothesis. The results, presented in Table 4, indicate that SP non-affiliated LS firms realize ARs at 5 % significance level. However, they do not support the main hypothesis that SP affiliated firms outperform non-affiliated ones since the data do not provide enough evidence to prove statistical significance.

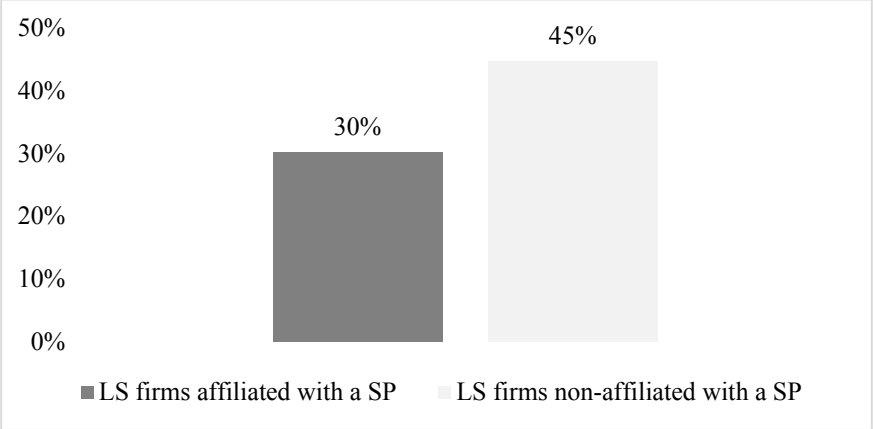
Table 4: Parametric T-test of 36-months BHAR_w

SP affiliated and non-affiliated LS firms	BHAR_w mean	T-statistic	Standard deviation	P-value	Significance level
SP affiliated LS firms	0.30	1.54	1.66	0.13	
SP non-affiliated LS firms	0.45	2.33	1.90	0.02	**

The significance level is divided into three different levels: * - 10% level ** - 5% level; *** - 1% level.

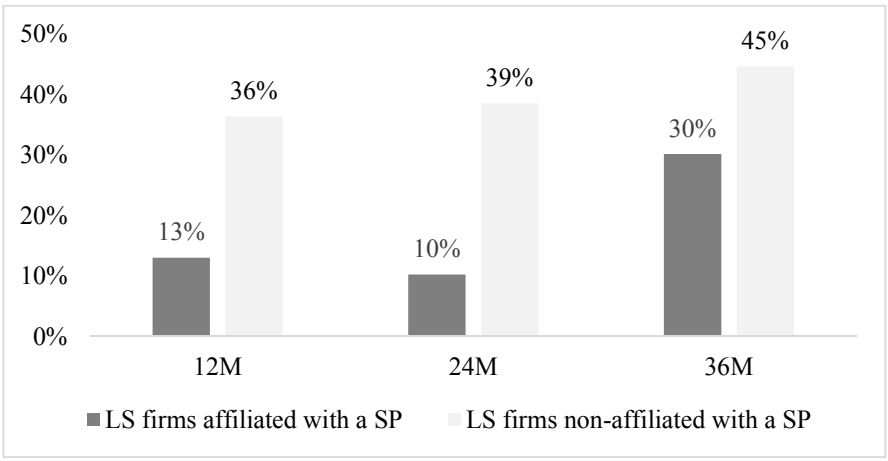
Second, the average BHARs of the LS affiliated and non-affiliated firms are compared under the three-year event window as presented in Figure 2.

Figure 2: Mean BHAR_w Development in Three-year Event Window



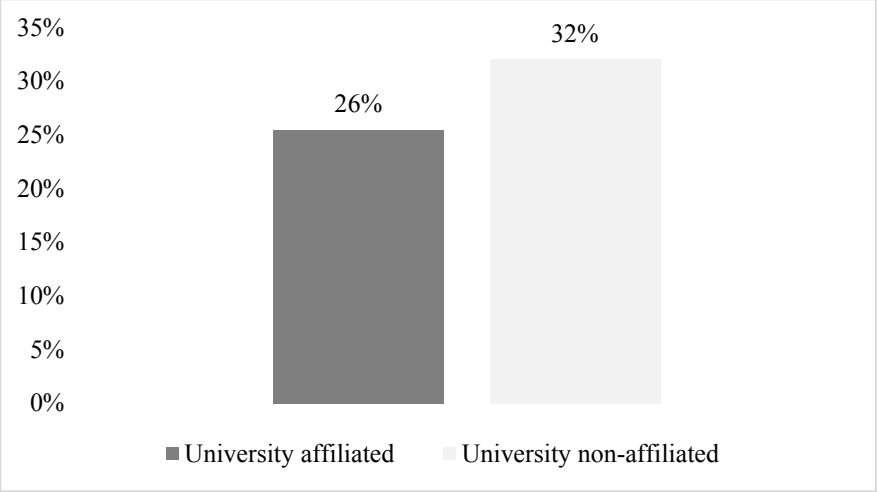
The results show that the non-affiliated SP firms have been performing 50 % better than the affiliated firms. However, no meaningful conclusions can be drawn since the returns of affiliated firms are insignificant. The underperformance of the BHARs is additionally presented for the separate event windows of 12M, 24M and 36M in Figure 3. One can observe that the non-affiliated firms outperform the affiliated ones with 177 % in the 12M period, 290 % in the 24M period and 50 % in the 36M period, but again inferences cannot be made.

Figure 3: Mean BHAR_w Development in 12M, 24M, 36M Event Windows



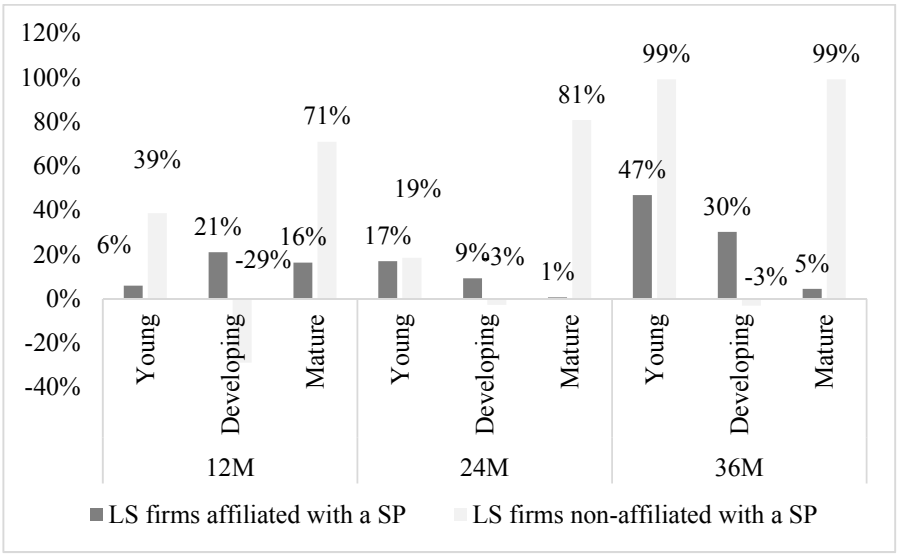
To test the supplementary hypothesis, a comparative analysis of the performance of the 21 LS firms that are partly owned by a university and all other affiliated SP firms is presented in Figure 4. The results are showing a trend that indicates that university ownership is not value-adding for SP affiliated firms from the financial markets perspective.

Figure 4: Mean BHAR_w Analysis of University Affiliated and Non-affiliated LS Firms



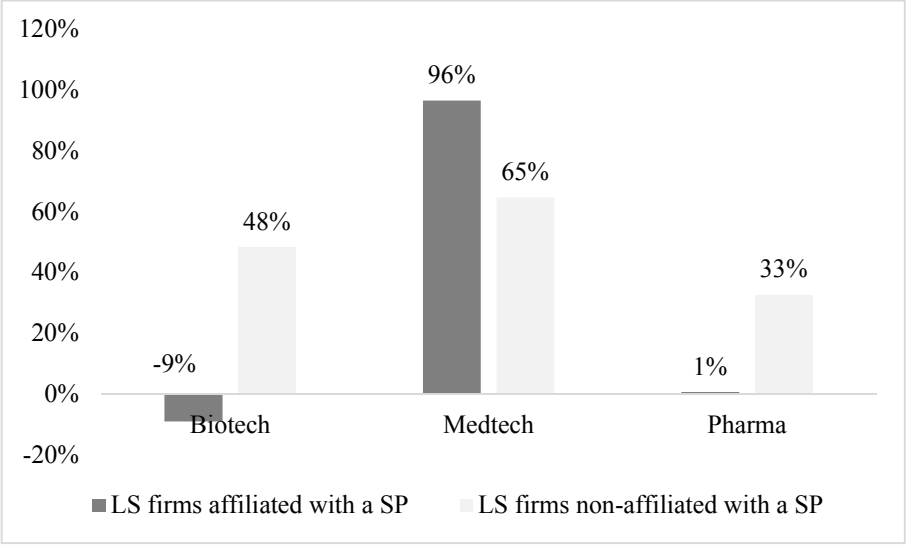
To gain insights of the stock underperformance of SP affiliated firms, several supplementary analyses are conducted. First, an age analysis presents how younger and older firms perform in the three-year event window. Three age categories are introduced in this analysis: young - 0 to 5 years, developing - 5 to 10 years, and mature - 10 and above years, as shown in Figure 5. The results are in line with Squicciarini (2009) who finds that younger SP affiliated firms experience positive value effects due to a higher degree of innovation as compared to older ones in the 24M and 36M period. In the 12M period developing firms perform better than mature but worse than young. Whereas a trend can be observed for younger SP affiliated firms, no stock outperformance of younger non-affiliated SP firms was detected.

Figure 5: Age Analysis of Mean BHAR_w Development in 12M, 24M, 36M Event Windows



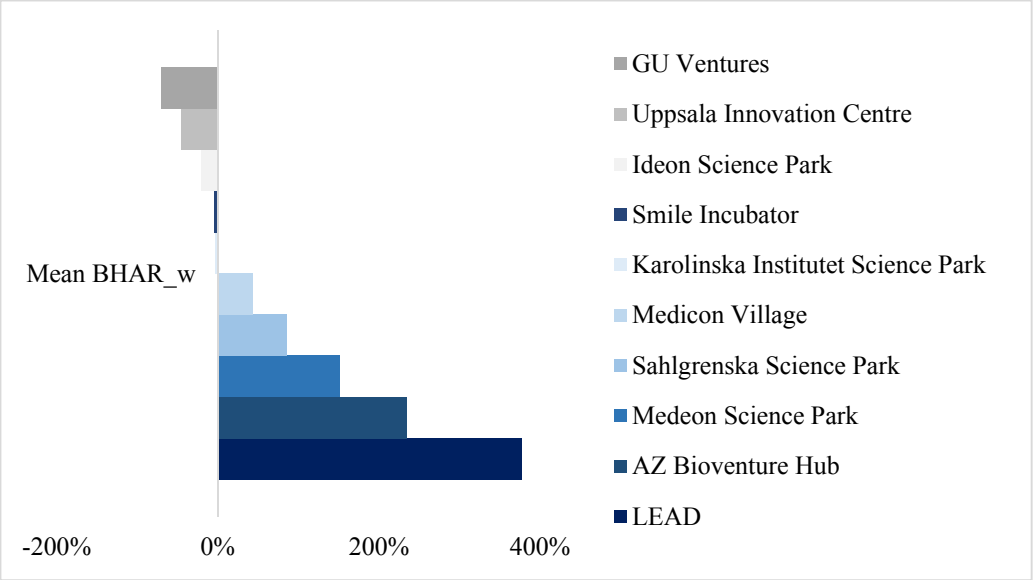
Additionally, an inspection of the BHARs performance of SP affiliated and non-affiliated LS firms in the context of the three sectors, comprising the total sample - biotechnology, medical technology and pharmaceuticals is conducted. The sector classification is in line with the definition by SISP. More information about the sector to which each firm belongs can be seen in Appendix B. The results from Figure 6 indicate that the medical technology sector is the only sector that outperforms for SP affiliated firms as compared to non-affiliated ones.

Figure 6: Industry Analysis of Mean BHAR_w Development



Lastly, an exemplification of the stock performance of affiliated LS companies as per SP is introduced. The average winsorized BHAR serves as a differentiator between the ten SPs analysed in this study. The results, illustrated in Figure 7, demonstrate that LS firms that are affiliated with AZ Bioventure Hub, LEAD, Medeon Science Park, Sahlgrenska Science Park and Medicon Village realize on average positive ARs. As compared to LS firms from Smile Incubator, Karolinska Institutet Science Park, Ideon Science Park, Uppsala Innovation Centre and GU Ventures, where the LS firms experience negative BHARs on average.

Figure 7: Mean BHAR_w Analysis per SP



5.1.2 Regression Analysis Results

5.1.2.1 Descriptive Statistics of Regression Variables

In this section, the regression variables will be estimated by evaluating the quality of the data. For this purpose, normality and multicollinearity tests are performed.

Table 5: Descriptive Statistics of Regression Variables

	Dependent variable	Independent variables		Continuous variable	Interaction term	Control variables						
	BHAR_w	d_SP	d_University	< or = 3Y	SP and Age	Cash Flow	Earnings	Age	ln_Size	d_biotech	d_medtech	d_pharma
Mean	0.40	0.43	0.13	0.90	3.30	45.71	-3.83	9.38	2.27	0.22	0.37	0.49
Median	0.12	0.00	0.00	0.00		18.09	-0.24	7.00	2.18	0.00	0.00	0.00
Maximum	8.77	1.00	1.00	3.00	25.00	2109.79	0.15	67.00	3.83	1.00	1.00	1.00
Minimum	-4.03	0.00	0.00	0.00	0.00	-135.67	-567.03	0.00	1.16	0.00	0.00	0.00
Std. Dev.	1.80	0.50	0.33	1.20	5.26	220.42	43.89	9.43	0.57	0.41	0.48	0.50
Skewness	1.84	0.28	2.26	0.91	1.85	3.42	-12.77	3.20	0.63	1.38	0.53	0.06
Kurtosis	9.61	1.08	6.10	2.14	6.34	56.47	164.35	18.12	3.03	2.91	1.28	1.00
Jarque-Bera	398.63	27.87	208.55	28.41	175.46	20587.90	185688.20	1875.63	10.95	53.32	28.39	27.83
Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	66.08	72.00	21.00	153.00	558.00	777.17	-639.05	1567.00	378.32	36.00	62.00	81.00
Sum Sq. Dev.	539.57	40.96	18.36	245.30	4659.61	82122.88	319742.90	14755.47	54.22	28.24	38.98	41.71
Observations	167.00	167.00	167.00	170.00	169.00	167.00	167.00	167.00	167.00	167.00	167.00	167.00

The significance level is divided into three different levels: * - 10% level ** - 5% level; *** - 1% level. The variables are: *BHAR_w* is the buy-and-hold-abnormal return adjusted for extreme outliers, *d_SP* is taking the value of one if the LS firm is affiliated with SP and the value of zero if it is not affiliated, *d_university* signifies the ownership by university, *continuous variables* assumes a continuous value between 0 and 3 depending on the duration under which the LS was affiliated with SP. *Interaction term* shows the interaction between firm's age and SP affiliation. Control variables: *Cash flow is* cash flow divided by book value of equity, *Earnings* is net income divided by total assets. *Age* is firm's age as of the IPO. *Size* is the logarithm of the average MVE.

