ESST

The European Inter-University Association on Society, Science and Technology

http://www.esst.eu

Focused and General science parks: a study of New Technology Based Firms within Life-sciences in Sweden

Keyvan Alvandi

Lund University

Masters Programme in Society, Science and Technology/ Science, Entrepreneurship and Innovation in Time and Space

2008/2010

Word count

17,781

Acknowledgements

The process of writing this thesis proved to be more challenging than anticipated but a few individuals made it possible for me to bring it to an end. First and foremost, I would like to express my gratitude to my supervisor Jonas Gabrielsson who treated this project as one of his own. His ideas and insight shaped the structure of this thesis right from the start and his feedbacks throughout were more than inspiring.

I would also like to thank Emelie Stenborg for her help during my studies and writing of this thesis. She did not hesitate to respond to my questions when I needed guidance and I am truly grateful for that.

I would not have been able to finish the masters programme nor this thesis if it wasn't for Goya Harirchi. Thank you for being my compass in times of despair. You are truly a great friend and I wish you all the best.

My love and gratitude to Viveka Schaar, whose support and patience kept me going through the harshest of times. Without you none of this would have been possible. Thank you for being there for me.

Last but definitely not the least, I would like to thank my beloved parents for believing in me even when I stopped believing in myself. I'm eternally grateful for the love and support you gave me. Words cannot begin to express how much I love you both.

Abstract

New Technology-Based Firms (NTBFs) contribute greatly to the development and construction of their nations' economies. Therefore their creation, survival and growth have become a major focus for policy. Science parks as actors within regional innovation systems can be suitable tools to carry out this objective. This paper investigated whether the type of science park has any effect on performance of NTBFs. To this end science parks were categorized as focused –hosting firms from a single industry- and general –more than one industry. A comparative study based on second hand data collection was performed on Swedish science parks working within Life-sciences. The results revealed that focused science parks are better stimulants of employment creation and that their residents enjoy higher rates of sales growth. The author recommends that further categorization of science parks leads to better recognition and utilization of their potential.

Keywords: science parks, NTBFs, performance, Life-sciences, Sweden

Table of Contents

Illustrations

FIGURES

TABLES

Chapter 1

1. Introduction

In recent years, new technology-based firms (NTBFs) have become a focus for policy around the globe. This stems from the idea that these firms have high growth potential to explore and exploit new technologies and ultimately contribute greatly to their nation's economies (Ferguson & Olofsson, 2004, p. 5). Science parks are an example of such policies that advocate the creation, survival and growth of this group. Among other things[1], policy makers utilize science parks to implement transfer and commercialization of knowledge from universities to the industry. In fact, science parks "demonstrate the willingness and ability of universities to work successfully with the commercial sector" (Monck et al, 1988, p. 4).

However, most studies done on science parks (cf. Malairaja & Zawdie, 2008; Löfsten & Lindelöf, 2001; Chan et al, 2010) point to inconsistencies between the expected outcomes and the actual results. Ferguson and Olofsson (2004), note that research in this field signalizes to no consistent outcome rather than a 'prestigious address' provided by science parks (p. 5). Whilst it is not the intention of this thesis to accuse these studies of being incorrect, it seems clear that there are shortcomings in the general view towards science parks and the way they are evaluated. Amirahmadi and Saff (1993) in the introduction of their paper say:

Science parks differ in size and structure, in the amount and type of employment they provide, and in goals and development histories. Despite these differences, the parks exhibit enough common characteristics (such as their predominant function) for them to be categorized as "science parks."

Although this is logically correct, it points out to an unfortunate trend in the science park studies that they are treated as identical units with similar expected outcomes i.e. any science park is indeed a science park. In other words, what is being analyzed could only remotely

[1] Goals and purposes of science parks are studied in detail in the 2nd chapter of this thesis.

resemble a science park. To give an example, one can refer to Westhead (1997) who links low results of science park firms to the fact that some park managers in order to sustain rent income have lowered the entry barrier. This in turn makes it possible for some firms to enter the park merely to take advantage of the 'image' rather than what the park really has to offer (p. 57). Such management decisions turn a science park into a 'firm hotel' which is merely a "real estate developments primarily designed to accommodate high-tech firms" (Monck et al. 1988, P.64).

Of course one should not go as far as saying such establishments are not science parks or should not be called so, but one should be cautious before generalizing results based on these establishments or others alike to the concept of science Park as a whole. Consequently, it seems that the current discourse on science parks is rather broad which does not appear to be constructive or accurate. It is logical then, to move away from such generalization within science park studies towards a more individual and narrow approach.

Aims and Objectives

In order to move away from such generalization, this thesis proposes that categorization of science parks would be a solid way to achieve this goal. In this sense, science parks should be grouped based on what they are in reality and whatever they provide rather than what they (ideally) represent. Such categorization would bring about an adjective before the word 'science park' which helps us distinguish them on a basis more than just their names. One of the few major studies where this point was taken into consideration is Westhead and Batstone's study of British science parks in 1999. They divided science parks on the basis of those with full time, on-site managers and the ones without (p. 134). Extracted results from such an approach can be used to classify science parks into groups with shared characteristics and similar outcomes. Their study classified science parks into two different *types* namely managed and non-managed science parks.

In order to take a further step towards categorization of science parks, this paper proposes another classification; *Focused* and *General* science parks. The former relates to science parks who host firms from a single industry while the latter is not exclusive. In practice, such distinction can be seen within science parks around the globe; for instance in the United States the Research Triangle Park is a general science park hosting firms from Biotechnology, ICT and Life Sciences while BioSquare at Boston University is a focused science park exclusive to Life

Sciences (IASP, 2010). The performance implications for such a distinction are however not explored in the academic literature.

It would not be farfetched to assume that a science park which is home to firms from a single industry would have different characteristics compared to a park where firms belong to several, perhaps unrelated fields of science. This paper tries to seek truth behind this assumption. If there are deviations between the two groups and they have different effects on their tenants, then one can argue that they can be categorized as different classifications or types of science parks. In other words, this paper investigates if tenants in focused science parks perform differently from their counterparts in general science parks. Thus the following research question is proposed:

RQ: Are there any differences in firm performance stemming from the type of science park firms reside in as tenants?

To this end, a comparative study is done on science parks in Sweden which host firms from the life sciences industry. The most common approach in science park studies (for example Squicciarini, 2008; Westhead, 1997; Yang et al, 2009; Monck et al. 1988; Löfsten & Lindelöf, 2001, 2002, 2005) takes the form of 'On-Park vs. Off-Park' where firms residing on science parks are compared to firms located elsewhere. This is mainly to point out to existence of any added value of science parks to their tenants. However, in this thesis as all firms are residents of science parks an 'On-Park vs. On-Park' comparison is done to examine any added value of one group of parks over the other.

In order to perform such face to face comparison, one should take off from a hypothesis that relates the two entities together. Forming such hypothesis at this stage is not possible as the proposed categorizations (focused and general) are rather new and quite unrepresented in the literature. In fact the only paper, to my knowledge, that talked about this topic was a brush off in a footnote in Squiciarrini (2009) where he examined if a 'specialised' science park affects a firm's tendency to patent (p. 185, footnote). Consequently, this also brings about the need to define the concept of a focused and a general science park before moving on to creating the hypothesis. Hence, formation of the hypothesis and defining the two groups are done after the literature review section.

Structure of the thesis

The rest of this paper is organized as follows. In chapter two, I present the literature review done for this paper in which Regional Innovation System (RIS) is the point of departure. This is followed by linking science parks and new technology based firms (NTBFs) together. And finally, characteristics of science parks are introduced.

In chapter three, I try to define the concepts of a focused and general science park. This is done based on the literature review done in chapter two. Furthermore, another literature review is done to help form a hypothesis that would be the core of my comparison.

In chapter four, the methodology used in this thesis is explained. “Why”s and “how”s of choosing science parks and firms for this study are explained in detail along with the process through which the whole sample was filtered to make way for a more accurate comparison.

In chapter five, the results of the comparison are presented. It should be noted that the comparison is done in two ways; firstly characteristics of the two groups are compared through several illustrations based on their attributes. And secondly, an independent T-test is done on both groups to reveal their differences in their tenants’ financial performance.

Finally, in chapter six I analyze and explain the outcome of the comparisons done on my two samples. This is followed by a section to conclude this dissertation and recommendations for further studies.

Chapter 2

2. Theoretical Framework

Regional Innovation System

In recent decades innovation has come to be seen as a crucial part of economic growth. This in turn has transformed innovation policy into a legitimate and popular economic field especially since the beginning of the 1980s when macroeconomic policies fell short of explaining the slowdown of economic growth and the increase of unemployment at the time (Lundvall & Borrás, 2005, p. 603). In this sense then, the *systemic* version of the innovation policy –opposed to the laissez-faire model- was directed at "reviewing and redesigning of linkages between the parts of the system" which recognized the importance of competition as well as a need for cooperation of the economic entities (Ibid, pp, 611-612).

Not surprisingly geographical conditions and circumstances have made their way onto being considered as crucial aspects of the innovation process. 'Region' in this sense has come to be a solid spatial boundary in innovation studies and as Lundvall and Borrás (1999) assert, it is "increasingly the level at which innovation is produced through regional networks of innovators, local clusters and the cross-fertilizing effects of research institutions" (p. 39). Consequently concept of regional innovation system (RIS) was established as *systemic* innovation policy frameworks to assist governments and authorities in stimulating innovation in their regions of interest (Asheim B. , 2007, p. 223). RIS is defined as "the institutional infrastructure supporting innovation within the production structure of a region" (Asheim & Coenen, 2005, p. 1177).

Popularity of the RIS concept can be related to two reasons; firstly, an earlier upswing in adoption of concepts such as Marshall's industrial districts and Lundvall's National Innovation System (Christopherson et al., 2008, p. 170). And secondly, an ever growing view that territorial agglomerations generates positive advantages for firms especially in knowledge intensive industries (Asheim B. , 2007, p. 223).

RIS theory recognizes innovation as a result of "interaction between economic agents" (Coenen, 2007, p. 805)and emphasizes that "knowledge exploitation subsystem" and “knowledge generation subsystem” should be systematically involved in an interactive learning process. The former is also known as regional production structure and includes for instance firms with high clustering tendencies (Asheim B. , 2007, p. 229).The latter on the other hand is known as regional supportive structure which includes “public and private research laboratories, universities and colleges, technology transfer agencies and vocational training organizations” (Ibid).

It is believed that such interaction constructs and increases regional advantage leading to economic growth (Coenen, 2007, p. 803). It is worthy to mention that co-location of the two subsystems would not, on its own, develop such advantages and “continuous organizational and institutional support” is required to facilitate such systemic involvement of interactive learning (Moodysson, 2007, p. 38).

This in turn brings about the two types of implementing RIS i.e. top-down and bottom-up approach. The top-down approach is more closely associated with national interests and thus resembles a more macro perspective (Howells, 2005, p. 1223). This view “focuses on the specific way(s) in which the dynamic interaction between the knowledge-exploitation and knowledge-generation subsystems of a region is organized” (Coenen, 2007, p. 805).This is achieved by integrating R&D function of universities, public and private research institutes (Asheim B. , 2007, p. 230). On the other hand bottom-up approach “is more concerned with the actual knowledge and learning dynamics between actors in the regional knowledge network (Howells, 1999, as cited in Coenen, 2007, p. 806) with regards to their capability of learning, generating and diffusing knowledge (Asheim B. , 2007, p. 230).

According to Asheim (2007) there are three different types of RIS namely territorially embedded regional innovation system, regionally networked innovation system and regionalized national innovation system (p. 231). Regionalized National Innovation System (RNIS) compared to the first two models is more closely linked to the national innovation system. RNIS focuses mainly on analytical and scientific knowledge bases as well as recognizing the importance of project based collaborations with exogenous actors to the region (Ibid).

This type of RIS encompasses the concept of science parks as “planned innovative milieux” and considers them as tools to achieve benefits of territorial agglomerations (Ibid). The central idea here is that clustering of innovative firms in proximity to each other is advantageous to the firms (Ibid, p. 223) and their interaction will facilitate prosperity (Moodysson, 2007, p. 29). This, on the one hand, is due to the belief that agglomeration of firms from a single industry into a place accumulates knowledge related to that industry overtime which becomes embedded within that place (Maskell & Malmberg, 1999, p. 180).

On the other hand it is believed that social codes, rules and other forms of informal conventions associated with every region develop mutual understanding and a sense of trust between different actors in that place which can ultimately bring them closer to each other (Coenen, 2007, p. 805). These non ubiquitous factors shape norms, values and routines that form the "regional culture" which defines how actors of every region come to interact with one another (Asheim B. , 2007, p. 230).

Science parks are parts of regional supportive structure and are established mainly to facilitate formation and growth of New Technology Based Firms (NTBFs) (Yang et al., 2009, p. 84). In order to study the connection between the two aims and purposes of both science parks and NTBFs are examined in the following two sections.

Why NTBFs?

A major part of contemporary regional (and national) policy has come to focus on establishment and growth of NTBFs. This, as Westhead (1997) suggests, stems from the belief that they bestow greatly to the economy based on their "direct and indirect contribution to wealth creation and job generation" and that they are "major sources of technological innovation" (p. 45). Monck et al. (1988) suggest that NTBFs are key elements in the economy because:

- ❖ They are ought to embody the technology of the future and hence provide secure employment opportunities for several generations.
- ❖ In the United States NTBFs have exhibited spectacular rated of employment growth.
- ❖ The areas in which NTBFs are important in the United States (Boston, Massachusetts; Palo Alto and Orange County in California) have also exhibited major job creation in the business and consumer service sector locally.

- ❖ The quality of the jobs provided in NTBFs are significantly better than those in traditional manufacturing. (p. 44)

Clearly the quantity and quality of jobs created by NTBFs are of great value. Storey and Tether (1998) acknowledge such role of NTBFs as means to reduce unemployment rates but further include that they (NTBFs) play an important role in industrial networks as well as a crucial part in technology transfer (p. 933). Similarly Ferguson and Olofsson (2004) acknowledge the high growth potential of NTBFs and their impact on economy through commercialization of academic research and diffusion of emerging technologies (p. 5). Compared to more ‘conventional firms’ NTBFs stand out because they are believed to have tendencies to grow faster, survive better and internationalize quicker (Löwegren, 2003, p. 38). Löfsten and Lindelöf (2001) claim that in Sweden NTBFs are important as they help ‘renew’ and ‘vitalize’ the industrial structure of the country (p. 317). Dahlstrand (2007) notes that NTBFs affect economic growth directly through their own growth as well as indirectly through supplying other firms with specialized input (p. 375). She also claims that NTBFs tend to “cluster in a specific region, contribute to technology transfer within a region and benefit from and establishment in an incubator or science park” (ibid, P.376).

Why science parks?

The aims and purposes of building science parks are rather divergent as they differ from one place to another. Westhead (1997), claims in Britain science park were established to “encourage regional development and stimulate R&D and innovation in small and medium-sized firms” (p. 46). Bigliardi et al. (2006) associate aims of building science parks in Europe to different time periods (span of 50 years) and include assisting high-tech startups to establish and develop, implementing technology transfer programs, intensifying industry-university collaboration and reindustrialization of under developed areas (pp. 489-490). These aims and purposes according to him are somewhat extracted from parks’ ‘mission statements’ (Ibid). Similarly, Massey et al. (1992) created a list of 25 science park objectives mentioned by the park managers and sponsors in the UK (p. 21). However, they point out to the following four as “dominant reasons for establishing science parks”:

- Parks will promote the formation of new firms
- They will facilitate links between the host academic institutions and park firms and thus improve the take-up of ideas to new products and processes.
- Firms on the park will have a high level of technology and be ‘at the leading edge’; they promise a sunrise future, in many areas to replace a ‘sunset’ existing local economy.
- They will create employment opportunity (Ibid, p. 28).

It is rather clear that the objectives and purposes of NTBFs and science parks are very similar if not identical. If the main objectives of NTBFs are to (among other things) facilitate technology transfer, create employment and reindustrialization, then purpose of science parks are to help create these NTBFs and assist them in reaching their objectives. Moonck et al. (1988) call science parks an ‘important vehicle’ for establishment and development of new technology based firms (p. 5).

Science parks and NTBFs, a closer look

In the beginning of this chapter science parks were introduced within the context of regional innovation systems. Then the link was drawn between purposes of NTBFs and those of science parks. In what follows rest of the science parks and NTBFs’ literature is reviewed to examine the definitions and characteristics related to them. The part on features of NTBFs will later help form the criteria of choosing the sample firms from the database.

What are NTBFs?