For the BHAR_w measure, the significant difference between the mean and the median would mean that there are several negative ARs. The high mean indicates that BHAR values are inflated by some of the observations. The Jarque-Bera test shows that all variables but cash flow and earnings are close to normally distributed. Upon logging the firm's size, measured by MVE, the distribution of the variables improved. The cash flow's tail is skewed more to left, meaning negative skewness, whereas earnings have a long right tail, which indicates a positive skewness. The presence of more negative than positive values requires the log (X+1), where X stands for one of the control variables to be the appropriate solution. After the transformations, the Jarque-Bera test shows that earning's normality value is 8,342, while cash flow's is 4.77. The skewness of both measures, however, imposes a drop in the observations from 170 to 128, when both the

independent and the control variables are included in the regression analysis. Please refer to Appendix C for the normality tests of those control variables.

Multicollinearity Test

Before proceeding with the regression analysis, all regression variables are investigated to account for problems of correlation. The multicollinearity test is done in order to ensure that the regression variables are not correlated. As a rule of thumb, if the correlation is approaching 0.8, there is a potential multicollinearity problem (Gujarati, 2003).

Table 6: Correlation Matrix of Regression Variables

	BHAR_w		d_SP		d_ university		Continuous variable		Interaction term		Earnings		Cash Flow		Age		Size		Dummy Biotech		Dummy Medtech		Dummy Pharma	
BHAR_w	1.00		-0.02		-0.02		-0.04		-0.04		-0.08		-0.05		0.09		0.08		-0.06		0.15	*	-0.18	**
d_SP	-0.02		1.00		0.42	***	**0.88**	***	**0.72**	***	-0.06		0.27	***	-0.15	*	-0.21	**	0.21	**	-0.04		-0.13	
d_university	-0.02		0.42	***	1.00		0.29	***	0.26	***	0.07		0.19	**	-0.10		-0.12		0.17	*	-0.13		0.08	
Continuous variable	-0.04		**0.88**	***	0.29	***	1.00		**0.64**	***	-0.07		0.20	**	-0.12		-0.19	**	0.16	*	-0.03		0.15	*
Interaction term	-0.04		**0.72**	***	0.26	***	**0.64**	***	1.00		0.08		0.22	**	0.24	***	-0.07		0.21	**	0.05		-0.24	***
Earnings	-0.08		-0.06		0.07		-0.07		0.08		1.00		-0.10		0.16	*	0.34	***	-0.07		0.07		-0.07	
Cash Flow	-0.05		0.27	***	0.19	**	0.20	**	0.22	**	-0.10		1.00		0.04		-0.16		0.19		-0.14		0.02	
Age	0.09		-0.15	*	-0.10		-0.12		0.24	***	0.16	*	0.04		1.00		0.20		-0.01		0.11		-0.19	**
Size	0.08		-0.21	**	-0.12		-0.19	**	-0.07		0.34	***	-0.16		0.20		1.00		-0.04		-0.09		0.09	
Dummy Biotech	-0.06		0.21	**	0.17	*	0.16	*	0.21	**	-0.07		0.19		-0.01		-0.04		1.00		-0.39		-0.32	***
Dummy Medtech	0.15	*	-0.04		-0.13		-0.03		0.05		0.07		-0.14		0.11		-0.09		-0.39		1.00		-0.59	***
Dummy Pharma	-0.18	**	-0.13		0.08		-0.15	*	-0.24	***	-0.07		0.02		-0.19	**	0.09		-0.32	***	-0.59	***	1.00	

The significance level is divided into three different levels: * - 10% level ** - 5% level; *** - 1% level. The variables are: *BHAR_w* is the buy-and-hold-abnormal return adjusted for extreme outliers, *d_SP* is taking the value of one if the LS firm is affiliated with SP and the value of zero if it is not affiliated, *d_university* signifies the ownership by university, *continuous variable* assumes a continuous value between 0 and 3 depending on the duration under which the LS was affiliated with SP. *Interaction term* shows the interaction between firm's age and SP affiliation. Control variables: *Cash flow* is log(CF/BVE+1), *Earnings* is log(NI/TA+1). *Age* is firm's age as of the IPO. *Size* is LOG(MVE).

The results from the correlation matrix show that there may be a potential multicollinearity problem between the dummy variable for SP affiliation and the continuous variable for a period under which the firm was SP affiliated. The test proves that those variables should not be included together and, therefore, we take this into consideration in the regression analysis. Whereas the value of 0.72 indicates that there is correlation between the SP dummy and the interaction term, both variables need to be included in order to yield a well-specified model when testing for the effect of the interaction term of SP and age on the ARs.

5.1.2.2 Regression Results

After the descriptive statistics, this section is focused on presenting the regression results, performing robustness check and minimizing the endogeneity problem. The regression analysis provides an opportunity to study the effects of the regression variables on the ARs.

$$BHAR_w = \alpha + \beta_1 * Dummy_{SP_{affiliation.}} + \beta_2 * Dummy_{University_{ownership}} + \beta_3 * \log(MVE) + \beta_4 * age$$
$$+\beta_5 * \log\left(\frac{NI}{TA} + 1\right) + \beta 6 * log\left(\frac{CF}{BVE} + 1\right) + \varepsilon i, t$$

The dependent variable in the regression is the winsorized BHAR, derived from the long-term event study. The main independent variables are dummies for SP and university affiliation, which take the value of 0 or 1 depending on the affiliation status. Additionally, the control variables of firm's size, age, cash flow and earnings are included.

Table 7: BHAR_w Main Regression Model of SP Affiliated and Non-affiliated LS Firms

BHAR_w	**Initial OLS model: no control variables**				**Initial OLS model: control variables**		
	Coeff.	T-statistic	Prob.		Coeff.	T-statistic	Prob.
Dummy_SP_affiliation	-0.17	-0.55	0.58		0.07	0.19	0.84
Dummy_university_ownership	-0.03	-0.05	0.95		0.04	0.08	0.93
LOG(MVE)					0.32	1.00	0.32
Age					0.02	1.07	0.28
LOG(NI/TA+1)					-0.44	-1.34	0.18
LOG(CF/BVE+1)					-0.06	-0.06	0.54
Intercept	0.46	2.50	0.01	***	-0.56	-0.62	0.53
R-squared		1%				3%	
Adjusted R-squared		-1%				-1%	
Prob(F-statistic)		0.82				0.72	
Observations		170				128	

The significance level is divided into three different levels: * - 10% level ** - 5% level; *** - 1% level. The dependent variable is the *winsorized BHAR (BHAR_w)* estimated with the control firm approach in a three-year event window, starting in the initial public offering of the firms. The main independent variables are *dummies for SP* and *university affiliation*. The control variables are *firm's size, age, cash flow* and *earnings. Size* is the logarithm of the average MVE. *Age* is firm's age as of the public listing. *Earnings* is the natural logarithm of net income divided by total assets plus one. *Cash flow* is the natural logarithm of cash flow divided by book value of equity plus one.

The OLS regression coefficients indicate that both the SP (-0.17) and university affiliation (-0.03) are negatively related to BHARs. However, this cannot be an explicit conclusion since the regression and its variables are not significant at the 10 % level (R^2 of 1% and p-values of 0.58 for dummy SP and 0.95 for dummy university). The high value of P(F-statistic) (0.82) minimizes the probability that the results are subject to chance. The only significant value at 1% level is the

regression coefficient. The intercept coefficients regard only the affiliated firms since all three models assume zero values for non-affiliated firms. In the initial regression, 46 % increase in BHAR is expected when the independent variables increase by one. By adding control variables, the R^2 improves to 3 % but the significance level of the independent variables does not change, thus, no further discussion is provided on them.

Autocorrelation and Heteroskedasticity

In the following section, two tests for heteroskedasticity and autocorrelation are performed, as shown in Table 8. The heteroskedasticity test examines if the variance of the error terms is constant whereas the autocorrelation test investigates the correlation between the error terms of the variables. The Durbin-Watson statistic shows that there is little autocorrelation since the value is close to two (Wagner et al., 2002). The heteroskedasticity test shows that the time series data is slightly heteroskedastic. Adjustments for heteroskedasticity and autocorrelation are conducted through the HAC Consistent Covariance (Newey-West) test, which can be observed in Appendix C. After the transformations, the coefficients of the regression variables improved slightly and their standard errors changed, however, there is no significance at the 10 % level. The rest of the regression analysis assumes the correction for heteroskedasticity and autocorrelation data.

Table 8: Heteroskedasticity and Autocorrelation Tests

	Initial regression model: no control variables				
	Durbin-Watson statistic	White heteroskedasticity-consistent standard errors and covariance			
Initial OLS	1.85	F-statistic	0.31	Prob. F(2,167)	0.73
		Obs*R-squared	0.63	Prob. Chi-Square(2)	0.73
		Scaled explained SS	2.58	Prob. Chi-Square(2)	0.28
	Initial regression model: control variables				
	1.81	F-statistic	0.456	Prob. F(24,103)	0.99
		Obs*R-squared	12.29	Prob. Chi-Square(24)	0.98
		Scaled explained SS	43.22	Prob. Chi-Square(24)	0.009

Robustness Test

Since no significance could be observed in the models introduced so far, several different robustness tests were performed, by means of introducing new variables, controlling for industry effects and changing the event window.

Table 9: Robustness Tests of BHAR_w Main Regression Model

BHAR_w	Initial OLS model			Continuous variable			Interaction Term			Industry effects			Another event window (12M)		
	Coeff.	Prob.		Coeff.	Prob.		Coeff.	Prob.		Coeff.	Prob.		Coeff.	Prob.	
D_SP	0.07	0.85					0.49	0.33		-0.07	0.84		-0.05	0.85	
D_university	0.05	0.93		0.10	0.84		0.01	0.99		0.40	0.30		0.02	0.97	
LOG(MVE)	0.32	0.18		0.31	0.17		0.32	0.18		0.47	0.07	*	0.37	0.08	*
Firm's age	0.02	0.19		0.02	0.22		0.04	0.10	*	0.01	0.62		0.03	0.15	
log(NI/TA+1)	-0.44	0.09	*	-0.44	0.10	*	-0.39	0.11		-0.59	0.05	**	-0.16	0.01	***
log(CF/BVE +1)	-0.06	0.47		-0.06	0.50		-0.06	0.48		-0.02	0.79		-0.52	0.02	**
CV_SP_affiliation				-0.01	0.90										
SP*age							-0.05	0.15							
D_biotech										-1.03	0.10				
D_medtech										-0.49	0.41				
D_pharma										-1.26	0.03				
Intercept	-0.56	0.42		-0.51	0.45		-0.66	0.34		0.08	0.93		-0.42	0.50	
R-squared	3%			3%			4%			9%			10%		
Adjusted R-squared	-1%			-1%			-1%			2%			5%		
Prob(F-statistic)	0.72			0.72			0.69			0.24			0.05		
Observations	128.00			128.00			128.00			128.00			128.00		

The significance level is divided into three different levels: * - 10% level ** - 5% level; *** - 1% level. The dependent variable is the *winsorized BHAR (BHAR_w)* estimated with the control firm approach in a three-year event window, starting in the initial public offering of the firms. The main independent variables are *dummies for SP* and *university affiliation*. The independent variables used in the robustness OLS models are as follows. Continuous variable for SP affiliation (*CV_SP_affiliation*) showing the duration under which a firm has been affiliated with a SP. Interaction term between SP and age (*SP*age*) is the product of SP affiliation dummy and firm's age. The control variables are *firm's size, age, cash flow* and *earnings. Size* is the logarithm of the average MVE. *Age* is firm's age as of the public listing. *Cash flow* is the natural logarithm of cash flow divided by book value of equity plus one. *Earnings* is the natural logarithm of net income divided by total assets plus one.

Most of the regressions are consistent with the initial results. First, no significant results are observed for the dummies of SP and university affiliation. The sign of the coefficients of the independent variable for SP affiliation is positive in the models with lower R^2 and negative in the models with higher R^2, however, no significance at the 10 % level for the coefficients of this variable was observed. Therefore, no conclusions could be drawn. Second, the OLS models that differ from the initial OLS are the model controlling for industry effects from the biotechnology, medical technology, pharmaceutical sector and the OLS model estimated on the basis of the 12-month event window. The sign of the SP affiliation coefficients in those two models are negative, but again conclusions cannot be made because of high p-values. Each of the models are hereafter discussed.

Including Continuous Variables

$$BHAR_w = \alpha + \beta_1 * CV_{SP_{affiliation.}} + \beta_2 * Dummy_{University_{ownership}} + \beta_3 * \log(MVE) + \beta_4 * age + \beta_5 * \log\left(\frac{NI}{TA} + 1\right) + \beta 6 * log\left(\frac{CF}{BVE} + 1\right) + \varepsilon i, t$$

The first test replaces the dummy for SP affiliation with a continuous variable, which assumes a rounded value from 0 to 3 depending on the period length of the 36-month event window, in which the firm has been affiliated with a research-based SP. Introducing this variable aims to see if the duration of affiliation causes ARs. The only significant variable at 10 % significance level is the natural logarithm of earnings, which indicates that BHAR_w in the three-year event window is predicted to decrease by 44 % when the earnings increase by one. However, no further conclusions could be drawn due to the insignificance of the remaining coefficients and low R^2.

Including Interaction Term Between SP Affiliation and the Firm's age

$$BHAR_w = \alpha + \beta_1 * (SP * age) + \beta_2 * Dummy_{SP_{affiliation}} + \beta_3 * Dummy_{University_{ownership}} + \beta_4 * \log(MVE) + \beta_5 * age + \beta_6 * \log\left(\frac{NI}{TA} + 1\right) + \beta_7 * \log\left(\frac{CF}{BVE} + 1\right) + \varepsilon_{i,t}$$

Previously in the research, we have shown that younger SP affiliated firms experience higher BHARs than older SP affiliated firms. Introducing the interaction term between SP affiliation and the firm's age is one way to observe if a positive effect on stock performance is experienced based on the development stage of the LS firm. The interaction term variable turned out to be an insignificant variable (p-value of 0.15), however, it improved significantly the results for SP affiliation from the initial regression model. The relationship that could be observed is that the interaction between affiliation and firm's age are negatively related to BHAR, which is in accordance with the results from the analysis of the BHAR, demonstrating that young but not old firms are benefiting from SP affiliation. The only significant at 10 % significance level variable is the firm's age yielding a positive relationship with BHAR_w. Taking into consideration the insignificance of the results, however, no explicit conclusions could be drawn.