It seems rather difficult to associate NTBFs to a unique definition or a singular set of characteristics since their assumed tasks and features vary from one place to another. In 1979 in a highly referred to study, Arthur Little examined new technology based firms in the US and compared them with NTBFs in the UK and Germany and assigned the following characteristics to them:

- It must not have been established for more than 25 years.
- It must be a business based on a potential invention or one having substantial technological risks over and above those of a normal business.
- It must have been established by a group of individuals -not as a subsidiary of an established company.
- It must have been established for the purpose of exploiting an invention or technological innovation. (Monck et al.1988, p. 45;Löfsten&Lindelöf 2002, p. 865)

Although this formed the very basic of NTBF definition, there are descriptions that negate this one. Somewhat contradictory to the third point, Oakey (1995) claims NTBFs can be distinguished based on their origins; those being spin-offs from a Higher Education Institute (HEI) and those from existing well established companies (as cited in Löwegren, 2003, p. 36). The behavior of HEI spin-offs with founders with academic background is reasonably expected to differ from those founded by people related to the industry. According to Monck et al. (1988) it should be of no surprise if academic spin-offs would perform less well compared to 'professional' spin-offs mainly because the academic founders might be more committed to scientific research and university teaching and less committed to generating firm growth or income (p. 222). This is of course beside the fact that they most probably lack the experience and knowledge required to run a business (Ibid, p. 221). Löfsten and Lindelöf's study of Swedish science park firms (2005) bears witness to this fact as their results showed that although academic spin-offs, as opposed to corporate spin-offs, have higher rate of linkages and cooperation with host HEI and universities, they don't necessarily show differences in performance in regards to growth and profitability (pp. 1033-1035). NTBFs in general rely on external assistance which seems more necessary in case of academic based NTBFs.

Another set of characteristics being related to NTBFs is based on their size. Tidd et al. (2005) claim NTBFs are different from 'Small and Medium-sized Enterprises' (SMEs) mainly because they are "established by highly qualified personnel, require large amounts of capital and are characterized by greater technical and market risk" (p. 523). Fukugawa (2006) also suggests that NTBFs, as opposed to SMEs, are more reliant on science-based innovation which makes them more in need of HEI linkages (p. 382). The characteristics or if one can call it delicacies of

NTBFs would somewhat escalate if one considers them to be small-sized firms. Oakey et al. (1988) describe NTBFs as “small firms with a higher inherent innovative potential than large firms and small firms in general” (as cited in Lindelöf & Löfsten 2003, p. 252).

It should be noted that in this paper NTBFs are taken as ‘small’ firms whom, according to European Commission (2005), are categorized as “firms with less than 50 employees and annual turnover of less than €10 million” (as cited in Moodysson, 2007, p. 25). Further in the paper this definition will be employed to form the selection criteria for choosing the data sample.

Small NTBFs enjoy advantages of having better job flexibility and less hierarchy in their overall structure which allows for a better flow of knowledge through different levels of the firm (Lindelöf & Löfsten, 2003, pp. 247-248). This provides their managers with a better overview of the overall innovation process which makes the firm more responsive towards “financial, technological, and marketing risks” (Ibid, p. 248). These managers, as Löwegren (2003) suggests, embody the whole knowledge base of the firm which makes their firms more heavily relying on their surroundings and facilities provided by others compared to larger firms (p. 35).

Of course it is not all positive for NTBFs; the fact that these firms are young (new) and small makes them very vulnerable to obstacles related to early development phases. These obstacles are normally referred to as “liability of newness/smallness” (Ibid, p. 36). One of the main reasons behind this is the founders’ unfamiliarity with running a business (Ibid) and a lack of legitimacy especially in the market place (Ferguson & Olofsson, 2004, p. 6). Chan et al. (2010) relate this liability to “a lack of external resources, access to formal financial funding and internal routines” and conclude that firms would face higher rates of failure if they are not helped in overcoming these hurdles (p. 224).

Based on the literature of NTBFs it could be asserted that what gives these small firms their advantage, is what makes them vulnerable at the same time i.e. their flexibility, openness and risk taking could on the one hand cause their growth and prosperity and on the other lead to their failure and disappearance. This is specifically clear when one compares them to large firms; Rothwell (1986) concludes in his study of small firms that:

"*...whilst small firms have the ability to react quickly, are most willing to take risks, and have better internal communications than large firms, they generally lack the large firms' access to finance, lack its ability to market products through established dealer networks and lack large firms' expertise in dealing with government bureaucracy which can be very important in the case of new products*" (as cited in Monck 1988, P.43)

This suggests that small firms (NTBFs) could be complemented by large firms' advantages and abilities; thus there is a need to support such firms to gain advantages similar to those capabilities of large firms in order to help them overcome their liabilities. To better understand the liability or simply necessities of small NTBFs, one can take up on a resource-based perspective. Löwegren (2003) suggests that NTBFs need to acquire capital, space, personnel, production equipment and knowledge in forms of technological, financial, accounting, marketing, production, personnel and general management (p. 39). These resources according to Barney (1991) fall into three major categories namely Physical capital resources, human capital resources and organizational capital resources (p. 101). Chen (2008) refers to these requirements as organizational resources and claims that they include human resources, tangible and intangible resources (p. 94). Further in this chapter it will be analyzed how science parks would come to supply NTBFs with such resources.

What are science parks?

The first science park was built in 1951 in the United States called Stanford Industrial Park. This later lead to the development of Silicon Valley which following its success increased the popularity of the science park concept (Chan & Pretorius, 2007, p. 567). In 1980's, policy makers from the US and Europe, who were facing increased unemployment rates and low revenues, took on creating science parks to inject life into their stagnating regions and nations' economies (Amirahamdi & Saff, 1993, p. 107). This lead to a visible increase in the number of science parks in the 1990's and majority of existing parks in the world date back to this time period (Chan et al. 2008, p. 444).

Definitions:

Although the concept of science park is not a new phenomenon there is still no uniformly accepted definition of them available (Chan et al, 2008, p. 444, Löfsten & Lindelöf, 2005, p. 1026), not to mention the fact that there are several terms used to refer to these facilities such as technology parks, innovation centers and research parks. United Kingdom Science Park Association (UKSPA) defines science parks 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 centres 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 (IASP, 2010).

International Association of Science Parks (IASP) uses the following definition to describe science parks:

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).

It is clear from these definitions that science parks are supposed to provide certain services to their inhabitants as well as their encompassing economy. These services are the same as aims and purposes of science parks mentioned earlier in the paper. The second definition provided by the IASP holds more aspects of the concept thus in this paper this definition is used.

Characteristics:

Based on the literature review, characteristics of science parks can be categorized into four groups of Clustering effect and the proximity factor; Networking effect and the knowledge flow; University and other higher education institute (HEI) linkages; and finally the management function. In the following four segments each characteristic is introduced along with related supporting theories from the literature. If available, links are drawn between these effects and the expected goals of science parks.

Clustering effect and the Proximity factor

The concept of clusters, similar to that of RIS, is based on the notion that territorial agglomerations will provide desirable circumstances for growth of knowledge based industries and is defined as "a concentration of 'inter-dependent' firms within the same or adjacent industrial sectors in a small geographic area" (Asheim & Coenen, 2005, p. 1174). Gilbert et al. (2008) claim that "firms located within geographical clusters have been found to exhibit higher innovative performance, rates of growth and survival than do firms not located within geographical clusters" (p. 405).

The territorial agglomerations' benefits are by definition provided in science parks since they are considered a "cluster of firms engaging in activities mostly located at the higher end of the spectrum of knowledge intensiveness" (Zhang, 2008, p. 60). Chan et al. (2008) also refer to science parks as a 'cluster' of independent, knowledge-based firms and emphasizes the importance of learning and research as proximity to higher education institutions is one of the fundamental principles in the science park phenomenon (p. 444).

This geographical proximity within the boundary of a park brings about on the one hand the static effects of territorial agglomeration. Moodysson (2007) defines these as "direct economic benefits or returns to scale, such as reduced transport and transaction costs between interacting actors and cost saving from sharing of territorially contained resources" (p. 29). On the other hand it induces dynamic effects through which path dependent, socially constructed and rather informal values such as trust and openness comes to connect firms, universities and other co-located actors together (Ibid). This results an increase in the propensity as well as intensity of their interaction. Maskell and Malmberg (1999) relate to the former set of effects as "time geography" noting that geographical proximity will facilitate cheaper and smoother collaboration, as for the latter, it is the cultural and social proximity of the actors in terms of understanding and trust that binds them together (p. 180).

In order to back these ideas, economists and proponents of the theory use the importance and characteristics of tacit form of knowledge. Asheim and Gertler (2005) claim “tacit knowledge constitutes the most important basis for innovation-based value creation” (p. 292). It is argued that in today's globalizing economies where accessing codified knowledge is rather easily and ubiquitously exercised (Maskell & Malmberg, 1999, p. 172), it is the capabilities and competences based on tacit knowledge that come to form the firms and regions' competitiveness (Asheim & Coenen, 2005, p. 1176). Needless to say, flow of tacit knowledge as opposed to codified or codifiable knowledge is more reliant on face to face and informal interaction. This makes up for the competitive advantage associated to the proximity concept or spatial agglomerations.