Controlling for Industry Effects

As three main sectors of the LS industry are observed in this analysis as defined by SISP - biotechnology, medical technology and pharmaceuticals, we control for those effects. Significance is observed in the p-values of the firm's size and earnings. The coefficient of firm's size predicts that the BHAR_w increases by 47 % when size increases by one at 10 % significance level. The coefficient of earnings confirms the observed earlier negative relationship with ARs and indicates that BHAR_w decreases by 59 % when earnings increase by one. The results provide insights that the pharmaceutical sector at 5 % significance level and the biotechnology sector at 10% significance level underperform. When controlling for industry effects, the adjustment improved R^2 to 9 %, however, the significance of the main independent variables was not influenced, therefore, no inferences with regards to the main hypothesis could be made. Another drawback of the model is the low value of the P(F-statistic) (0.24) which indicate that there is a probability that the results happened by chance.

Introducing New Event Window

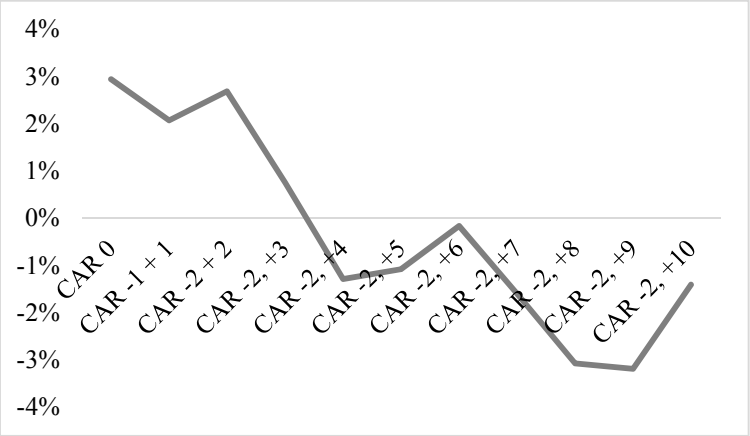
Lastly, an event window of 12M was introduced primarily because one of the limitations of this thesis is that some of the firms have been listed recently and thereby the period for utilizing the BHARs may not be grasped fully. The size coefficient is significant at 10 % significance level and provides insights for a positive relationship with BHAR_w, where ARs increase by 37 % when size increase by one. Earnings are negatively related to ARs and yield prediction at 1 % significance level for a 16 % decrease in BHAR_w when earnings increase by one. Last, there is a negative relationship between cash flow and ARs at 5 % significance level, where a 52 % decrease in BHAR_w is predicted when cash flow increases by one. Whereas the R^2 improves from 3 % to 10 %, there is no significant change in the p-values for SP and university affiliation. Moreover, the P(F-statistic) (0.05) is extremely low, which may indicate that the model is erroneous.

5.2 Supplementary Methodology

5.2.1 Short-term event study results

The results of the short-term event study analysis are presented below. Day zero signifying the first trading day of the published announcement and if reported after closing, the following day of trading. Multiple event windows have been calculated to achieve a comprehensive understanding of how the market's response changes across different windows. As previously mentioned, most companies were affiliated with a SP before their IPO, thereby, reducing our sample to 19 companies.

Figure 8: Mean CAR Development in Different Event Windows of SP Affiliated LS Firms



As the graph highlights, an initial positive response is measured following the announcement. Table 10 shows the results from the parametric t-test. The CAR means, as well as their significance levels, are presented for the multiple event windows.

Table 10: Parametric T-test of CAR for Different Event Windows

	CAR Mean	Standard deviation	T-statistic	P-value	Significance level
CAR 0	0.03	0.06	2.23	0.04	**
CAR -1 + 1	0.02	0.06	1.45	0.17	
CAR -2 + 2	0.03	0.10	1.20	0.25	
CAR -2, +3	0.01	0.11	0.29	0.77	
CAR -2, +4	-0.01	0.14	-0.40	0.69	
CAR -2, +5	-0.01	0.14	-0.34	0.74	
CAR -2, +6	0.00	0.13	-0.05	0.96	
CAR -2, +7	-0.02	0.13	-0.52	0.61	
CAR -2, +8	-0.03	0.11	-1.16	0.26	
CAR -2, +9	-0.03	0.13	-1.08	0.29	
CAR -2, +10	-0.01	0.12	-0.52	0.61	

The significance level is divided into three different levels, t-statistic for a two-tailed test with 18 degrees of freedom at * 10%, ** 5%, *** 1% significance level.

The null hypothesis tested in this event study is that the event, joining a SP, has no impact on the shareholder returns. Based on the significance level tests, the null hypothesis can be rejected only for the event day at 5 % significance level. The calculations of the ARs are provided in Appendix D. The results allow conclusions to be drawn only for one event window. Event zero as in the announcement effect of the first day, indicating a mean CAR of 0.03 with significance at 5 % level. To check the robustness of the event study results, the non-parametric Wilcoxon signed-rank test is performed, under which the significance of the medians are tested. The null hypothesis for the sign test is that the median CAR is zero. The methodology is in line with the testing of ARs in previous research (Veld and Veld-Merkoulova, 2004). The results of the Wilcoxon signed-rank test are presented in Table 11 and are consistent with the results from the parametric t-test.

Table 11: Non-parametric Wilcoxon Signed-rank Test of CAR

	T-statistic	P-value	Significance level
CAR 0	2.64	0.01	***
CAR -1 + 1	1.31	0.19	
CAR -2 + 2	1.11	0.27	
CAR -2, +3	0.14	0.89	
CAR -2, +4	0.70	0.48	
CAR -2, +5	0.70	0.48	
CAR -2, +6	0.30	0.76	
CAR -2, +7	0.78	0.43	
CAR -2, +8	1.55	0.12	
CAR -2, +9	1.19	0.24	
CAR -2, +10	0.58	0.56	

Table 12: Descriptive Statistics of CAR in the Event Day

Descriptive statistics of CAR in the event day	
Mean	0.03
Median	0.02
Maximum	0.20
Minimum	-0.04
Std. Deviation	0.06
Skewness	2.02
Kurtosis	6.28
Jarque-Bera	21.52
Probability	0.00
Sum	0.56
Sum Sq. Dev.	0.06
Observations	19

The significance level is divided into three different levels: * - 10% level ** - 5% level; *** - 1% level.

Since the results turned to be significant only for the event day, additional descriptive statistics for the CARs in this event window are presented in Table 12. The mean is greater than the median, which explains the skewness of the data to the right. With regards to the normality of the distribution, the Jarque-Bera test is performed and it shows that the distribution is positively skewed but close to normality (21.5), therefore, no adjustments of the CARs were conducted. A histogram analysis of CAR is additionally presented in Appendix D.

6. Analysis and Discussion

The sixth chapter presents the empirical results of both methodologies as well as it is analysed in context with the existing literature and theoretical framework. The hypotheses are rejected or failed to be rejected based on this connection.

6.1 Buy-and-hold Abnormal Returns

As opposed to our hypothesis, no ARs were yielded for the affiliated companies. Interestingly there existed observable trends within the sample. It was found that younger firms outperform mature companies, which aligns with the findings of Squicciarini (2009), however, the low statistical significance behind these trends makes it impossible to draw meaningful conclusions. Theory as well as previous research have shown an outperformance in various metrics such as strengthened survival rate (Westhead and Storey, 1995) patent productivity (Link and Scott, 2003; Squicciarini, 2009; Yang et al., 2009) and employment growth (Lindelöf and Löfsten, 2001; Colombo and Delmastro, 2002) however, no evidence of stock outperformance of SP affiliated firms was found in our sample. The breakdown of BHARs between the different SPs also shows great differences, although they are not statistically significant to draw any conclusions based on this observation. The BHAR performance was also broken down by sector which showed trends of medical technology of affiliated companies to outperform the non-affiliated companies. With the reverse results being true for biotechnology and pharmaceuticals, however, the low statistical significance makes it impossible to draw any inferences. Even though university affiliation has been found to be beneficial from a research-based perspective, as discussed by Dièz-Vial et al. (2015), our hypothesis of formal university affiliation and ownership showed to be rejected and no ARs were recognized for this group of companies.

6.2 Cumulative Abnormal Returns

The results from the supplementary methodology, demonstrating ARs on the event day, produced contradictory results as compared to the results from the BHARs and the regression analysis. One potential reason for this can be that the main methodology relies on a much larger sample. Therefore, it carries more weight in the main conclusion of this study. Nevertheless, the CARs might indicate a relief from investors as the risk of operations is lowered when entering a SP. This is both based on previous theories, but also exemplified in the conducted interviews

where affiliation was seen as a stamp of approval and lowered financial risk. Lastly, an announcement of SP affiliation does influence positively the shareholder returns in the short period after the announcement, however, no long-term effects on shareholder returns could be observed.

6.3 Discussion of Regression Results

Turning to the SP and formal university affiliation measures, no significant differences in ARs between SP affiliated and non-affiliated LS firms were found. The OLS results proved to be insignificant and even though the main regression model was challenged by several robustness checks, none of these alternative models could prove the hypothesis that there is a positive relationship between shareholder returns and SP/university affiliation. When introducing the interaction term between SP affiliation and age, the significance of the variable improved, however, not enough to prove that there is any kind of relationship between BHAR and SP affiliation. Since in the BHAR analysis, a trend of stock outperformance for younger affiliated LS firms was observed, a potential research direction would be to expand the sample size and to test again the significance of the interaction term. Interestingly, when controlling for industry effects, the R^2 of the regression improved from 3 % to 9 %, however, no significance at 10 % significance level of p-values for the affiliation variables could be observed. With regards to this, one could possibly examine if firms from a specific sector benefit from SP affiliation.

Indeed, the regression results show the complexity of the area and perhaps the criticism presented by the research from Phan et.al which exemplified the problems of measuring performance and making the effects concrete and tangible due to the variability of studies as well as the lack of cohesive research structure on the phenomenon of SPs (Phan et.al, 2005). As previously mentioned, attempts to measure the effectiveness have been criticized by Phan et.al which claims that SPs and incubators are examined in terms of four levels of analysis 1) the SPs and incubators themselves, 2) the enterprises located upon SPs and incubators, 3) the entrepreneurs and teams of entrepreneurs involved in these enterprises 4) and at the systemic level, which causes confusion amongst the measured outcomes (Phan et.al, 2005). Our aim was to circumvent this dilemma in an approach previously not tested, however, the results might be an additional example of the complexity. As the authors also recommend, the analysis would

also have to account for the fact that the causes and consequences of SPs may be contingent upon their geographical location, social and political systems as well as the economic context (Phan et.al, 2005). Factors which we have not dealt with in our regression and would require a larger sample for comparison given the nature of the variables.

A potential problem to the explanatory effect of the regression could be that of matched firms and definitions of SPs. After reviewing all companies' geographical locations and potential connections when collecting the data, it was evident that there exists a couple of LS and NTBF clusters, however, without any connection to the Swedish Incubators and Science Parks organization. This means that there could be firms that benefit from the collaborative effects and knowledge sharing although not recognized due to lack of municipal involvement. They constitute, therefore, not a policy driven initiative but a spontaneous cluster with similar achieved effects. This would naturally cause dilution of results in the regression analysis due to misspecifications. The findings problematize and contradict the research on positive aspects of SP affiliation (Link and Scott, 2003; Squicciarini, 2009; Yang et.al, 2009; Lindelöf and Löfsten, 2001; Colombo and Delmastro, 2002) from the perspective of the financial markets. However, the natural correlation of these factors in relation to our limited sample have influenced the explanatory power. It is important to note that the assumptions where constructed upon the fact that strengthened innovative power would lead to increased share performance (Onetti and Zucchela, 2014). The lack of explanatory power of the regression, the SP- and university-variable, could be caused by a weak relationship given the size of the sample.

7. Conclusion

The seventh chapter aggregates the main conclusions of this study. The research aims and objectives are presented. Suggestions for future research and additions of the studied subject is proposed and outlined.

7.1. Research Aim and Research Objectives

A number of researchers have been analyzing the performance differences of firms affiliated or not with SP (Fukugawa, 2015; Lindelöf and Löfsten, 2001, 2002, 2003, 2004; Squicciarini, 2009). No research previously was conducted in observing those differences from the financial markets perspective. In addition, the study has a niche focus on the LS industry since the LS firms are explicitly defined as beneficiaries of SPs, thus informing all interested actors in the industry. In this thesis, the authors aimed to understand:

"Are research-based science parks value creators in life science and is there a difference in the stock performance which can be associated with being or not being a part of a research-based science facility?"

To answer this question a long-term and short-term event study analyses of ARs were performed. Based on the empirical results and analysis, it is concluded that there are no long-term ARs, however, there are statistically significant short-term ARs associated with SP affiliation on the first day of announcing SP affiliation. The first analysis examined 170 firms, 72 of which being SP affiliated. The second one relied on a representative sample of 19 firms that joined a SP subsequent to their IPO. The small sample in the short-term event study is a major limitation of the study, which is taken into consideration. Assuming that the long-term analysis of ARs has more weight, the first hypothesis that there is positive relationship between shareholder ARs and SP affiliation is rejected. The effect of formal university affiliation, discussed by Díez-Vial (2015) was analyzed from the stock market perspective for 21 university owned firms. The weak explanatory power of the regression analysis, presumably due to the limitations of the sample, led to the rejection of the supplementary hypothesis for a positive relationship between university ownership and shareholder returns.

Although no significant positive relationship between SP/university affiliation and shareholder returns was observed, in this thesis two trends were identified. First, young SP affiliated firms outperform as compared to old SP affiliated firms. Second, there is a sector trend for underperformance in the LS industry which may be an important consideration for future research. To sum up, the knowledge contribution of this research has been the first attempt at estimating the differences between these groups based on shareholder returns. According to Phan et al. (2005) such attempts are important due to the complex nature of SP and SP affiliated firms and the need for creation of a systematic framework for examining SP affiliation differences.

7.2. Further Research

The following suggestions are recommended for future research on this subject. In estimating the effects of collaborative power, the reasoning of Asheim was followed which predicted that the complex nature of developing and launching LS products are amongst the most likely of benefitting from affiliation and its collaborative effects (Asheim, 2007). However, this naturally restrained the sample which could have included all listed SP affiliated companies.

Doing so would ensure larger degrees of freedom and a more granular approach to evaluating and testing the regressions. Statistical significance was unfortunately not found on a number of variables. During the background industry research, it also becomes evident that Denmark has a much similar structure to Sweden regarding SPs and their connectedness such as through the Swedish SISP counterpart. Naturally, expanding the research to our neighbouring country would be advantageous and a natural extension as long as the definitions and aims of SPs and institutions were to remain intact.