It is then logical to argue that in transferring and exchanging tacit knowledge which contains competences and capabilities, firms' willingness toward such interaction would very well be determined by factors such as openness and trust. As noted earlier, these factors are directly related to the dynamic effects of the proximity factor and its path dependent attributes. Therefore one can propose that geographical proximity is a tool (static effects) as well as a cause (dynamic effects) to collaboration and knowledge exchange within economic actors in a science park. Chan et al. (2010) state that “ firms located in science parks are assumed to profit from transmission of (tacit) knowledge as a result of lower communication costs in a dense and knowledge rich environment” (p. 207).

The presumed advantages stemming from clustering high-tech firms onto a science park does not limit to firms and entities inside a science park and spreads beyond physical boundaries of a park. Zhang (2008) claims that parks can act as ‘core of the cluster’ by attracting firms to not only locate inside a park but also outside yet close to it while granting them access to science park firms and management and hence creating a bigger cluster (p. 60). Monck et al. (1988) examined the ‘fact’ that areas with high concentration of high-tech firms (mainly as science parks) will manifest ‘above average’ performance in their more conventional sectors and industries. This as they claim, stems from the belief that high tech sector leads the economy, thus a cluster of such firms will create surplus wealth in terms of ‘additional purchasing power’ for the conventional sector of that area (p. 50).

This is how science parks fulfill their ‘regional development’ purpose i.e. they act as magnets to attract supporting industries such as banking, consulting and other services that come to serve the whole region (Löwegren, 2003, p. 33). In this sense science parks can act as the “miraculous formula” that help authorities to revitalize and reindustrialize less prosperous regions (Ibid).

Networking effect and the knowledge flow

One of the main assumed benefits of being located in a science park is the networking effect through which firms can tap into a web of knowledge external to their own in order to increase their innovativeness. Chan and Pretorius (2007) claim that firms who ‘innovate alone’ face problems of inefficiency and unsustainability and recommend networking as a solution through which they can “acquire, develop and share information, knowledge and other resources” (p. 1926). Inside a science park, these networks can be formed between firms, university and other higher education institutes, suppliers, customers and researchers (Löfsten & Lindelöf, 2005, p. 1027). As a consequence of this networking, knowledge flow is enabled across the science park which creates an environment desirable for knowledge and information circulation.

The literature on knowledge flow suggests two categories on this matter. Chan et al. (2008) categorize knowledge flow into intended or *knowledge transfer* where knowledge is “exchanged with intended people or organizations” and unintended or *knowledge spillover* where knowledge is “exchanged unwillingly outside the intended boundary” (p. 445). They go on to conclude that the positive effects of knowledge transfer are negatively affected by knowledge spillovers and some firms (more successful ones perhaps) tend to locate farther from science parks or other agglomerations to avoid having their core capabilities being imitated (ibid,P.443). Similarly, Christopherson et al. (2008) distinguish *knowledge transfer* from *knowledge exchange* claiming that the former represents a rather linear and unidirectional knowledge flow (mainly from university to industry) while the latter manifests a more complex non linear relationship (p. 169).

Therefore evidence from the literature suggests a rather twofold view on the knowledge flow concept. Despite this negativity towards knowledge spillovers, researchers associate innovative performance to this type of knowledge flow rather than knowledge transfer (Chan et al. 2008, p. 447). There seems to be a need for a reevaluation regarding knowledge flow especially within firms in proximity or in this case science parks. Squicciarini (2009) acknowledges that knowledge spillover can be both positive and negative and recommends science park managers to supervise and channel these spillovers toward increasing their tenant firms' innovativeness (p. 171). This supervised knowledge spillovers within a science park would help firms reduce the uncertainties of being involved in innovation activities (Gilbert et al. 2008, p.406).

Needless to say, the strength of the networks created as well as the expected knowledge flow is heavily affected by the dynamic effects of the proximity factor i.e. elements such as trust and openness are decisive in firms' willingness to establish linkages with other firms and share their knowledge with them. Thus one can argue that the aforementioned clustering characteristic can amplify the effects of the networking and ultimately knowledge flow within a science park.

As noted earlier, the knowledge flow occurs provided that the networks are in place between actors in the park. These networks can be divided into formal and informal. Within formal networks, as Chan and Pretorius (2007) suggest, "participating organizations are bound by an explicit agreement to achieve their common objective requiring some level of coordination of actions and resources" (p. 1926). These formal networks include activities such as R&D collaborations and partnerships (Ibid), strategic as well as cooperative alliances, licensing (Löfsten & Lindelöf, 2005, p. 1027). Informal networks on the other hand are not necessarily indentured by explicit agreements and mainly take the form of social interactions such as meetings, discussions and conferences (ibid) and are to a great extend based on affection, trust and mutual interests (Westhead & Batstone, 1999, p. 131).

When it comes to networking and knowledge flow, universities are one of the most crucial parts of the equation. Establishing linkages between different entities to these sources of knowledge generation is essential in the concept of science parks. More on such linkages and their supervision by science parks will be discussed within sections on universities and the management function (coming two sections).

Similar to clustering, the networking effect of science parks is also not limited to physical boundaries of the park and the knowledge flow, whether spillover or exchange, can spread to actors located outside perimeters of the park. Chan et al. (2010) studied the knowledge exchange behavior of firms located inside Innovation Hub in South Africa and concluded that linkages to firms located outside -yet rather close- to the park not only constitute the majority of on park firms' networks but also that these linkages provide better and more effective technological knowledge exchange as opposed to links to on park firms (p. 224). Inability to create such outward networks by science parks and their managers means that tenants are not connected to global networks and unable to enjoy a solid inflow of knowledge. This in turn constrains them to only locally available knowledge and competences thus increasing the possibility of technological and cooperative lock-in situations (Christopherson et al, 2008, P. 168). Asheim (2007) however, claims that science parks in general have been unable to create such linkages as he questions their ability to connect firms together or to other entities through innovative networks (p. 231).

Nevertheless, not everything is science park related; how much these firms benefit from availability of such networks depends mainly on themselves and their level of *absorptive capacity.* Soo and Devinney (2003) claim “although the firm's formal and informal networks of interaction can be important sources of knowledge, the firm's own innate capacity to absorb and learn is crucial” (p. 5). Cohen and Levinthal (1990) conclude that the ability of a firm to evaluate and recognize external knowledge and further utilizing them for commercial ends stems from within the firm and is a function of that firm's prior related knowledge (p. 128). They also suggest 'R&D investment' as the main indicator to determine a firm’s absorptive capacity (ibid, P. 138). Mowery et al. (1996), recognize the importance of firms' absorptive capacity with regards to technology transfer and take into account patents, size of the firm and 'intent to learn' as important measuring indicators (pp. 80-81).

Universities and other HEI Linkages

From the stated definitions and purposes of science parks, it is clear that universities and other higher education institutions (HEI) rest at the core of the science park concept. As noted earlier, science parks as segments of the regional supportive infrastructure are envisioned to facilitate a systematic involvement between the knowledge generation subsystem actors (university and other HEI) and knowledge exploitation actors (e.g. firms inside science park). In fact a major portion of science parks' mission is to provide university-industry linkages, technology transfer and commercialization of university research (Massey et al. 1992, p. 34). Science parks provide two different channels to disseminate the generated knowledge from universities; firstly, 'academic start ups' where academics take out knowledge from universities' laboratories into the market by establishing their own firms in the park. And secondly, through *tapping in* where non academic firms take advantage of the knowledge and resources provided by the university (Ibid). The two resemble what was earlier introduced as HEI spin off and professional spin off respectively.

Monck e. al. (1988) dug more in detail into this subject and suggested more forms of linkages between science park firms and their hosting university or HEI:

- The transfer of people including founder-members of firms, key personnel and staff into employment in firms.
- The transfer of knowledge (often embodied in the above personnel);
- Contract or sponsoring research in the university by researchers and students;
- Contract development, design, analysis, testing, evaluation etc.;
- Access to university facilities such as libraries, and especially journals;
- Less formal interchange with academics which may lead to the important exchange of information, or provide access to a network of people and resources. (p. 167)

In the same study they analyzed firms located inside UK science parks and their linkages with the HEI and host universities. Their results suggest that informal contracts, access to research equipment and graduate employment are the most common linkages with the HEI while libraries and recreation provision are the most used facilities of the universities (ibid, pp170-172).