From researching the industry, a potential trend emerges of sophisticated investors screening the SPs for suitable investments. Potentially making it easier to receive funding and outside investors based on the SP affiliation and its signalling effects as compared to non-affiliated companies. There is a possibility that these forces drive change in ways that we statistically not have been able to account or control for. Thereby making ownership and early financing structures of the companies interesting variables to investigate in addition to university ownership.

Lastly, an important aspect to investigate is the screening procedure taking places prior to LS companies are able and allowed to affiliate themselves with the SP. What factors determine which companies are granted access is something that we have been unable to obtain due to confidentiality agreements of the SPs as well as difficulty in reaching the decision makers and committees in charge of such decisions. In some instances, the entry-barriers seem quite low and at other times, very rigorous. From the research, it is evident that different SPs have utilized different criteria, which potentially creates a selection bias due to the screening process and the resulting separation between on-and-off locations as well as it could cause differences between SPs.

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List of Interview Questions

The interviews were semi-structured and aim at understanding the dynamics of the industry and their decision making. They were conducted at the company locations, industry seminar presentations as well as by telephone.

Questions:

Location

Which/how many research facilities did you evaluate before deciding on a location?

- What were the main determinants?
- What were to cost differences?
- What has the reactions been of employees and what have the reactions been of other stakeholders?

Effects

What are your expectations on your research facility?

- Have you established any formal contacts within the SP? Have you established any informal contacts within the SP? What have the results been of those contacts?
- What distinguishes this research facility from the others you have looked at or know of?

Value

What are the main determinants and value drivers for a LS company?

- How can the SP affect these factors positively and negatively?

Rental agreement

- How does the lease/rental agreement compare with other facilities?
- How large was this factor in the final decision and what other factors have been considered?

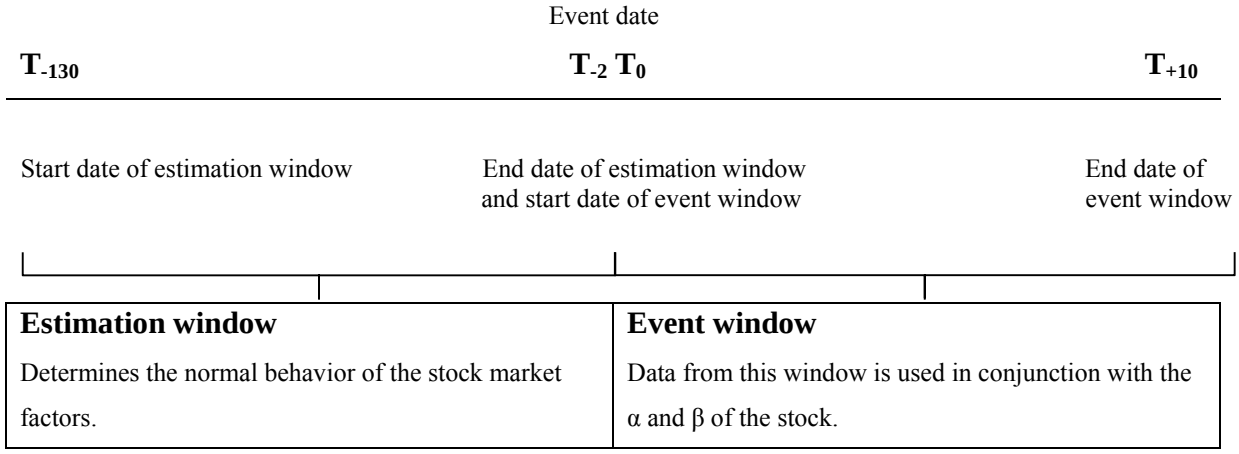
University affiliation

- Does the SP have a university affiliation? In what ways is this noticeable from the company's perspective?

Appendices

Appendix A: Event Study Fundamentals

A1. Short Study Event-Study Timeline



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Appendix B: Data essentials

B1. Detailed Data about SP Affiliated and Non-affiliated LS Firms

Business data			IPO data		SP affiliation & Univ./SP ownership data	
Company	**Sector**	**Founding date**	**IPO date**	**Stock exchange**	**SP affiliation**	**Univ./ SP ownership**
A+ Science AB	Pharma (Life Science)	2003	30/12/2009	Aktie Torget	affiliated	
A1M Pharma AB	Pharma	2008	03/04/2013	Nasdaq First North	affiliated	✓
Acarix AB	Medtech	2015	19/12/2016	Nasdaq First North	non-affiliated	
Accelerator Nordic AB	Medtech	1993	18/11/2008	Aktie Torget	non-affiliated	
AcouSort AB	Pharma (Life Science)	2010	09/01/2017	Aktie Torget	affiliated	✓
Active Biotech AB	Pharma (Life Science)	1983	17/12/1986	Nasdaq OMX Nordic	non-affiliated	
AcuCort AB	Pharma (Life Science)	2006	24/04/2017	Aktie Torget	non-affiliated	
AddLife AB	Medtech	2014	16/03/2016	Nasdaq OMX Nordic	non-affiliated	
Addvise AB	Medtech	1989	27/03/1998	Nasdaq First North	non-affiliated	
Allenex AB	Pharma (Life Science)	1998	12/12/2006	Nasdaq OMX Nordic	non-affiliated	
Alligator Bioscience AB	Biotech	2000	23/11/2016	Nasdaq OMX Nordic	affiliated	
AlphaHelix Molecular Diagnostics AI	Medtech	1998	15/09/2006	Aktie Torget	non-affiliated	
Alteco Medical AB	Medtech	2002	12/03/2014	Aktie Torget	non-affiliated	
Alzinova AB	Biotech	2011	25/11/2015	Aktie Torget	affiliated	✓
Annexin Pharmaceuticals AB	Biotech	2014	19/04/2017	Nasdaq First North	non-affiliated	
Aptahem AB	Pharma (Life Science)	2014	17/04/2015	Aktie Torget	affiliated	
Arcoma AB	Medtech	1990	14/11/2014	Nasdaq First North	non-affiliated	
Arjo AB	Medtech	1993	12/12/2017	Nasdaq OMX Nordic	non-affiliated	
AroCell AB	Pharma (Life Science)	2000	25/05/2011	Nasdaq OMX Nordic	affiliated	✓
Artimplant AB	Medtech	1991	05/11/1997	Nasdaq OMX Nordic	non-affiliated	
Attana AB	Biotech	2013	07/03/2018	Nordic Growth Market	non-affiliated	
B!BB Instruments AB	Pharma (Life Science)	2013	27/10/2017	Aktie Torget	affiliated	✓
Bactiguard Holding AB	Medtech	2010	19/06/2014	Nasdaq OMX Nordic	affiliated	
BioArctic AB	Pharma	2000	12/10/2017	Nasdaq OMX Nordic	non-affiliated	
BioInvent International AB	Pharma (Life Science)	1997	12/06/2001	Nasdaq OMX Nordic	affiliated	✓
Biolin Scientific Holding AB	Pharma (Life Science)	1984	22/04/1997	Nasdaq OMX Nordic	non-affiliated	
Biophausia AB	Pharma	1994	18/06/1996	Nasdaq OMX Nordic	non-affiliated	
Bioservo Technologies AB	Biotech	2003	22/05/2017	Nasdaq First North	non-affiliated	
Biotage AB	Pharma (Life Science)	1997	30/06/2000	Nasdaq OMX Nordic	non-affiliated	
Biovica International AB	Pharma (Life Science)	2008	29/03/2017	Nasdaq First North	non-affiliated	
Bio-Works Technologies AB	Pharma (Life Science)	2013	14/12/2017	Nasdaq First North	non-affiliated	
BONESUPPORT HOLDING AB	Pharma (Life Science)	2010	21/06/2017	Nasdaq OMX Nordic	affiliated	
Boule Diagnostics AB	Medtech	1996	23/06/2011	Nasdaq OMX Nordic	non-affiliated	
BrainCool AB	Medtech	2010	07/05/2014	Aktie Torget	affiliated	
Brighter AB	Medtech	2007	03/02/2012	Nasdaq First North	non-affiliated	
Camanio Care AB	Medtech	2008	28/03/2017	Aktie Torget	affiliated	
Camurus AB	Pharma (Life Science)	2004	03/12/2015	Nasdaq OMX Nordic	affiliated	
Cantargia AB	Biotech	2009	17/03/2015	Nasdaq First North	affiliated	✓
Capio AB	Pharma (Life Science)	2006	30/06/2015	Nasdaq OMX Nordic	non-affiliated	
Cellavision AB	Medtech	1994	28/05/2007	Nasdaq OMX Nordic	non-affiliated	
CELLINK AB	Biotech	2016	03/11/2016	Nasdaq First North	affiliated	✓
Cereno Scientific AB	Pharma	2012	22/06/2016	Aktie Torget	affiliated	✓
Chordate Medical Holding publ AB	Medtech	2005	08/03/2017	Nordic Growth Market	non-affiliated	
Cline Scientific AB	Medtech	2011	30/03/2015	Aktie Torget	non-affiliated	
Clinical Laserthermia Systems AB	Pharma (Life Science)	2006	13/04/2009	Nasdaq First North	affiliated	
CombiGene AB	Biotech, Pharma	1990	25/05/2015	Aktie Torget	affiliated	
Corline Biomedical AB	Biotech	1991	03/06/2015	Nasdaq First North	affiliated	
C-Rad AB	Pharma (Life Science)	2001	23/07/2007	Nasdaq OMX Nordic	non-affiliated	
Creative Antibiotics Sweden AB	Pharma (Life Science)	2000	12/02/2004	Aktie Torget	non-affiliated	
Cyxone AB	Pharma	2015	08/06/2016	Nasdaq OMX Nordic	non-affiliated	
Dextech Medical AB	Pharma (Life Science)	2004	19/06/2014	Aktie Torget	non-affiliated	
Diamyd Medical AB	Pharma	1984	20/05/2013	Nasdaq OMX Nordic	non-affiliated	
Dignitana AB	Pharma (Life Science)	2007	18/06/2009	Nasdaq First North	non-affiliated	

B1. Detailed Data about SP Affiliated and Non-affiliated LS Firms (continued)

Business data			IPO data		SP affiliation & Univ./SP ownership data	
Company	**Sector**	**Founding date**	**IPO date**	**Stock exchange**	**SP affiliation**	**Univ./ SP ownership**
Double Bond Pharmaceutical Int. AB	Pharma	2014	10/07/2015	Aktie Torget	non-affiliated	
Doxa AB	Medtech	1987	07/04/2014	Nasdaq First North	non-affiliated	
Elekta AB	Pharma (Life Science)	1972	01/03/1994	Nasdaq OMX Nordic	non-affiliated	
Elos Medtech AB	Medtech	1923	16/08/1989	Nasdaq OMX Nordic	non-affiliated	
Emotra AB	Medtech	2001	28/06/2013	Aktie Torget	non-affiliated	
Enorama Pharma AB	Pharma	2006	13/06/2016	Nasdaq OMX Nordic	non-affiliated	
Enzymatica AB	Pharma (Life Science)	2007	12/06/2015	Nasdaq OMX Nordic	affiliated	
Episurf AB	Pharma (Life Science)	2008	05/11/2010	Nasdaq OMX Nordic	non-affiliated	
Eurocine Vaccines AB	Pharma	1999	12/12/2006	Aktie Torget	affiliated	✓
European Institute of Science AB	Medtech	1990	23/11/1999	Aktie Torget	affiliated	
Exini Diagnostics	Medtech	1999	10/08/2009	Nasdaq First North	affiliated	✓
ExpreS2ion Biotech Holding AB	Biotech	2015	29/07/2016	Nasdaq First North	non-affiliated	
Follicum AB	Biotech	2011	25/11/2014	Aktie Torget	non-affiliated	
Gabather AB	Biotech	2014	03/11/2014	Aktie Torget	non-affiliated	
Genovis AB	Biotech	1999	14/09/2006	Nasdaq OMX Nordic	affiliated	
Getinge AB	Medtech	1990	19/05/1993	Nasdaq OMX Nordic	non-affiliated	
GHP Specialty Care AB	Pharma (Life Science)	2008	03/10/2008	Nasdaq OMX Nordic	non-affiliated	
Glycorex Transplantation AB	Medtech	1995	01/09/1999	Nordic Growth Market	affiliated	
Hamlet Pharma AB	Pharma	1999	23/10/2015	Aktie Torget	non-affiliated	
Handicare Group AB	Pharma (Life Science)	2014	10/10/2017	Nasdaq OMX Nordic	non-affiliated	
Hansa Medical AB	Pharma	2007	17/10/2007	Nasdaq OMX Nordic	affiliated	
Hemcheck Sweden AB	Medtech	2010	15/03/2017	Nasdaq First North	non-affiliated	
IDL Biotech AB	Biotech	1988	04/10/1999	Aktie Torget	non-affiliated	
Idogen AB	Biotech	2008	12/06/2015	Aktie Torget	affiliated	✓
Immunicum AB	Pharma	2002	22/04/2013	Nasdaq OMX Nordic	non-affiliated	
Immunovia AB	Medtech	2007	01/12/2015	Nasdaq OMX Nordic	affiliated	
InDex Pharmaceuticals Holding AB	Pharma	2006	11/10/2016	Nasdaq First North	affiliated	
Infant Bacterial Therapeutics AB	Biotech	2011	29/03/2016	Nasdaq OMX Nordic	non-affiliated	
Inhalation Sciences Sweden AB	Biotech	2004	28/09/2017	Aktie Torget	affiliated	
Insplorion AB	Medtech	2010	25/06/2015	Aktie Torget	affiliated	
Integrum AB	Medtech	1990	15/05/2017	Nasdaq First North	non-affiliated	
Intervacc AB	Biotech	1983	07/04/2017	Nasdaq OMX Nordic	non-affiliated	
Invent Medic AB	Medtech	2005	29/02/2016	Aktie Torget	affiliated	
IRLAB Therapeutics AB	Biotech	2013	28/02/2017	Nasdaq First North	affiliated	
IRRAS AB	Medtech	2011	22/11/2017	Nasdaq First North	non-affiliated	
Isconova AB	Biotech	1999	10/11/2010	Nasdaq First North	affiliated	
Isofol Medical AB	Pharma	2008	04/04/2017	Nasdaq First North	non-affiliated	
ISR Immune System Reg. Hold. AB	Pharma (Life Science)	2007	24/03/2017	Nasdaq First North	non-affiliated	
Kancera AB	Biotech	2010	25/02/2011	Nasdaq OMX Nordic	affiliated	
Karessa Pharma Holding AB	Pharma	2014	10/02/2015	Nasdaq First North	non-affiliated	
Karo Pharma AB	Biotech	1987	03/04/1998	Nasdaq OMX Nordic	affiliated	✓
Karolinska Development AB	Biotech	2006	15/04/2011	Nasdaq OMX Nordic	affiliated	✓
Klaria Pharma Holding AB	Pharma	2014	21/10/2015	Nasdaq First North	non-affiliated	
Kontigo Care AB	Pharma (Life Science)	2013	23/06/2015	Nasdaq First North	affiliated	
LIDDS AB	Biotech	1999	31/07/2014	Nasdaq First North	affiliated	
LifeAssays AB	Medtech	2000	28/06/2002	Nordic Growth Market	non-affiliated	
Meda AB	Biotech	1991	27/06/1995	Nasdaq OMX Nordic	affiliated	✓
MedCap AB	Pharma (Life Science)	2001	23/06/2004	Nasdaq OMX Nordic	non-affiliated	
Medfield Diagnostics AB	Medtech	2005	02/05/2012	Aktie Torget	affiliated	✓
Medivir AB	Pharma	1987	29/02/1996	Nasdaq OMX Nordic	non-affiliated	
Mertiva AB	Medtech	1996	15/01/1997	Nordic Growth Market	non-affiliated	
Micropos Medical AB	Medtech	2003	21/12/2009	Aktie Torget	non-affiliated	
Miris Holding AB	Biotech	2005	22/06/2006	Aktie Torget	non-affiliated	
Moberg Pharma AB	Pharma	2006	26/05/2011	Nasdaq OMX Nordic	non-affiliated	
Nanexa AB	Pharma	2010	06/11/2017	Aktie Torget	non-affiliated	
Nanologica AB	Pharma (Life Science)	2004	30/10/2015	Aktie Torget	non-affiliated	
NeuroVive Pharmaceutical AB	Biotech	2000	03/10/2008	Nasdaq OMX Nordic	affiliated	✓