Löfsten and Lindelöf in their series of papers and studies on Swedish science parks have found more positive results compared to many other studies in this field. In their 2002 paper they concluded that On-park firms have more and stronger links to the HEI and university compared to their Off-park samples. Moreover they include that these linkages are mostly in terms of what they call “low-level contacts” such as recruitment of graduates and other informal contacts with academe along with a stronger emphasis on utilizing equipments and R&D personnel and facilities (Löfsten & Lindelöf, 2002, pp. 870-871). Similar conclusion is made in their 2004 paper after trying to trace a relation between proximity and HEI linkages. They conclude that despite no significant relation between HEI links and firms' performance, it is rather clear that on-park sample relies more heavily on collaboration with universities in terms of formal contacts with academics, access to R&D equipment, R&D documents, and recruitment of university graduates (Lindelöf & Löfsten, 2004, p. 320).

Squicciarini (2009), studied firms located inside Finnish science parks and concluded that universities can in fact hinder innovativeness of firms in terms of their patenting activities. However, he concluded that this is the case only in short term and on the long run firms would be able to benefit from HEI linkages and proximity to university if they spend a ”long enough” time inside a park. (pp. 182-185). Westhead and Batstone (1999), suggest that science park firms through linkages with the HEI would have the opportunity of decreasing their R&D costs in terms of personnel and risks while simultaneously acquiring and disseminating technical knowledge (p. 146).

These interactions are of course not unique to within science parks but having the clustering and networking effects in mind one can argue that the benefits of having HEI linkages would be intensified within boundaries of a park. For instance, created linkages between firms and the hosting HEI are in fact results of the networks established within that park. Thus arguably the better a science park manages the networking effect (or clustering for that matter) the stronger and more efficient these linkages would be. So yet again it is pointed out to the connectivity of these characteristics as they each represent a holistic part of the science park concept as a whole.

Management Function

A large number of studies (see Fukugawa, 2006, p. 386 for a list of some of these studies) point out to a non unanimous and rather dissimilar set of contributions of science parks to their tenant firms. Adding to the perplexity of this value added assessment is the fact that different actors and entities have different expectations from locating/interacting within a science park i.e. universities, local governments, banks, firms and other stakeholders have different objectives which should be fulfilled by the park and its management (Monck et al. 1988, p. 239). It is argued then that such expectations rather implicitly[2] form a science park's purpose and mission. This is due to the fact that a science park's mission is the result of a prioritization of different actors' demands by the management of that park (Bigliardi et al. 2006, p. 491).

Physical structure of a park management, mostly referred to as a 'management agreement' can be crucial in this context (Westhead & Batstone, 1999, p. 134). Management agreements in general can be of three types;

- *informal teams* in which management responsibilities are divided and shared among partners and stakeholders while property based dimension is handled by local authorities or development agencies,
- *single on-site management* who has either academic background or industry related experience and property dimension could as well be the responsibility of local authorities
- *on-site management company* which is rather uncommon and a set of representatives from stakeholders and partners are to handle property as well as other dimensions of the park (Ibid).

Science parks with the first type of management are referred to as 'non-managed parks' and the latter two correspond to 'managed science parks' which were introduced in the introduction section. The difference between the two is that in the former, management helps their tenants by guiding tenants to third party business support entities while in the former support is given directly by the management (Ferguson & Olofsson, 2004, pp. 6-7). A good example in this regard would be the case of financial support where in managed science parks provide their tenants with direct 'seed corn' funds but in non-managed parks, firms are assisted in "identifying relevant external funding opportunities" (Westhead P. , 1997, p. 59).

Regardless of the type of management agreements, science parks should fulfill their management function. It should be noted that sometimes what is referred to as management function corresponds to a marginal part of what science parks' management should perform. For instance UKSPA limits the concept of management function to being "actively engaged in the

[2]Bigliardi et al. (2006) claim that the science park's statutes (where institutional goals are written) is a 'generic statement' and they are not a good source for extracting aims and purposes of a science park (p.491)

transfer of technology and business skills to the organization on site" (Monck et al. 1988, p. 64). However, in this paper the importance of management function is acknowledged and it is seen as the key to deliverance of benefits stemming from all the aforementioned characteristics of science parks i.e. clustering, networking and HEI linkages. Chan et al. (2008) provide a more concrete definition of the concept as they assert that management function is:

a formal administrative structure to manage the property on the park and/or to manage the delivery of auxiliary activities and professional services required by firms located on science parks, with a focus on channeling information and resources to the on-park firms by providing networking services both internal amongst on-park firms and HEIs as well as external with customers, collaborators, and potential investors (p. 445).

Thus creation of formal as well as informal linkages aimed to facilitate the knowledge flow within a park and connecting tenants to the local HEI as well as global networks is the direct consequence of management function in a park. Löfsten and Lindelöf (2002) claim that park managers not only play a crucial role in creating linkages, they also advocate development of formal links over time (p. 870).

As mentioned before, due to their newness and smallness, NTBFs lack business knowledge and expertise and thus rely heavily on informal linkages to outside sources such as HEIs and their academics. Westhead and Batstone (1999) claim that management function of a park should help its tenants overcome this hurdle by providing them with related business, marketing and accounting advice which is done either by establishing training programs at the local university or other external training providers such as local economic development department (p. 135). These external trainings can in turn enhance firms' absorptive capacity (Cohen & Levinthal, 1990, p. 129).

Park managers should also facilitate what Monck et al. (1988) refer to as "social engineering" through which not only firms and academics are brought closer but also they become aware of their capabilities as well as their common interest (p. 189). This is an important responsibility as firms within a park are not usually aware of the local HEI skills and capabilities (and vice versa) thus science park managers should 'facilitate communication' between the two through meetings, presentations by academics, magazines and seminars (ibid, p.58). The social engineering concept can be used to facilitate informal linkages as well. In this sense, management function should contain policies to encourage their tenants to use different facilities inside the park such as shared social and recreational areas (Westhead & Batstone, 1999, p. 135).

Regarding clustering, as mentioned earlier, mere collocation of economic subsystems (in this case in a science park) would not necessarily produce economic benefits. In this sense, management function should act as the “continuous organizational and institutional support” required to facilitate the collective learning between actors thus giving way to creation and development of clustering effects and its presumed benefits (Moodysson, 2007, p. 38). Here, science parks' management can set up plans to link NTBFs together through for instance, conferences and tenant clubs to facilitate the knowledge sharing between these firms and help them acquire useful and essential contacts (Löwegren, 2003, p. 39).

Therefore, it is evident that the stimulation of benefits associated to the characteristics of science parks depends heavily on implementation of the management function. Thus it can be argued that whether this function is implemented or not makes the difference between science parks and simple firm hotels. As opposed to the full potential of science parks and what was explained, these firm hotels are only “real estate developments primarily designed to accommodate high-tech firms” (Monck et al. 1988, P.64). In this sense and as the definition by Chan suggests (above), science parks either focus on property based needs of their tenants thus working as mere landlords ‘and/or’ they try to channel required resources to their tenants by implementing the management function.

As mentioned in the section on NTBFs, there are three groups of resources required for them to develop and grow. Management function as pointed out by literature can be seen as a catalyst which makes the science park characteristics and their expected benefits to serve as resources for their inhabiting tenants and NTBFs. A summary of what was introduced in this chapter can be seen in table 2.1. The resource categories and required resources by NTBFs are taken mainly from the literature related to resource-based views and the third column, what science parks can offer, is taken from the literature associated with science parks and their management.

Table 2.1 science parks' Management Function from a resource-based view

Resources category	**Resources required by NTBFs**	**science park (management) can offer**
Physical Capital [a]	- funds - space and geographical location [a b] - production equipment and physical technology [a b]	- Seed corn finance [e] - Act as brokers, links to private and public sector funding sources [f] - Hosting venture capitalists firms (VCFs) - Facilitating communication about HEI equipment - Flexible leasing agreements [f] - Office space and provision of common services [g] - Prestigious address and location [h]
Human Capital [a]	- Personnel [b] - Technological knowledge [b] - Relationships [a] - Experience and judgment [a] - Talent, Creativity and Skills [c] - Motivation [d]	- Tenant clubs, seminars and organized social events (social engineering) [i] - Management of social and recreational facilities within a park [f] - Promoting the use of local HEI's library facilities [f] and university journals [j] - High profile manager (gate keeper) who can act as an interface between academia and tenants [k]
Organizational Capital [a]	- Financial & Accounting knowledge [b] - Marketing knowledge [b] - Production knowledge [b] - General management knowledge [b] - Personnel management knowledge [b] - Informal inter as well as intra firm relationships [a] - Intra-firm learning [d]	- Establishing business training programs at the local HEI [f] - Provision of businesses advice by on-site management [g] who has expertise in financial matters [k] - Utilization of external training programs [f] - Host consultancy and business service firms [k]

[a] Barney 1991, P.101

[b] Löwegren 2003, P.39

[c] Chen 2008, P.94

[d] Hansson 2004,P.361

[e] Westhead 1997, P.59

[f] Westhead & Batstone 1999, P.135

[g] Monck et al. 1988, P.190

[h] Ferguson & Olofsson 2004,P.5

[i] Monck et al. 1988,P.189

[j] Monck et al. 1988, P.16

[k] Cabral, R. 1998a, P.723

Chapter 3

3. Focused vs. general science park

As mentioned in the introduction, the aim of this thesis is to see whether the type of science parks will have any effect on performance of their residing tenants. To this end, a new categorization was proposed; focused and general. It should be noted that the word ‘focused’ was chosen instead of alternatives such as specialized or dedicated. This was done as the two latter options could suggest an unnecessary sense of excellence in what a science park offers with regard to the sector it hosts which might be credit where it is not necessarily due.