B1. Detailed Data about SP Affiliated and Non-affiliated LS Firms (continued)

Business data			IPO data		SP affiliation & Univ./SP ownership data	
Company	**Sector**	**Founding date**	**IPO date**	**Stock exchange**	**SP affiliation**	**Univ./ SP ownership**
NextCell Pharma AB	Biotech	2014	13/07/2017	Aktie Torget	affiliated	✓
Norinvent AB	Pharma	2014	23/05/2017	Aktie Torget	affiliated	
Oasmia Pharmaceutical AB	Pharma	1988	18/09/2007	Nasdaq OMX Nordic	non-affiliated	
Obducat AB	Medtech	1989	08/04/1999	Nordic Growth Market	affiliated	
Obstecare AB	Pharma (Life Science)	2004	04/01/2018	Aktie Torget	affiliated	
Oncopeptides AB	Pharma	2000	22/02/2017	Nasdaq OMX Nordic	non-affiliated	
Orasolv AB	Medtech	2000	01/06/2004	Aktie Torget	non-affiliated	
Orexo AB	Pharma	1994	09/11/2005	Nasdaq OMX Nordic	non-affiliated	
Ortivus AB	Medtech	1985	03/01/1997	Nasdaq OMX Nordic	non-affiliated	
Ortoma AB	Medtech	2001	31/03/2014	Aktie Torget	non-affiliated	
Panion Animal Health AB	Medtech	2015	06/07/2017	Aktie Torget	affiliated	
Paxman AB	Medtech	2016	12/06/2017	Nasdaq OMX Nordic	non-affiliated	
PEPTONIC medical AB	Pharma	2009	02/07/2014	Aktie Torget	affiliated	
PExA AB	Pharma (Life Science)	2014	02/11/2015	Aktie Torget	affiliated	
Pharmacolog i Uppsala AB	Pharma	2007	06/08/2015	Aktie Torget	non-affiliated	
PharmaLundensis AB	Pharma	2006	06/07/2010	Aktie Torget	affiliated	
Phase Holographic AB	Pharma (Life Science)	1997	20/01/2014	Aktie Torget	non-affiliated	
PledPharma AB	Pharma	2006	07/04/2011	Nasdaq OMX Nordic	non-affiliated	
Prebona AB	Biotech	2011	17/12/2015	Aktie Torget	non-affiliated	
Probi AB	Biotech	1991	16/12/1998	Nasdaq OMX Nordic	affiliated	
Prolight Diagnostics AB	Medtech	1999	31/03/2017	Nordic Growth Market	non-affiliated	
Promore Pharma AB	Biotech	2003	06/07/2017	Nasdaq First North	affiliated	
Prosta Lund AB	Medtech	2007	25/10/2013	Aktie Torget	non-affiliated	
QuiaPEG Pharmaceuticals Hold. AB	Pharma	2004	21/06/2005	Aktie Torget	affiliated	
Quickcool AB	Medtech	2003	18/12/2015	Aktie Torget	affiliated	
RaySearch Laboratories AB	Medtech	1988	01/11/2003	Nasdaq OMX Nordic	non-affiliated	
Recipharm AB	Pharma (Life Science)	1994	03/04/2014	Nasdaq OMX Nordic	non-affiliated	
Redsense Medical AB	Medtech	2003	02/08/2016	Nasdaq First North	non-affiliated	
Redwood Pharma AB	Pharma	2012	15/06/2016	Aktie Torget	non-affiliated	
Respiratorius AB	Biotech	1998	05/07/2012	Aktie Torget	affiliated	
RhoVac AB	Pharma (Life Science)	2015	09/03/2016	Aktie Torget	affiliated	
RLS Global AB	Medtech	2007	04/05/2012	Nasdaq First North	affiliated	
ScandiDos AB	Medtech	2001	11/04/2014	Nasdaq OMX Nordic	affiliated	
Scandinavian ChemoTech AB	Medtech	2013	06/12/2016	Nasdaq First North	non-affiliated	
Scandinavian Real Heart AB	Medtech	2007	26/11/2014	Aktie Torget	non-affiliated	
Scibase Holding AB	Medtech	2009	02/06/2015	Nasdaq First North	non-affiliated	
SECTRA AB	Medtech	1957	03/03/1999	Nasdaq OMX Nordic	non-affiliated	
Sedana Medical AB	Medtech	2004	21/06/2017	Nasdaq First North	non-affiliated	
SensoDetect AB	Medtech	2005	24/11/2009	Aktie Torget	non-affiliated	
SenzaGen AB	Medtech	2010	21/09/2017	Nasdaq First North	affiliated	✓
Senzime AB	Medtech	1999	18/06/2008	Nasdaq First North	non-affiliated	
Spago Nanomedical AB	Medtech	1999	15/01/2013	Aktie Torget	affiliated	
Spectra Cure AB	Pharma (Life Science)	2003	01/07/2015	Aktie Torget	non-affiliated	
Sprint Bioscience AB	Pharma	2009	07/11/2014	Nasdaq First North	affiliated	
Surgical Science Sweden AB	Medtech	1997	19/06/2017	Nasdaq First North	affiliated	
Swedencare AB	Medtech	1993	13/06/2016	Nasdaq OMX Nordic	affiliated	
Swedish Orphan Biovitrum AB	Pharma	1939	15/09/2006	Nasdaq OMX Nordic	affiliated	
SynAct Pharma AB	Biotech	2016	11/07/2016	Aktie Torget	affiliated	
SyntheticMR AB	Medtech	2007	18/10/2013	Aktie Torget	affiliated	
Toleranzia AB	Pharma (Life Science)	2011	16/12/2015	Aktie Torget	affiliated	✓
Vibrosense AB	Medtech	2004	04/05/2015	Aktie Torget	affiliated	
Vicore Pharma AB	Biotech	2001	10/12/2015	Nasdaq First North	affiliated	
Vitrolife AB	Medtech	1997	26/06/2001	Nasdaq OMX Nordic	non-affiliated	
Wilson Therapeutics AB	Biotech	2012	12/05/2016	Nasdaq OMX Nordic	non-affiliated	
WntResearch AB	Biotech	2007	17/12/2010	Aktie Torget	affiliated	✓
Xbrane Biopharma AB	Pharma	2008	03/02/2016	Nasdaq First North	non-affiliated	
Xintela AB	Biotech	2009	22/03/2016	Nasdaq First North	affiliated	
XSpray Pharma AB	Biotech	2003	28/09/2017	Nasdaq First North	non-affiliated	
Xvivo Perfusion AB	Medtech	1998	08/10/2012	Nasdaq OMX Nordic	non-affiliated	
Zenicor Medical Systems AB	Medtech	2003	18/11/2014	Aktie Torget	non-affiliated	

B2. Detailed Data about SP Affiliation and University/SP Ownership

Company	Science Park name	SP affiliation period	University/ SP ownership	Ownership period
A+ Science AB	GU Ventures	1997 - 2009		
A1M Pharma AB	Smile Incubator	2008 - 2015	LU Holding AB	2013 - 2017
AcouSort AB	Medicon Village	2011 - 2017	LU Holding AB	2017 - current
Alligator Bioscience AB	Medicon Village	2011 - current		
Alzinova AB	GU Ventures	2011 - current	GU Ventures	2015 - 2017
Aptahem AB	Smile Incubator	2017 - current		
AroCell AB	Uppsala Innovation Centre	2005 - 2010	Uppsala Universitet Holding AB	2011 - 2016
B!BB Instruments AB	Medicon Village	2013 - current	LU Holding AB	2017 - current
Bactiguard Holding AB	Karolinska Institutet Science Park	2014 - current		
BioInvent International AB	Ideon Science Park	1997 - current	LU Holding AB	2001 - 2013
BONESUPPORT HOLDING AB	Ideon Science Park	2001 - current		
BrainCool AB	Medicon Village	2014 - current		
Camanio Care AB	Uppsala Innovation Centre	2009 - 2017		
Camurus AB	Ideon Science Park	2001 - current		
Cantargia AB	Smile Incubator	2012 - 2015	Lund University Bioscience AB	2015 - 2017
CELLINK AB	AZ Bioventure Hub	2018 - current	GU Ventures	2016 - current
Cereno Scientific AB	AZ Bioventure Hub	2016 - current	GU Ventures	2016 - current
Clinical Laserthermia Systems AB	Medicon Village	2013 - current		
CombiGene AB	Medicon Village	2015 - current		
Corline Biomedical AB	AZ Bioventure Hub	2015 - current		
Enzymatica AB	Ideon Science Park	2011 - current		
Eurocine Vaccines AB	Karolinska Institutet Science Park	1999 - current	Karolinska Innovations AB	2006 - 2009
European Institute of Science AB	Ideon Science Park	1994 - current		
Exini Diagnostics	Ideon Science Park	2001 - current	LU Holding AB	2009 - 2014
Genovis AB	Medicon Village	2013 - current		
Glycorex Transplantation AB	Ideon Science Park	2011 - current		
Hansa Medical AB	Ideon Science Park	2008 - current		
Idogen AB	Medicon Village	2014 - current	LU Holding AB	2015 - current
Immunovia AB	Medicon Village	2012 - current		
InDex Pharmaceuticals Hold. AB	Karolinska Institutet Science Park	2013 - current		
Inhalation Sciences Sweden AB	Karolinska Institutet Science Park	2004 - 2016		
Insplorion AB	Sahlgrenska Science Park	2014 - current		
Invent Medic AB	Medicon Village	2015 - current		
IRLAB Therapeutics AB	Sahlgrenska Science Park	2013 - current		
Isconova AB	Uppsala Innovation Centre	1999 - current		
Kancera AB	Karolinska Institutet Science Park	2011 - current		
Karo Pharma AB	Karolinska Institutet Science Park	1987 - current	Karolinska Institutet Holding AB	2001 - current
Karolinska Development AB	Karolinska Institutet Science Park	2016 - current	Karolinska Institutet Holding AB	2011 - current
Kontigo Care AB	Uppsala Innovation Centre	2014 - current		
LifeAssays AB	Ideon Science Park	2001 - current		
Meda AB	Karolinska Institutet Science Park	2015 - current	Stockholms Universitet	2005 - 2015
Medfield Diagnostics AB	Sahlgrenska Science Park	2006 - 2012	Sahlgrenska Science Park AB	2012 - 2014
NeuroVive Pharmaceutical AB	dicon Village, Karolinska Science P	2012 - current	LU Holding AB	2008 - 2014
NextCell Pharma AB	Karolinska Institutet Science Park	2014 - 2017	Karolinska Institutet Holding AB	2017 - current
Norinvent AB	Smile Incubator	2015 - current		
Obducat AB	Medicon Village	2012 - current		
Obstecare AB	Karolinska Institutet Science Park	2017 - current		
Panion Animal Health AB	Medicon Village	2015 - 2016		
PEPTONIC medical AB	Uppsala Innovation Centre	2009 - 2013		
PExA AB	GU Ventures	2014 - current		
PharmaLundensis AB	Smile Incubator	2013 - current		
Probi AB	Ideon Science Park	1991 - current		
Promore Pharma AB	Karolinska Institutet Science Park	2010 - current		
QuiaPEG Pharmaceuticals Hold. AE	Karolinska Institutet Science Park	2013 - current		
Quickcool AB	Ideon Science Park	2003 - current		
Respiratorius AB	Medicon Village	2013 - current		
RhoVac AB	Medicon Village	2015 - current		
RLS Global AB	AZ Bioventure Hub	2017 - current		
ScandiDos AB	Uppsala Innovation Centre	2004 - current		
SenzaGen AB	Medicon Village	2015 - current	LU Holding AB	2017 - current
Spago Nanomedical AB	Smile Incubator	2008 - 2015		
Sprint Bioscience AB	nstitutet Science Park, Uppsala Innov	2012 - current		
Surgical Science Sweden AB	GU Ventures	2001 - 2017		
Swedencare AB	Medeon Science Park	2010 - current		
Swedish Orphan Biovitrum AB	Karolinska Institutet Science Park	2010 - current		
SynAct Pharma AB	Medicon Village	2016 - current		
SyntheticMR AB	LEAD	2008 - 2011		
Toleranzia AB	GU Ventures	2015 - current	GU Ventures	2015 - current
Vibrosense AB	Medeon Science Park	2005 - current		
Vicore Pharma AB	AZ Bioventure Hub	2014 - current		
WntResearch AB	Medeon Science Park	2015 - current	LU Holding AB	2010 - 2014
Xintela AB	Medicon Village	2017 - current		