To the best of my knowledge there is no previous definition or categorization of science parks into these two groups and there is a certain lack of direct theoretical foundation. This calls out for a fresh definition of the two concepts which further bears witness to the novelty of this study. In this paper then, a focused science park is referred to a property based initiative aimed to achieve regional economic growth, commercialize academic knowledge and create employment by providing a management function to small technology based firms belonging to one and only one specific high tech sector or industry (e.g. only IT or only Life sciences). Worthy to mention here is that fields in the parks such as banking, financing, services and other non high-tech are not considered in this definition and are rather taken as a small –though not insignificant- part of any science park.

General science parks on the other hand share similar goals and functions with the focused science parks with the difference being that they host firms belonging to two or more different high-tech sectors or industries (for example IT and Life sciences). Sherbrook Innopole in Canada, Technopark in Switzerland and High Tech Campus Eindhoven in Netherlands who specialize in life sciences are examples of focused science parks and Symbion SP in Denmark, Technopole Rennes Atalante in France and The Research Triangle Park in the US who host firms from ICT and life sciences could be categorized in the general SP group (IASP, 2010).

Forming a Hypothesis

The assumption here is that focused and general science parks would behave differently which ultimately affects their tenant firms' performance. Literature on agglomeration economics suggests two categorizations in this regard; 'Urbanization economics' which "are associated with benefits that arise as the result of co-location of unrelated actors" similar to a general science park and 'Localization economics' which refer to "benefits that arise as the result of co-location of related or similar actors" thus resembling a focused science park (Moodysson, 2007, p. 31). The arguments in favor of the latter seem to overpower the former mainly based on the concept of embedded knowledge; agglomeration of firms from a single sector will increase the speed of knowledge accumulation and leads to a richer embedded knowledge in the area based on the knowledge base of those firms. This is why despite a trend toward globalization, firms tend to cluster in places with strong specialized embedded knowledge (ibid, p.32).

Some literature, mainly based on the knowledge creation approach suggest on the one hand that diversity in sources of knowledge can be beneficial for innovative actors as they can take on more complex and novel ideas, but on the other hand it questions the 'complementarity' of such knowledge stemmed from dissimilar sources (Chan et al. 2008,p .447). This is based on a claim that transferring of unrelated knowledge could induce problems in absorption and utilization of that knowledge by receiving firms (ibid P.446). Chan et al (2010), in their study of firms' knowledge exchange behavior on Innovation HUB in South Africa (a general science park) conclude that networks and linkages between firms within a park tend to decrease due to a lack of complementarity which makes firms look for linkages outside the park with firms who have similar and related knowledge bases (p. 219). Cassiman et al. (2005) assert that "when the knowledge bases are unrelated, assimilation or application of the new knowledge is likely to be difficult and resource consuming, if not counter-productive" (p. 198). They also claim that there would be synergies formulated in firms as a consequence of 'technological relatedness' (Ibid).

This is what Knoben and Oerlemans (2006) refer to as 'technological proximity' and associate it with two different levels of analysis; general and dyadic (p. 77). The former as they claim is linked with the concept of absorptive capacity and implies that firms' capacity to absorb knowledge relies only on the firm itself (P.78). The latter however, relates to the concept of 'relative absorptive capacity' which suggests that firms' learning capacity is also dependent on the sources of knowledge being exchanged. They note that “the dyadic level of technological proximity states that firms must have comparable knowledge bases in order to be able to recognize the opportunities offered by collaboration, but a different specialized knowledge base in order to permit effective and creative utilization of new knowledge” (ibid). This means that agglomerated firms with *similar* general knowledge bases will benefit from interacting with each other if they have dissimilar *specialized* knowledge base. This relates to the concept of focused science park since clustered firms come from a similar general knowledge base for example life sciences but with different specialized knowledge bases like biotechnology, pharmaceuticals and medical technology.

Colombo (2003), claims that firms' knowledge base similarity is a positive ‘moderating factor’ in creating partnerships, alliances and ultimately knowledge transfer despite the availability of unintended knowledge and information leakage (pp. 1213-1214). Desrochers (2001) claims that “geographical concentration of related firms balance cooperative and competitive forms of economic activity, leading to greater innovation and flexibility (p. 29).

Thus, it is clear that the literature leans in favor of the concentration in the focused science parks. Hence, from a theory stand point focused science parks compared to their general counterparts provide more potential and opportunity for their tenants. Hence the following hypothesis is formed:

Hypothesis: focused science parks provide a more favorable environment for their tenants' performance compared to general science parks.

Chapter 4

4. Methodology

In this chapter the research methodology is explained followed by a section representing the cases used in the study. At the end of the chapter, an overview of the database used for this study and a brief description on the process of data collection and filtering is provided.

Research Methodology and Performance indicators

Based on the hypothesis, focused science parks are assumed to provide better opportunities for their tenants. A comparative study approach constituting the research design of this paper can be utilized to analyze this assumption. In this sense, in order to point out to any differences stemming from being located in different types of science parks, several performance indicators related to firms from both groups should be measured.

The framework of measurements in this paper is taken from the work of Murphy et al. (1996) and their study of performance measurements based on literature and works previously done on the subject. Their study suggested that firm performance measures fall into one of eight dimensions of efficiency, growth, profit, size, liquidity, success/failure, market share and leverage which are in ascending order on the basis of frequency of usage in firm performance studies (p. 16). Each dimension then is assigned with several indicators which are similarly weighted based on popularity of use. Venkatraman and Ramanujam (1986) refer to these as 'financial performance' indicators which are presumed to represent the overall economic goals of every firm (p. 803).

In this study in order to increase reliability and accuracy, a multi-dimensional approach is taken into account. In this sense, the top five dimensions are chosen as the basis of comparison between the two groups i.e. efficiency, growth, profit, size and liquidity along with their constituting *indicators* pointed out by Murphy et al's study. It should be noted that in their study, they concluded that correlation between indicators within any dimension is "not substantive and potentially due to chance" (p. 20). This as they claim, is even the case with correlations that are statistically significant. Consequently this thesis refrains from finding correlations between indicators.

With regard to the growth dimension, another method was chosen which varied from Murphy’s two suggested indicators (changes in sales and changes in assets). Löfsten and Lindelöf (2001) claim that “growth must be seen as employment growth and sales growth” and suggest that both aspects should be considered (p. 314). In this sense, a similar approach to their study is applied here through which employment growth and sales growth are calculated from the following formula (Ibid, P.315):

$$growth\%/Year = \frac{\left(\frac{X_{n+1}}{X_n}\right) - 1 + \left(\frac{X_{n+2}}{X_{n+1}}\right) - 1}{2}$$

Where X_n = value for year n and n is the base year.

These financial indicators were put together in a table and an independent T-test was performed which will be discussed in the next chapter. Moreover, other comparisons are performed on characteristics of the two groups to point out to any differences between them. These comparisons include illustrations of differences in age, size and fields of practice among others. Needless to say, the size dimension is analyzed within these illustrations instead of being included in the T-test.

Case Representation

According to the literature review, most studies done on science parks take the form of comparing On-park vs. Off-park firms to analyze availability and degree of value-added contribution of parks to their tenants (e.g. Monck et al 1988, Westhead 1997, Löfsten & Lindelöf 2002, Lindelöf & Löfsten 2003, Ferguson & Olofsson 2004, Malairaja & Zawdie 2008). This approach is seen as a “logical way to assess the performance of science parks” (Löfsten & Lindelöf, 2001, p. 313).

In this paper however, similar evaluation comparison approach is performed but on an on-park vs. on-park sample as all the firms are located inside science parks. This approach can be a solid tool for analysis since our two groups of study have similar ‘core objectives’ but feature slight differences (Ibid). In order to carry out a reliable comparison, firms from both data sets (focused and general) should be filtered properly. The filtering criteria in this study are age, industry, location and size of the firms.[3]

As mentioned before, NTBFs in this paper are taken new as well as small. So the definitions introduced in the first chapter can be taken as criteria for age and size. This narrows down firms to those of less than 25 years of age and those categorized as small with less than 50 employees.