B3. Press Release for LS Firms that Joined a SP subsequent to their IPO

Company	IPO date	Event date	Press Release	Science Park
Aptahem AB	17/04/2015	02/01/2017	http://aptahem.com/aptahems-nyhetsbrev-mars-2017/	Smile Incubator
Bactiguard Holding AB	19/06/2014	01/12/2014	https://www.bactiguard.se/sv/om-bactiguard/historia	Karolinska Institutet Science Park
CELLINK AB	03/11/2016	17/01/2018	https://www.azbioventurehub.com/system/files/cellink_blogpost_final_180117_0.pdf	AZ Bioventure Hub
Clinical Laserthermia Systems AB	13/04/2009	04/09/2014	https://www.mediconvillage.se/en/two-incubator-companies-move-out-lund-life-science-incubator-lsi-larger-premises-medicon-village	Medicon Village
CombiGene AB	25/05/2015	01/11/2015	Confirmation by email for the event dateand in http://combigene.com/en/about-us/journey/	Medicon Village
Genovis AB	11/11/2005	13/06/2013	https://www.mediconvillage.se/sv/nanomedicinbolag-flyttar-till-medicon-village	Medicon Village
Glycorex Transplantation AB	06/07/1998	01/11/2011	http://docplayer.se/26433137-Citymark-battre-lage-avgjorde-flytten-smarta-tips-fran-nyx-security-for-ett-sakrare-kontor-ny-checklista-infor-f	Ideon Science Park
Hansa Medical AB	17/10/2007	01/05/2008	http://hansamedical.com/en/investors-media/press-releases/2008/5D3267DF3A7E89D9/	Ideon Science Park
Kancera AB	31/01/2011	01/09/2011	http://news.cision.com/se/kancera-ab/r/kancera-flyttar-till-karolinska-institutet-science-park,c9120741	Karolinska Institutet Science Park
Karolinska Development AB	15/04/2011	09/09/2013	http://www.mynewsdesk.com/se/karolinska-institutet-science-park-ab/pressreleases/unikt-tillfaelle-hyra-toppmodernt-hos-ki-science-park-90	Karolinska Institutet Science Park
Meda AB	25/05/2012	12/01/2015	Confirmation by email for the event date	Karolinska Institutet Science Park
NeuroVive Pharmaceutical AB	03/10/2008	03/05/2012	http://news.cision.com/se/neurovive-pharmaceutical/r/neurovive--neurovive-flyttar-till-medicon-village,c9396855	Medicon Village
Obducat AB	08/04/1999	01/10/2012	http://www.etn.se/index.php/57151?via=r	Medicon Village
PharmaLundensis AB	06/07/2010	07/03/2012	http://www.pharmalundensis.se/wp-content/uploads/2015/05/PharmaLundensis-press-120307.pdf	Medicon Village
QuiaPEG Pharmaceuticals Holding AB	21/06/2005	09/09/2013	https://www.aktiespararna.se/nyheter/lucent-oil-byter-namn-till-quiapeg-pharmaceuticals-och-byter-ut-nastan-hela-styrelsen	Karolinska Institutet Science Park
Respiratorius AB	05/07/2012	01/04/2013	https://www.aktietorget.se/media/3289/c-temp-file.pdf	Medicon Village
Swedish Orphan Biovitrum AB	11/09/2006	01/05/2010	http://www.bolagsfakta.se/sites/bolagsfakta.se/files/SwedishOrphanBiovitrum_2010.pdf	Karolinska Institutet Science Park
WntResearch AB	17/12/2010	01/11/2015	Confirmation by email for the event date and the disclosure of the information	Medeon Science Park
Xintela AB	22/03/2016	09/11/2017	https://www.bequoted.com/bolag/xintela/pressmeddelande/xintela-uppfor-egen-gmp-anlaggning-for-produktion-av-stamcel-60747/	Medicon Village

Appendix C: Main methodology

C1. BHARs Calculations

Company	IPO Y	Reference Portfolio: OMXS TRI	BHAR 36M Reference Portfolio: AFGX TRI	Control firm approach	BHAR_w 36M	BHAR_w 24M	BHAR_w 12M
A+ Science	2009	-106%	-101%	-9%	-9%	-19%	46%
A1M Pharma	2013	-74%	-75%	-74%	-74%	-275%	-71%
Acarix	2016	-56%	-55%	-84%	-84%	-84%	-42%
Accelerator Nordic	2008	-78%	-39%	-79%	-79%	126%	-106%
AcouSort	2017	19%	24%	80%	80%	80%	69%
Active Biotech	1986	24%	-45%	6%	6%	-66%	-78%
AcuCort	2017	-20%	-21%	13%	13%	13%	13%
AddLife	2016	44%	50%	-46%	-46%	-6%	-12%
Addvise	1998	-49%	-111%	26%	26%	37%	5%
Allenex	2006	-36%	-44%	-247%	-247%	-451%	-69%
Alligator Bioscience	2016	-50%	-48%	-5%	-5%	-5%	-5%
AlphaHelix Molecular Diagnostics	2006	-67%	-68%	1%	1%	5%	46%
Alteco Medical	2014	-55%	-51%	66%	66%	57%	1%
Alzinova	2015	11%	14%	7%	7%	-42%	-56%
Annexin Pharmaceuticals	2017	-52%	-53%	1%	1%	1%	1%
Aptahem	2015	-73%	-70%	-79%	-79%	-104%	-63%
Arcoma	2014	-89%	-87%	36%	36%	-23%	-116%
Arjo	2017	-3%	1%	-1%	-1%	-1%	-1%
AroCell	2011	134%	135%	14%	14%	-124%	-305%
Artimplant	1997	123%	15%	144%	144%	-90%	-369%
Attana	2018	203%	207%	204%	204%	204%	204%
B!BB Instruments	2017	-9%	-7%	-59%	-59%	-59%	-59%
Bactiguard Holding	2014	-87%	-80%	-51%	-51%	-27%	-44%
BioArctic	2017	-24%	-22%	18%	18%	18%	18%
BioInvent International	2001	-130%	-63%	-29%	-29%	-44%	-83%
Biolin Scientific Holding	1997	66%	-109%	114%	114%	-3%	199%
Biophausia	1996	-71%	-206%	-88%	-88%	-113%	-73%
Bioservo Technologies	2017	-18%	-16%	9%	9%	9%	9%
Biotage	2000	-100%	-41%	-187%	-187%	-229%	-13%
Biovica International	2017	-28%	-24%	-118%	-118%	-118%	-44%
Bio-Works Technologies	2017	-33%	-29%	-22%	-22%	-22%	-22%
Bonesupport	2017	-58%	-52%	-3%	-3%	-3%	-3%
Boule Diagnostics	2011	-41%	-33%	30%	30%	55%	41%
BrainCool	2014	56%	61%	56%	56%	397%	63%
Brighter	2012	5%	10%	42%	42%	442%	51%
Camanio Care	2017	-56%	-51%	-64%	-64%	-64%	-79%
Camurus	2015	50%	62%	-16%	-16%	-46%	35%
Cantargia	2015	-31%	-30%	69%	69%	29%	61%
Capio	2015	-43%	-29%	25%	25%	55%	16%
Cellavision	2007	-8%	-12%	7%	7%	31%	-8%
CELLINK	2016	124%	127%	180%	180%	180%	132%
Cereno Scientific	2016	-17%	-11%	81%	81%	81%	45%
Chordate Medical Hold.	2017	-87%	-82%	-30%	-30%	-30%	-35%
Cline Scientific	2015	5%	6%	79%	79%	104%	63%
Clinical Laserthermia Systems	2009	-28%	-42%	-28%	-28%	-230%	-66%
CombiGene	2015	-93%	-89%	-27%	-27%	-49%	34%
Corline Biomedical	2015	-29%	-16%	-16%	-16%	-167%	-18%
C-Rad	2007	11%	11%	-286%	-286%	-279%	-235%
Creative Antibiotics Sweden	2004	-87%	-74%	39%	39%	-39%	-50%
Cyxone	2016	10%	17%	35%	35%	35%	9%
Dextech Medical	2014	131%	138%	-209%	-209%	39%	238%
Diamyd Medical	2013	12%	12%	76%	76%	220%	49%
Dignitana	2009	293%	294%	306%	306%	230%	268%

C1. BHARs Calculations (continued)

Company	IPO Y	BHAR 36M			BHAR_w 36M	BHAR_w 24M	BHAR_w 12M
		Reference Portfolio: OMXS TRI	Reference Portfolio: AFGX TRI	Control firm approach			
Double Bond Pharmaceutical Int.	2015	-80%	-77%	21%	21%	59%	-96%
Doxa	2014	-87%	-87%	-72%	-72%	-103%	-93%
Elekta	1994	44%	-37%	-50%	-50%	-106%	49%
Elos Medtech	1989	-42%	-8%	33%	33%	27%	53%
Emotra	2013	188%	201%	281%	281%	186%	372%
Enorama Pharma	2016	1629%	1636%	913%	877%	782%	7%
Enzymatica	2015	-91%	-77%	-158%	-158%	-164%	-146%
Episurf	2010	228%	232%	286%	286%	120%	128%
Eurocine Vaccines	2006	296%	288%	286%	286%	279%	235%
European Institute of Science	1999	-75%	-33%	-26%	-26%	-37%	-5%
Exini Diagnostics	2009	-108%	-102%	4%	4%	-5%	-11%
ExpreS2ion Biotech Holding	2016	10%	10%	42%	42%	42%	-32%
Follicum	2014	-101%	-98%	-84%	-84%	-111%	-25%
Gather	2014	42%	44%	-17%	-17%	-106%	201%
Genovis	2006	-23%	-24%	-39%	-39%	39%	326%
Getinge	1993	177%	73%	83%	83%	-77%	91%
GHP Specialty Care	2008	-79%	-56%	-409%	-403%	-188%	-54%
Glycorex Transplantation	1999	341%	365%	330%	330%	169%	291%
Hamlet Pharma	2015	0%	-2%	85%	85%	126%	168%
Handicare Group	2017	-18%	-16%	3%	3%	3%	3%
Hansa Medical	2007	-43%	-40%	-33%	-33%	4%	-5%
Hemcheck Sweden	2017	37%	41%	48%	48%	48%	53%
IDL Biotech	1999	-11%	17%	33%	33%	-4%	148%
Idogen	2015	-62%	-49%	21%	21%	20%	-43%
Immunicum	2013	245%	244%	-99%	-99%	194%	73%
Immunovia	2015	288%	299%	221%	221%	85%	131%
InDex Pharmaceuticals	2016	-38%	-32%	25%	25%	25%	5%
Infant Bacterial Therapeutics	2016	141%	147%	-22%	-22%	-64%	-45%
Inhalation Sciences Sweden	2017	-2%	-4%	69%	69%	69%	69%
Insplorion	2015	114%	128%	-34%	-34%	106%	-4%
Integrum	2017	-30%	-29%	28%	28%	28%	28%
Intervacc	2017	-59%	-59%	-42%	-42%	-42%	-42%
Invent Medic	2016	436%	442%	354%	354%	434%	270%
IRL Therapeutics	2017	117%	120%	67%	67%	67%	145%
IRRAS	2017	-25%	-17%	5%	5%	5%	5%
Isconova , Novavax	2010	-91%	-87%	-141%	-141%	-85%	-57%
Isofol Medical	2017	-17%	-18%	38%	38%	38%	38%
ISR Immune System Reg. Hold.	2017	-28%	-23%	-102%	-102%	-102%	-81%
Kancera	2011	-56%	-57%	-56%	-56%	-120%	-58%
Karessa Pharma Holding	2015	-88%	-91%	-98%	-98%	-129%	-18%
Karo Pharma	1998	94%	56%	-83%	-83%	77%	-91%
Karolinska Development	2011	-62%	-66%	26%	26%	-26%	-78%
Klaria Pharma Holding	2015	67%	65%	152%	152%	164%	146%
Kontigo Care	2015	-69%	-55%	25%	25%	2%	-40%
LIDDS	2014	-74%	-75%	-82%	-82%	-172%	-13%
LifeAssays	2002	-164%	-97%	-20%	-20%	-1%	-1%
Meda	1995	18%	-151%	-6%	-6%	66%	78%
MedCap	2004	-174%	-164%	20%	20%	1%	1%
Medfield Diagnostics	2012	258%	264%	299%	299%	150%	77%
Medivir	1996	68%	-72%	50%	50%	0%	22%
Mertiva	1997	-21%	-158%	-39%	-39%	-140%	-40%
Micropos Medical	2009	-109%	-104%	-4%	-4%	5%	11%
Miris Holding	2006	9%	10%	69%	69%	105%	266%
Moberg Pharma	2011	-30%	-29%	-380%	-380%	-139%	-35%
Nanexa	2017	-16%	-8%	-93%	-93%	-93%	-93%
Nanologica	2015	-104%	-106%	-30%	-30%	-2%	40%
NeuroVive Pharmaceutical	2008	144%	167%	-461%	-403%	-451%	-91%

C1. BHARs Calculations (continued)

Company	IPO Y	BHAR 36M			BHAR_w 36M	BHAR_w 24M	BHAR_w 12M
		Reference Portfolio: OMXS TRI	Reference Portfolio: AFGX TRI	Control firm approach			
NextCell Pharma	2017	95%	103%	121%	121%	121%	121%
Norinvent	2017	-73%	-72%	-120%	-120%	-120%	-120%
Oasmia Pharmaceutical	2007	-12%	-21%	59%	59%	71%	11%
Obducat	1999	-21%	-43%	-144%	-144%	90%	596%
Obstecare	2018	-3%	0%	12%	12%	12%	12%
Oncopeptides	2017	145%	147%	185%	185%	185%	116%
Orasolv	2004	-138%	-128%	55%	55%	67%	50%
Orexo	2005	-37%	-60%	-26%	-26%	26%	78%
Ortivus	1997	-53%	-190%	29%	29%	44%	83%
Ortoma	2014	619%	623%	461%	461%	464%	91%
Panion Animal Health	2017	2%	9%	11%	11%	11%	11%
Paxman	2017	133%	139%	128%	128%	128%	128%
PEPTONIC medical	2014	-126%	-127%	-29%	-29%	-59%	96%
PExA	2015	-6%	-3%	-112%	-112%	-120%	-180%
Pharmacolog i Uppsala	2015	-34%	-19%	73%	73%	66%	88%
PharmaLundensis	2010	179%	170%	263%	263%	38%	-27%
Phase Holographic	2014	39%	49%	109%	109%	235%	24%
PledPharma	2011	-21%	-25%	51%	51%	27%	44%
Prebona	2015	-67%	-56%	20%	20%	13%	-1%
Probi	1998	-48%	-66%	-114%	-114%	3%	-199%
Prolight Diagnostics	2017	511%	515%	514%	514%	514%	596%
Promore Pharma	2017	-34%	-26%	42%	42%	42%	42%
Prosta Lund	2013	-52%	-52%	-34%	-34%	30%	-32%
QuiaPEG Pharmaceuticals	2005	-113%	-111%	-1%	-1%	-5%	-46%
Quickcool	2015	-105%	-94%	-162%	-162%	-241%	-369%
RaySearch Loratories	2003	482%	502%	667%	667%	782%	175%
Recipharm	2014	21%	21%	104%	104%	126%	133%
Redsense Medical	2016	-52%	-49%	10%	10%	10%	31%
Redwood Pharma	2016	7%	14%	108%	108%	108%	15%
Respiratorius	2012	-47%	-65%	84%	84%	111%	25%
RhoVac	2016	24%	30%	39%	39%	91%	-7%
RLS Global	2012	1464%	1470%	1473%	877%	570%	15%
ScandiDos	2014	-105%	-105%	-116%	-116%	-202%	-52%
Scandinavian ChemoTech	2016	-69%	-67%	-102%	-102%	-102%	-20%
Scandinavian Real Heart	2014	138%	140%	-163%	-163%	-1%	-67%
Scibase Holding	2015	-110%	-96%	-74%	-74%	-29%	-61%
SECTRA	1999	298%	277%	204%	204%	53%	371%
Sedana Medical	2017	113%	119%	46%	46%	46%	46%
SensoDetect	2009	131%	131%	-14%	-14%	124%	305%
SenzaGen	2017	-22%	-24%	3%	3%	3%	3%
Senzime	2008	-57%	-38%	70%	70%	54%	46%
Spago Nanomedical	2013	-31%	-45%	-85%	-85%	-84%	3%
Spectra Cure	2015	917%	921%	732%	732%	-397%	-63%
Sprint Bioscience	2014	40%	42%	-2%	-2%	-38%	180%
Surgical Science Sweden	2017	5%	11%	-128%	-128%	-128%	-128%
Swedencare	2016	55%	62%	115%	115%	115%	71%
Swedish Orphan Biovitrum	2006	-40%	-41%	-25%	-25%	-55%	-16%
SynAct Pharma	2016	134%	134%	150%	150%	150%	4%
SyntheticMR	2013	344%	344%	376%	376%	186%	59%
Toleranzia	2015	-87%	-75%	-33%	-33%	-29%	17%
Vibrosense	2015	227%	231%	305%	305%	219%	26%
Vicore Pharma	2015	107%	118%	47%	47%	32%	204%
Vitrolife	2001	-84%	-17%	12%	12%	-82%	9%
Wilson Therapeutics	2016	341%	341%	405%	405%	405%	105%
WntResearch	2010	88%	88%	32%	32%	-207%	4%
Xbrane Biopharma	2016	58%	58%	-93%	-93%	-61%	-157%
Xintela	2016	-48%	-42%	7%	7%	23%	-35%
XSpray Pharma	2017	96%	93%	143%	143%	143%	143%
Xvivo Perfusion	2012	109%	109%	203%	203%	162%	89%
Zenicor Medical Systems	2014	68%	70%	85%	85%	84%	-3%