All firms are residents of science parks in different parts of Sweden. Information on every science park and its hosting area or region is provided in the coming sections.

Table 4.1 Overview of science parks in this study

#	Name of science park	City (Cluster [j])	Fields of Study [fi]	Grouping in this study
1	Ideon	Lund (Medicon valley)	Life-sciences, IT, Mobile telephony and Cleantech	General
2	Medeon	Malmö (Medicon Valley)	Life-sciences	Focused
3	Uminova	Umeå (Biotech Umeå)	ICT, Cleantech, Life sciences	General
4	Karolinska	Stockholm (Stockholm-Uppsala)	Life-sciences	Focused
5	Sahlgrenska	Göteborg	Life-sciences	Focused

[j] if available

[fi] taken from website of each park, links are provided in the references section

Life-sciences were taken as the industry in practice for this study. Asheim (2007), claims sub categories of life-sciences such as biotechnology and pharmaceuticals belong to analytical

[3]Westhead (1997) and series of papers by Löfsten and Lindelöf (2002, 2003, 2004) also use *'type of ownership'* in their (matching) criteria. But in this paper due to a lack of availability of such information and to maintain a reasonable scale of data sample this criteria was not considered.

knowledge base where firms despite having their own R&D departments, also rely heavily on research, experiments and trainings of university (p. 225). This increases the importance of university-industry links and networks which manifests itself mainly in the form of establishment of spin-offs (Ibid). Similarly, Moodysson et al. (2008) associate life-science industry with 'open innovation' meaning firms rely to a great extent on exogenous sources of knowledge (p. 1040) similar to those provided by science parks.

Moreover, it was necessary to choose the industry in a way that the database would end up with a reasonable number of parks from both groups and life sciences fulfilled this condition. As shown in table 4.1 there are five science parks in Sweden who are eligible for the purpose of this study. Two are categorized as general science parks and three are grouped in the focused sample.

All science parks in this study are members of Swedish Incubator and Science Parks (SiSP) which connects 95 percent of all Swedish science parks and incubators together. SiSP functions as a communication channel which enables its members to share experience, knowledge and information and is aimed at creating better possibilities for commercialization of innovations and increasing collaboration and cooperation (SiSP, 2010).

In what follows a brief description of each science park is provided. Hosting region and cluster (if available) is introduced ahead of its member park to create a better picture of that park's surrounding environment.

Medicon Valley Life-science Cluster

The southernmost part of Sweden is home to a great number of life-science firms which along with their Danish counterparts[4] constitute the largest life-science cluster in Scandinavia; Medicon Valley (Medicon Valley Online, 2010). With its employments of more than 6000 life scientists, this area has a strong embedded knowledge and R&D infrastructure and is host to large pharmaceutical companies such as AstraZeneca and BioInvent (Coenen, 2007, p. 812). In fact more than 60% of Scandinavian pharmaceutical companies are residing in this very region which is also host to 11 universities and 26 hospital units (Moodysson, 2007, p. 26). Beside the Danish and Swedish regional authorities, organizations such as Medicon Valley Alliance also

[4]Skåne (or Scania) along with the Greater Copenhagen area constitute the Öresund Region (source:Wikipedia)

operate within the life-science cluster to create synergies, stimulate recognition and economic growth for the constituting members which include all relevant universities, hospitals and life-science firms (Medicon Valley Online, 2010). Ideon Science Park in Lund and Medeon in Malmö are two important components in Medicon Valley life-science cluster.

Ideon Science Park (General)

Ideon Science Park is located in small town of Lund and is home to 260 companies who employ more than 3000 people operating within IT, cleantech, life science, biotech and telecom (Ideon, 2010). Ideon was initiated by regional industry representatives and regional policy makers in 1983 as a response to closure of heavy industries such as shipbuilding and textile. The park was constructed to make use of knowledge and research done by different faculties in Lund University which is considered the main actor of the knowledge generating subsystem of the region (Coenen, 2007, p. 812). The Faculty of Science and faculty of Engineering (LTH) along with Faculty of Medicine and its six comprising departments (Departments of Experimental Medical Science, Health Science, Clinical Sciences and Laboratory Medicine) (LU, 2010) are the main sources of knowledge, specifically for the park and also for the cluster (Medicon Valley Online, 2010).

Ideon's properties are managed by two well known property companies who handle the office space in the park (Ideon, 2010). Other areas of management are supervised through three different organizations; Ideon Center, which is responsible for maintaining a stimulating environment through providing networks, infrastructure and other services to the inhabitants (Ibid). Ideon Business, who provide companies with knowledge and expertise on how to run their firms in areas such as financing, accounting, leadership, patent and law (Ibid). Ideon Innovation which consists of twenty incubator companies makes up for a competitive incubation program whose entry requirements include 'innovative distinction and excellent market potential' and helps hard working entrepreneurs to turn their ideas into successful businesses (Ibid). Ideon also provides its members with conference rooms both in large size for seminars and small for board meetings.

Medeon Science Park (Focused)

Medeon Science Park is located in Malmö in southernmost part of Sweden which is the third largest city in the country (visit http://en.wikipedia.org/wiki/Malmo for more information). The city is connected to Copenhagen Denmark through Öresund Bridge which brings the two regions closer to each other. Malmö is host to Malmö University which consists of five interdisciplinary faculties, two of which work directly with life-sciences namely faculty of Health and Society which educates "nurses, social workers, public health scientists and biomedical scientists" and faculty of Odontology which provides education and research in dental fields (MU, 2010). Note that presentation of Malmö University within the section for Medeon (and Lund University within the section dedicated to Ideon) does not in any way suggest an exclusive link between the university and the park as both universities are important contributors to the whole region.

Medeon Science Park is host to 30 companies within life-sciences and its sub fields such as pharmaceuticals, biotechnology, medical technology and healthcare (Medeon, 2010). Medeon connects its tenants with other actors in life-sciences such as university academics, hospital employees, other researchers and entrepreneurs through seminars and meetings in order to provide them with potential contacts to the industry and academia (Medeon, 2010). The park also provides educational, training and advisory programs in fields of legal, accounting, business counseling along with other services such as linkages to venture capital groups which are mainly integrated in their incubation program (Ibid).

Stockholm Life-Science Cluster

Stockholm in central Sweden together with some areas in Uppsala constitute Stockholm life-science cluster (or Stockholm/Uppsala cluster) and alongside Medicon Valley they represent Sweden's two solely [globally] recognized life science clusters (MBBNET, 2010). This cluster is ranked third best in Europe and is host to more than 500 life-science firms and more than 25000 employees (Stockholm Business Region, 2010). Biovitrum, Pfizer and GE healthcare are exemplary well known firms residing in the region (Ibid).

The area is rich in terms of knowledge and human resources thanks to six medical universities and three university hospitals (SULS, 2010). The cluster organization provides their tenants and interested bodies with networking opportunities through seminars and lectures as well as an ‘info bank’ which provides information on ongoing projects, researchers, publications and companies (Ibid). Info bank is a useful database not only for residing firms but also for entrepreneurs and investors.

Karolinska Science Park (Focused)

Karolinska Science Park is the youngest park in my sample and was established in 2006 (SiSP, 2010) with the purpose of commercializing knowledge and innovation stemmed from Karolinska Institutet (university) which is Sweden’s largest center for medical research with its 22 different medical departments (SSCF, 2010). The park also has close collaborations with The Royal Institute of Technology KTH and Södertörns University (Karolinska institutet, 2010).

Karolinska is dedicated to life-sciences and is host to 54 (including services) firms. Tenants are provided with high quality laboratories and equipments as well as office space to fulfill the needs of newly established as well as more mature firms (Ibid). Seminars and meetings are held regularly by the park in order to enable a smoother transfer of knowledge and facilitating networking opportunities for younger firms. Karolinska Science Park is a part of ‘Stockholm Science City Foundation’ whose mission is strengthening the life science sector in Stockholm region by attracting research and business through various projects such as constructing new university hospitals and new laboratories (SSCF, 2010).

Göteborg Region

Göteborg (or Gothenburg) is located on the west coast of Sweden and is home to about 400 life-science companies who employ around 7000 people (Business Region Göteborg, 2010). Its geographical location makes it a desirable location for life-science companies as it lies in close accessible distant from the two previously mentioned life-science clusters. The region is well known in areas such as “cardiovascular diseases, metabolic diseases such as diabetes and obesity, and biomaterials and cell therapy” (ibid). In fact stem-cell research in the western part of

Sweden attributes a large percentage of this field in the world. However, despite having a strong suite in life sciences, the regional authorities rather concentrate on a small part of the industry; biotechnology.