C2. Control Firm Approach - Matching of Returns

Control firm	Portfolio	IPO year	Average 3 year MVE, thSEK	Matched Firm	Portfolio	IPO year	Average 3 year MVE, thSEK
A+ Science AB	1	2009	14.54	Dignitana AB	2	2006	31.70
A1M Pharma AB	1	2013	147.25	Redsense Medical AB	2	2016	143.96
AcouSort AB	1	2017	82.35	Prosta Lund AB	2	2013	71.54
AcuCort AB	1	2017	27.79	Senzime AB	2	2008	38.46
Alligator Bioscience AB	1	2016	2,018.05	Handicare Group AB	2	2017	2,737.67
Alzinova AB	1	2015	75.89	Cline Scientific AB	2	2015	65.39
Aptahem AB	1	2015	62.08	Cline Scientific AB	2	2015	65.39
AroCell AB	1	2011	126.76	SensoDetect AB	2	2009	116.33
B!BB Instruments AB	1	2017	84.84	Cline Scientific AB	2	2015	65.39
Bactiguard Holding AB	1	2014	518.51	PledPharma AB	2	2011	466.30
BioInvent International AB	1	2001	536.76	Ortivus AB	2	1997	755.77
BONESUPPORT HOLDING AB	1	2017	1,048.80	BioArctic AB	2	2017	1,782.13
BrainCool AB	1	2014	209.72	Spectra Cure AB	2	2015	178.67
Camanio Care AB	1	2017	35.63	Pharmacolog i Uppsala AB	2	2015	38.49
Camurus AB	1	2015	3,835.78	Xvivo Perfusion AB	2	2012	1,063.85
Cantargia AB	1	2015	210.03	Scibase Holding AB	2	2015	191.99
CELLINK AB	1	2016	745.63	PledPharma AB	2	2011	466.30
Cereno Scientific AB	1	2016	78.16	Arcoma AB	2	2014	69.10
Clinical Laserthermia Systems AB	1	2009	123.85	Dignitana AB	2	2009	143.42
CombiGene AB	1	2015	67.99	Doxa AB	2	2014	68.50
Corline Biomedical AB	1	2015	124.97	Gabather AB	2	2014	135.43
Enzymatica AB	1	2015	258.97	Klaria Pharma Holding AB	2	2015	230.07
Eurocine Vaccines AB	1	2006	205.85	C-Rad AB	2	2007	160.03
European Institute of Science AB	1	1999	14.31	Addvise AB	2	1998	25.28
Exini Diagnostics	1	2009	56.24	Micropos Medical AB	2	2009	73.78
Genovis AB	1	2006	93.55	Creative Antibiotics Sweden AB	2	2004	107.52
Glycorex Transplantation AB	1	1999	110.72	Creative Antibiotics Sweden AB	2	2004	107.52
Hansa Medical AB	1	2007	49.09	IDL Biotech AB	2	1999	45.56
Idogen AB	1	2015	92.30	Follicum AB	2	2014	75.99
Immunovia AB	1	2015	1,382.78	Xvivo Perfusion AB	2	2012	1,063.85
InDex Pharmaceuticals Holding AB	1	2016	331.11	Acarix AB	2	2016	382.42
Inhalation Sciences Sweden AB	1	2017	88.04	Doxa AB	2	2014	68.50
Insplorion AB	1	2015	122.01	Gabather AB	2	2014	135.43
Invent Medic AB	1	2016	123.64	Diamyd Medical AB	2	2013	134.88
IRLAB Therapeutics AB	1	2017	834.59	Medivir AB	2	1996	848.38
Kancera AB	1	2011	227.30	Episurf AB	2	2010	187.06
Karo Pharma AB	1	1998	2,321.52	Getinge AB	2	1993	3,324.00
Karolinska Development AB	1	2011	970.66	Orexo AB	2	2005	1,227.29
Kontigo Care AB	1	2015	55.68	Nanologica AB	2	2015	64.55
LIDDS AB	1	2014	154.46	Diamyd Medical AB	2	2013	134.88
LifeAssays AB	1	2002	35.89	MedCap AB	2	2004	87.24
Meda AB	1	1995	244.36	Active Biotech AB	2	1986	253.25
Medfield Diagnostics AB	1	2012	151.39	Diamyd Medical AB	2	2013	134.88
NeuroVive Pharmaceutical AB	1	2008	294.73	Ortoma AB	2	2014	258.64
NextCell Pharma AB	1	2017	47.36	Double Bond Pharmaceutical International AB	2	2015	77.78
Obducat AB	1	1999	393.09	Artimplant AB	2	1997	455.44
Obstecare AB	1	2018	48.05	Annexin Pharmaceuticals AB	2	2017	43.00
Panion Animal Health AB	1	2017	18.44	Orasolv AB	2	2004	23.79
PEPTONIC medical AB	1	2014	85.62	Double Bond Pharmaceutical International AB	2	2015	77.78
PExA AB	1	2015	50.93	Emotra AB	2	2013	47.47
PharmaLundensis AB	1	2010	99.30	Follicum AB	2	2014	75.99
Probi AB	1	1998	288.72	Biolin Scientific Holding AB	2	1997	321.64
Promore Pharma AB	1	2017	26.78	Chordate Medical Holding publ AB	2	2017	25.13
QuiaPEG Pharmaceuticals Holding AB	1	2005	27.60	AlphaHelix Molecular Diagnostics AB	2	2006	31.70
Quickcool AB	1	2015	27.42	Emotra AB	2	2013	47.47
Respiratorius AB	1	2012	82.83	Follicum AB	2	2014	75.99
RhoVac AB	1	2016	76.21	Double Bond Pharmaceutical International AB	2	2015	77.78

C2. Control Firm Approach - Matching of Returns (continued)

Control firm	Portfolio	IPO year	Average 3 year MVE, thSEK	Matched Firm	Portfolio	IPO year	Average 3 year MVE, thSEK
RLS Global AB	1	2012	199.94	Phase Holographic AB	2	2014	252.17
ScandiDos AB	1	2014	133.34	Diamyd Medical AB	2	2013	134.88
SenzaGen AB	1	2017	544.20	IRRAS AB	2	2017	566.11
Spago Nanomedical AB	1	2013	87.61	Zenicor Medical Systems AB	2	2014	78.79
Sprint Bioscience AB	1	2014	216.51	Phase Holographic AB	2	2014	252.17
Surgical Science Sweden AB	1	2017	333.66	Paxman AB	2	2017	328.50
Swedencare AB	1	2016	406.67	PledPharma AB	2	2011	466.30
Swedish Orphan Biovitrum AB	1	2006	4,798.64	Capio AB	2	2015	6,812.76
SynAct Pharma AB	1	2016	94.50	Zenicor Medical Systems AB	2	2014	78.79
SyntheticMR AB	1	2013	526.65	PledPharma AB	2	2011	466.30
Toleranzia AB	1	2015	51.38	Alteco Medical AB	2	2014	48.94
Vibrosense AB	1	2015	92.93	Follicum AB	2	2014	75.99
Vicore Pharma AB	1	2015	250.16	Phase Holographic AB	2	2014	252.17
WntResearch AB	1	2010	267.01	Phase Holographic AB	2	2014	252.17
Xintela AB	1	2016	103.22	PEPTONIC medical AB	1	2014	85.62
Acarix AB	2	2016	382.42	InDex Pharmaceuticals Holding AB	1	2016	331.11
Accelerator Nordic AB	2	2008	179.21	Sprint Bioscience AB	1	2014	216.51
Active Biotech AB	2	1986	253.25	Meda AB	1	1995	244.36
AddLife AB	2	2016	3,537.85	Camurus AB	1	2015	3,835.78
Addvise AB	2	1998	25.28	European Institute of Science AB	1	1999	14.31
Allenex AB	2	2006	332.62	NeuroVive Pharmaceutical AB	1	2008	294.73
AlphaHelix Molecular Diagnostics AB	2	2006	31.70	QuiaPEG Pharmaceuticals Holding AB	1	2005	27.60
Alteco Medical AB	2	2014	48.94	Exini Diagnostics	1	2009	56.24
Annexin Pharmaceuticals AB	2	2017	43.00	Hansa Medical AB	1	2007	49.09
Arcoma AB	2	2014	69.10	PEPTONIC medical AB	1	2014	85.62
Arjo AB	2	2017	6,377.69	Swedish Orphan Biovitrum AB	1	2006	4,798.64
Artimplant AB	2	1997	455.44	Obducat AB	1	1999	393.09
BioArctic AB	2	2017	1,782.13	BONESUPPORT HOLDING AB	1	2017	1,048.80
Biolin Scientific Holding AB	2	1997	321.64	Probi AB	1	1998	288.72
Biophausia AB	2	1996	139.11	Meda AB	1	1995	244.36
Bioservo Technologies AB	2	2017	151.43	LIDDS AB	1	2014	154.46
Biotage AB	2	2000	1,185.38	Karo Pharma AB	1	1998	2,321.52
Biovica International AB	2	2017	98.89	Vibrosense AB	1	2015	92.93
Bio-Works Technologies AB	2	2017	183.80	RLS Global AB	1	2012	199.94
Boule Diagnostics AB	2	2011	251.40	Kancera AB	1	2011	227.30
Brighter AB	2	2012	110.78	Clinical Laserthermia Systems AB	1	2009	123.85
Capio AB	2	2015	6,812.76	Swedish Orphan Biovitrum AB	1	2006	4,798.64
Cellavision AB	2	2007	237.58	Kancera AB	1	2011	227.30
Chordate Medical Holding publ AB	2	2017	25.13	Kontigo Care AB	1	2015	55.68
Cline Scientific AB	2	2015	65.39	Aptahem AB	1	2015	62.08
C-Rad AB	2	2007	160.03	Eurocine Vaccines AB	1	2006	205.85
Creative Antibiotics Sweden AB	2	2004	107.52	Genovis AB	1	2006	93.55
Cyxone AB	2	2016	119.82	Corline Biomedical AB	1	2015	124.97
Dextech Medical AB	2	2014	417.96	SyntheticMR AB	1	2013	526.65
Diamyd Medical AB	2	2013	134.88	Kancera AB	1	2011	227.30
Dignitana AB	2	2009	143.42	Clinical Laserthermia Systems AB	1	2009	123.85
Double Bond Pharmaceutical International AB	2	2015	77.78	PEPTONIC medical AB	1	2014	85.62
Doxa AB	2	2014	68.50	Respiratorius AB	1	2012	82.83
Elekta AB	2	1994	1,244.45	Karo Pharma AB	1	1998	2,321.52
Elos Medtech AB	2	1989	32.51	European Institute of Science AB	1	1999	14.31
Emotra AB	2	2013	47.47	Hansa Medical AB	1	2007	49.09
Enorama Pharma AB	2	2016	163.15	RLS Global AB	1	2012	199.94
Episurf AB	2	2010	187.06	Kancera AB	1	2011	227.30
ExpreS2ion Biotech Holding AB	2	2016	74.61	Aptahem AB	1	2015	62.08
Follicum AB	2	2014	75.99	Respiratorius AB	1	2012	82.83
Gabather AB	2	2014	135.43	Insplorion AB	1	2015	122.01
Getinge AB	2	1993	3,324.00	Karo Pharma AB	1	1998	2,321.52

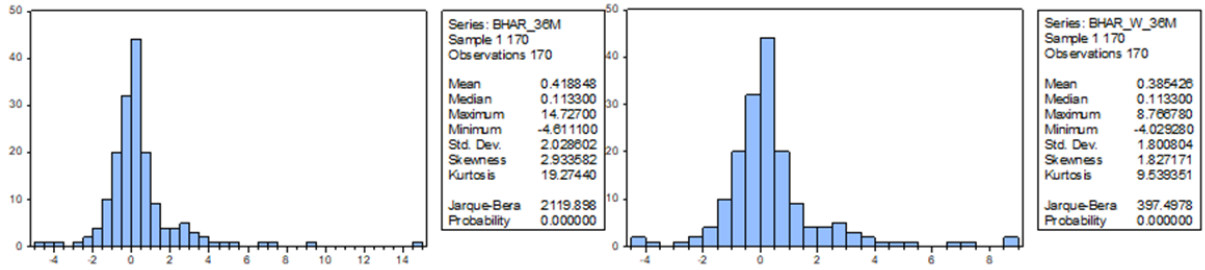
C2. Control Firm Approach - Matching of Returns (continued)

Control firm	Portfolio	IPO year	Average 3 year MVE, thSEK	Matched Firm	Portfolio	IPO year	Average 3 year MVE, thSEK
GHP Specialty Care AB	2	2008	583.61	SyntheticMR AB	1	2013	526.65
Hamlet Pharma AB	2	2015	293.69	Enzymatica AB	1	2015	258.97
Handicare Group AB	2	2017	2,737.67	Alligator Bioscience AB	1	2016	2,018.05
Hemcheck Sweden AB	2	2017	99.97	SynAct Pharma AB	1	2016	94.50
IDL Biotech AB	2	1999	45.56	Hansa Medical AB	1	2007	49.09
Immunicum AB	2	2013	478.33	SyntheticMR AB	1	2013	526.65
Infant Bacterial Therapeutics AB	2	2016	530.56	SyntheticMR AB	1	2013	526.65
Integrum AB	2	2017	158.80	ScandiDos AB	1	2014	133.34
Intervacc AB	2	2017	120.34	PharmaLundensis AB	1	2010	99.30
IRRAS AB	2	2017	566.11	SenzaGen AB	1	2017	544.20
Isofol Medical AB	2	2017	750.94	SenzaGen AB	1	2017	544.20
ISR Immune System Regulation Holding AB	2	2017	151.21	Medfield Diagnostics AB	1	2012	151.39
Karessa Pharma Holding AB	2	2015	171.30	Clinical Laserthermia Systems AB	1	2009	123.85
Klaria Pharma Holding AB	2	2015	230.07	Enzymatica AB	1	2015	258.97
MedCap AB	2	2004	87.24	LifeAssays AB	1	2002	35.89
Medivir AB	2	1996	848.38	Meda AB	1	1995	244.36
Mertiva AB	2	1997	153.71	Meda AB	1	1995	244.36
Micropos Medical AB	2	2009	73.78	Exini Diagnostics	1	2009	56.24
Miris Holding AB	2	2006	36.45	QuiaPEG Pharmaceuticals Holding AB	1	2005	27.60
Moberg Pharma AB	2	2011	456.67	SyntheticMR AB	1	2013	526.65
Nanexa AB	2	2017	64.48	NextCell Pharma AB	1	2017	47.36
Nanologica AB	2	2015	64.55	Kontigo Care AB	1	2015	55.68
Oasmia Pharmaceutical AB	2	2007	762.16	BioInvent International AB	1	2001	536.76
Oncopeptides AB	2	2017	2,561.59	Alligator Bioscience AB	1	2016	2,018.05
Orasolv AB	2	2004	23.79	LifeAssays AB	1	2002	35.89
Orexo AB	2	2005	1,227.29	Karolinska Development AB	1	2011	970.66
Ortivus AB	2	1997	755.77	BioInvent International AB	1	2001	536.76
Ortoma AB	2	2014	258.64	NeuroVive Pharmaceutical AB	1	2008	294.73
Paxman AB	2	2017	328.50	Surgical Science Sweden AB	1	2017	333.66
Pharmacolog i Uppsala AB	2	2015	38.49	Quickcool AB	1	2015	27.42
Phase Holographic AB	2	2014	252.17	Kancera AB	1	2011	227.30
PledPharma AB	2	2011	466.30	Bactiguard Holding AB	1	2014	518.51
Prebona AB	2	2015	56.51	Toleranzia AB	1	2015	51.38
Prolight Diagnostics AB	2	2017	116.46	Xintela AB	1	2016	103.22
Prosta Lund AB	2	2013	71.54	Spago Nanomedical AB	1	2013	87.61
RaySearch Laboratories AB	2	2003	38.02	LifeAssays AB	1	2002	35.89
Recipharm AB	2	2014	4,747.59	Swedish Orphan Biovitrum AB	1	2006	4,798.64
Redsense Medical AB	2	2016	143.96	A1M Pharma AB	1	2013	147.25
Redwood Pharma AB	2	2016	34.21	Quickcool AB	1	2015	27.42
Scandinavian ChemoTech AB	2	2016	91.52	Idogen AB	1	2015	92.30
Scandinavian Real Heart AB	2	2014	115.47	Glycorex Transplantation AB	1	1999	110.72
Scibase Holding AB	2	2015	191.99	Cantargia AB	1	2015	210.03
SECTRA AB	2	1999	1,342.54	Karo Pharma AB	1	1998	2,321.52
Sedana Medical AB	2	2017	562.02	CELLINK AB	1	2016	745.63
SensoDetect AB	2	2009	116.33	AroCell AB	1	2011	126.76
Senzime AB	2	2008	38.46	LifeAssays AB	1	2002	35.89
Spectra Cure AB	2	2015	178.67	BrainCool AB	1	2014	209.72
Vitrolife AB	2	2001	407.81	Probi AB	1	1998	288.72
Wilson Therapeutics AB	2	2016	2,141.26	Karolinska Development AB	1	2011	970.66
Xbrane Biopharma AB	2	2016	255.40	Vicore Pharma AB	1	2015	250.16
XSpray Pharma AB	2	2017	661.14	Bactiguard Holding AB	1	2014	518.51
Xvivo Perfusion AB	2	2012	1,063.85	Karolinska Development AB	1	2011	970.66
Zenicor Medical Systems AB	2	2014	78.79	Spago Nanomedical AB	1	2013	87.61

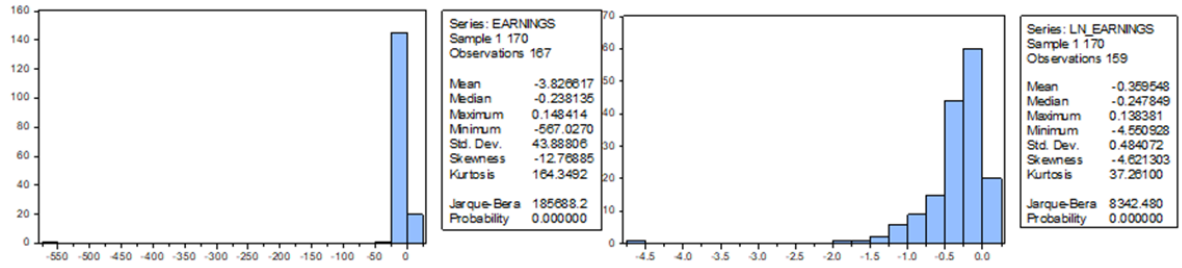
C3. Regression Tests

Normality Test

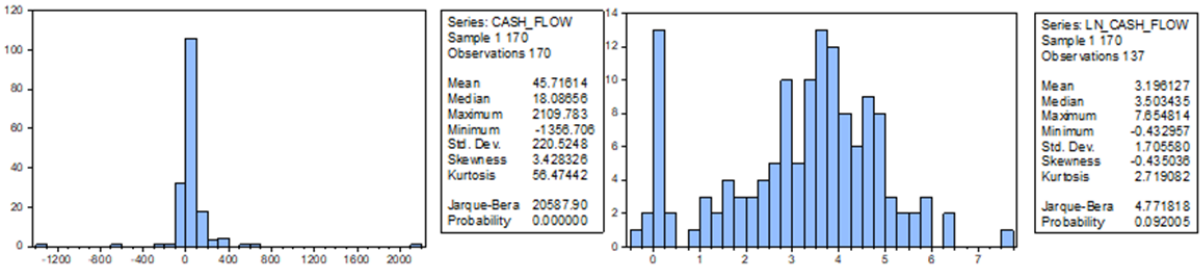
BHAR



Earnings



Cash Flow



Heteroskedasticity and Autocorrelation Test

INITIAL REGRESSION MODEL: NO CONTROL VARIABLES

Unadjusted for heteroskedasticity and autocorrelation
Dependent Variable: BHAR_W
Method: Least Squares
Sample: 1 170
Included observations: 170

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.463483	0.184662	2.509898	0.0130
D_SP	-0.171438	0.309623	-0.553699	0.5805
D_UNIVERSITY	-0.027783	0.466533	-0.059552	0.9526

R-squared	0.002473	Mean dependent var	0.385426
Adjusted R-squared	-0.009473	S.D. dependent var	1.800804
S.E. of regression	1.809314	Akaike info criterion	4.041262
Sum squared resid	546.6938	Schwarz criterion	4.096599
Log likelihood	-340.5072	Hannan-Quinn criter.	4.063717
F-statistic	0.207014	Durbin-Watson stat	1.855796
Prob(F-statistic)	0.813216		

Adjusted for heteroskedasticity and autocorrelation
Dependent Variable: BHAR_W
Method: Least Squares
Sample: 1 170
Included observations: 170
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.463483	0.233441	1.985440	0.0487
D_SP	-0.171438	0.321793	-0.532758	0.5949
D_UNIVERSITY	-0.027783	0.345898	-0.080321	0.9361

R-squared	0.002473	Mean dependent var	0.385426
Adjusted R-squared	-0.009473	S.D. dependent var	1.800804
S.E. of regression	1.809314	Akaike info criterion	4.041262
Sum squared resid	546.6938	Schwarz criterion	4.096599
Log likelihood	-340.5072	Hannan-Quinn criter.	4.063717
F-statistic	0.207014	Durbin-Watson stat	1.855796
Prob(F-statistic)	0.813216	Wald F-statistic	0.188735
Prob(Wald F-statistic)	0.828182		

INITIAL REGRESSION MODEL: CONTROL VARIABLES

Unadjusted for heteroskedasticity and autocorrelation
Dependent Variable: BHAR_W
Method: Least Squares
Sample: 1 170
Included observations: 128

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.562741	0.901558	-0.624187	0.5337
D_SP	0.070389	0.357318	0.196993	0.8442
D_UNIVERSITY	0.046990	0.535943	0.087678	0.9303
SIZE	0.324581	0.322113	1.007662	0.3156
AGE	0.023505	0.021880	1.074270	0.2848
LN_EARNINGS	-0.441610	0.328151	-1.345751	0.1809
LN_CASH_FLOW	-0.062379	0.100467	-0.620888	0.5358

R-squared	0.029360	Mean dependent var	0.380999
Adjusted R-squared	-0.018770	S.D. dependent var	1.728590
S.E. of regression	1.744738	Akaike info criterion	4.004221
Sum squared resid	368.3374	Schwarz criterion	4.160192
Log likelihood	-249.2702	Hannan-Quinn criter.	4.067593
F-statistic	0.610012	Durbin-Watson stat	1.813148
Prob(F-statistic)	0.721912		

Adjusted for heteroskedasticity and autocorrelation
Dependent Variable: BHAR_W
Method: Least Squares
Sample: 1 170
Included observations: 128
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.562741	0.707630	-0.795248	0.4280
D_SP	0.070389	0.379584	0.185438	0.8532
D_UNIVERSITY	0.046990	0.498095	0.094340	0.9250
SIZE	0.324581	0.239786	1.353624	0.1784
AGE	0.023505	0.018016	1.304648	0.1945
LN_EARNINGS	-0.441610	0.260350	-1.696218	0.0924
LN_CASH_FLOW	-0.062379	0.085791	-0.727108	0.4686

R-squared	0.029360	Mean dependent var	0.380999
Adjusted R-squared	-0.018770	S.D. dependent var	1.728590
S.E. of regression	1.744738	Akaike info criterion	4.004221
Sum squared resid	368.3374	Schwarz criterion	4.160192
Log likelihood	-249.2702	Hannan-Quinn criter.	4.067593
F-statistic	0.610012	Durbin-Watson stat	1.813148
Prob(F-statistic)	0.721912	Wald F-statistic	1.399485
Prob(Wald F-statistic)	0.220280		

Appendix D: Supplementary Methodology

D1. CARs Calculations

Company	Alfa	Beta	CAR 0	CAR -1, + 1	CAR -2, + 2	CAR -2, +3	CAR -2, +4	CAR -2, +5	CAR -2, +6	CAR -2, +7	CAR -2, +8	CAR -2, +9	CAR -2, +10
Aptahem AB	0.00	0.40	0.01	0.12	0.17	0.16	0.14	0.12	0.14	0.13	0.13	0.13	0.15
Bactiguard Holding AB	0.00	0.80	-0.04	-0.05	-0.06	0.02	0.03	0.04	-0.01	-0.05	-0.06	-0.09	-0.09
CELLINK AB	0.01	0.51	0.00	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	-0.04	-0.04	-0.05	-0.05
Clinical Laserthermia Systems AB	0.00	-0.05	-0.01	0.05	0.02	0.00	-0.05	-0.04	-0.07	-0.05	-0.05	-0.03	0.00
CombiGene AB	0.00	0.25	0.16	0.17	0.26	0.33	0.34	0.31	0.31	0.32	0.25	0.26	0.25
Genovis AB	0.00	0.76	0.20	0.07	0.19	0.15	0.16	0.16	0.16	0.13	0.04	0.10	0.11
Glycorex Transplantation AB	-0.01	0.65	0.03	0.04	0.04	0.04	0.02	0.01	0.00	-0.03	-0.04	0.01	0.03
Kancera AB	0.00	0.64	0.02	-0.05	-0.03	-0.07	-0.09	-0.05	0.00	-0.01	-0.08	-0.11	-0.11
Karolinska Development AB	0.00	0.55	0.03	0.05	0.05	0.01	0.01	0.02	0.09	0.08	0.08	0.08	0.08
Meda AB	0.00	0.73	0.00	0.01	0.00	0.00	0.00	-0.01	-0.02	-0.07	-0.06	-0.07	-0.06
Obducat AB	0.01	-0.65	0.02	0.01	-0.11	-0.04	-0.10	-0.09	-0.09	-0.12	-0.10	-0.11	-0.06
PharmaLundensis AB	0.00	0.09	-0.01	-0.07	-0.14	-0.13	-0.02	-0.01	-0.11	-0.11	-0.08	-0.06	-0.02
QuiaPEG Pharmaceuticals Holding AB	0.00	-0.83	0.01	-0.07	0.03	-0.15	-0.14	-0.15	-0.15	-0.15	-0.15	-0.16	0.04
Respiratorius AB	0.01	-1.98	0.06	-0.04	-0.05	-0.02	-0.11	0.00	0.14	0.10	0.05	0.05	-0.01
Swedish Orphan Biovitrum AB	0.00	0.88	0.01	0.01	0.02	0.02	-0.01	-0.01	0.01	0.01	-0.01	-0.02	-0.02
WntResearch AB	0.00	0.56	0.02	0.08	0.06	-0.12	-0.37	-0.41	-0.28	-0.32	-0.29	-0.34	-0.30
Xintela AB	0.00	0.62	0.00	0.01	-0.02	-0.06	-0.06	-0.06	-0.07	-0.11	-0.09	-0.13	-0.10
NeuroVive Pharmaceutical AB	0.00	0.22	0.02	0.04	0.07	-0.03	-0.02	-0.03	-0.07	-0.05	-0.11	-0.11	-0.14
Hansa Medical AB	0.00	0.30	0.02	0.02	0.02	0.03	0.03	0.02	0.03	0.03	0.03	0.04	0.04
CAR mean			0.03	0.02	0.03	0.01	-0.01	-0.01	0.00	-0.02	-0.03	-0.03	-0.01
Standard deviation			0.06	0.06	0.10	0.11	0.14	0.14	0.13	0.13	0.11	0.13	0.12
T-statistic			2.23	1.45	1.20	0.29	-0.40	-0.34	-0.05	-0.52	-1.16	-1.08	-0.52
P-value			0.04	0.17	0.25	0.77	0.69	0.74	0.96	0.61	0.26	0.29	0.61
Significance level			**										

D2. Normality Test

CAR in event window 0