GöteborgBio organization is responsible for improving the biomedical –as well as other life-sciences- field in the region of Göteborg. To this end, they attract capital and expertise, develop and improve the infrastructure, reinforce the turnover of R&D and facilitate commercialization of knowledge in the field of biomedicine onto the region (GöteborgBIO, 2010). GöteborgBio along with regional authorities help improve the image of the life-science sector through seminars, conferences and international trade fairs (Business Region Göteborg, 2010).

Sahlgrenska Science Park (Focused)

Sahlgrenska Science Park was established in 1998 as an initiative by two main regional authorities; the Business Region Göteborg and Region VästraGötaland (SiSP, 2010). Sahlgrenska is located inside Medicinareberget complex which comprises of three major sections; Sahlgrenska University Hospital which is the largest hospital in Northern Europe, Chalmers Technology University and Sahlgrenska Academy which is the health faculty of the University of Gothenburg (Business Region Göteborg, 2010). This complex serves as a useful resource pool for firms in the park in fields of biomedicine, odontology, clinical science and medicine to name a few (Sahlgrenska, 2010).

Management of the park provides their tenants with a network of investors, consultants and other firms in the field both inside and outside the region (Ibid). Similar to other parks in the sample this is carried out through seminars and conferences as well as attracting related firms to reside in the park such as consulting and venture capital firms. However, Sahlgrenska's strong suite is their modern laboratory facilities and its ease of access for the residing firms.

Most of the financial support and business advice given by the park falls in their incubator section which aims to support newly established spin-offs. Previously mentioned *GöteborgBio* corresponds to a large proportion of financing while GU Holding, a company owned by the University of Gothenburg, provides firms with financial as well as other kinds or supports such as business and marketing advice (Ibid).

Biotech-Umeå Cluster

Umeå in northern part of Sweden is a fast growing life-science cluster which is host to more than 3000 employees in this field (Biotech Umeå, 2010). This region is home to two well known universities namely Umeå Univeristiy and Sweden University of Agricultural Sciences (SLU) which provide a strong source of knowledge for the region. Despite its harsh winters, Umeå with its highly educated population and low crime rates makes up for a desirable place for researchers and employees who come to the region from all around the globe. A regional investment agency called Västerbotten Investment Agency (VIA) is in charge of promoting Umeå's life-sciences cluster (among other available clusters) to domestic as well as foreign investors and entrepreneurs (VIA, 2010).

Closely working with VIA is the Umeå Biotech Industry Organisation (UmeåBIO) who also aims at helping the development of the life-science industry in northern part of Sweden (UmeåBIO, 2010). Their mission is to connect region's life-science firms together and to related entities such as universities, different ventures and research centers (Ibid).

Uminova Science Park (General)

Uminova Science Park was established in 1987 in Umeå and today is home to more than 41 firms within its 25 thousand square meter area (SiSP, 2010). As shown in table 4.1 Uminova hosts firms from life-sciences, ICT and Cleantech. The universities introduced earlier locate in very close proximity of the park which facilitates a smooth interaction between the three entities. Umeå University has been named the fourth best place outside the US for postdocs studies in the field of life-sciences (Umeå University, 2010) which bears witness to the importance as well as the excellence of life-sciences in this region.

Alongside the two universities, Norrlands University Hospital is located which corresponds to a major part of the training and education required by life-science firms and their employees (Uminova, 2010). The park provides conference facilities in different sizes to fit the needs of their tenants. However, it should be noted that unlike other parks in this study, Uminova does not cite any services and value added provisions to their tenants beside that of conferences and seminars. This of course, can be taken as a negative point for any science park.

Database and Selection

The data source used for this study was taken from *affärsdata* which contains information about Swedish firms and their financial annual reports. Access to the data source (website) was granted through Lund University Electronic Library Navigator (ELIN). Names of the firms in the sample were taken out from the website of each science park and their annual report was extracted from the data source accordingly.

The filtering criteria were applied then to separate out NTBFs from the large sample. *Age* of the firms was calculated by the year this study is conducted minus the year the company was registered in the affärsdata database. There were some firms which were established earlier (perhaps with other names or in other places than their current location) but to avoid shrinking the database even further, the *Registerdatum* (registering date in the system) was taken as the establishment date of the firm. Some of the firms are older than the science parks there are located in especially in case of Karolinska Institute which is a young science park. Since this study is more focused on growth effects of the parks on their tenants and not the survival effects, then the origin of the firms i.e. whether born inside the park for instance as startups or moved in after establishment- can be overlooked here.

The reports in the database (*affärsdata*) were structured to contain information for four years for every firm for example 2004-2008 or 2005-2009. But not all firms had reported for the whole period and some had reported for two or three years only. A three-year span from 2006 to 2008 was taken as the basis for this research; this was mainly because of high frequency of firms with reported data for this period. The fact that a three year span was chosen was that it would be representing a trend or continuity in a firm's performance in any given indicator as opposed to choosing one or two year spans. The alternative would have made it possible for a few firms with exceptional outcomes (whether positive or negative) to impose unnecessary leverage on the final results. In short, the aim is to generate results based on norms rather than exceptions. Moreover, the three-year span approach also fits perfectly with the formula chosen to calculate sales and employment growth as it produces the growth percentage for a three year time where 2006 would be the base year (‘n’ in the formula).

For each firm then, the average or mean value for the three years in study was calculated for every indicator. This was done on the basis that mean value is believed to contain the most information compared to other ‘single valued parameters’ (Löfsten & Lindelöf, 2002, p. 865).

Table 4.2 number of firms in each sample

	Focused SP Sample	General SP Sample
N	110	88
n	43	42

N number of firms in the science parks, including non high tech and services

n number of valid NTBFs (final sample)

Furthermore, to decrease the magnification of exceptions, entries that were significantly greater or smaller than others were omitted from that firm’s report in that year. This was done in two different ways; if a firm showed unrealistically significant results for the whole three years then that firm’s entry was replaced with the corresponding indicator’s mean. But if only one of the three years had significant entries, then only that entry was replaced with the mean of that indicator. This was done within indicators with only one or two of such exceptions and if their occurrence exceeded in number then they were included regardless of their significance. This was the case particularly for the ‘cash flow’ section where derivation is very high.

In this study incorporated firms were also considered in the data sample i.e. firms whose name remain the same but their organization number changes after becoming subsidiary for another firm or establishing a holding firm. This was done based on the fact that these firms, despite their link and relation to their parent firms, have their own independent financial records (McKelvie & Wiklund, 2010, p. 265). Furthermore, one-person-firms were also taken into account. Although this was helpful in maintaining the sample quantity, it had drawbacks such as having “0” as their employee number. This in turn led to many entries in ‘Sales per employee’ or ‘Personnel cost per employee’ to be zero or undefined. In these cases those firms were replaced by the mean of that indicator for that group.

As shown in table 4.2, after applying the filtering criteria and choosing firms with sufficient reported data, the sample consists of 43 NTBFs belonging to the focused group and 42 to the general group.

Chapter 5

5. Presentation of Results

In this section the gathered sample will be represented with regards to the two groups of firms previously introduced. As noted earlier, the aim here is to compare the two groups of firms in order to examine the assumption that a focused science park will provide a better environment for firms from a single industry but with different specializations. In that sense then, it is logical to note differences not only in financial performance of the firms but also in overall characteristics of them. Monck et al. (1988) claim “the performance of a firm, however, depends upon a number of factors such as size of the firms, its age and the sector in which it operates” (p. 90). Therefore the filtering criteria that were used to create this paper’s database, come to play yet one more time.

As shown in table 5.1, NTBFs in the focused sample are slightly younger than firms in the general sample with respectively 10.02 and 11.83. A simple explanation for this could be that focused parks in the sample are younger than parks in the general sample (except Medeon).

The number of employees in every firm represents the size of that firm and as mentioned in the methodology section the criteria for choosing NTBFs was to have less than 50 employees.

Table 5.1 Age and size comparison of the two samples

	Mean		Standard Deviation	
	Focused	**General**	**Focused**	**General**
Age	10.02	11.83	5.10	5.02
Size	7.29	5.98	10.60	7.75

As the table suggests, NTBFs in the focused sample tend to be larger in size compared to their counterparts in the general sample but the difference is not substantial. Noteworthy here is that the reported employee number could include scientific researchers as well as non scientific staff and access to information such as ‘proportion of qualified scientists and engineers’ or QSEs (Westhead P. , 1997, p. 47) was not available. Nevertheless, most employees of the firms in the sample are believed to be engineers and scientific researchers. This is mainly because of a large proportion of high research intensive categories in the whole sample and that most of the firms in both groups enjoy reception, cleaning and technical maintenance services provided by their hosting parks and therefore do not hire such employees in the first place.

Figure 5.1 Field of practice for NTBFs in the general sample

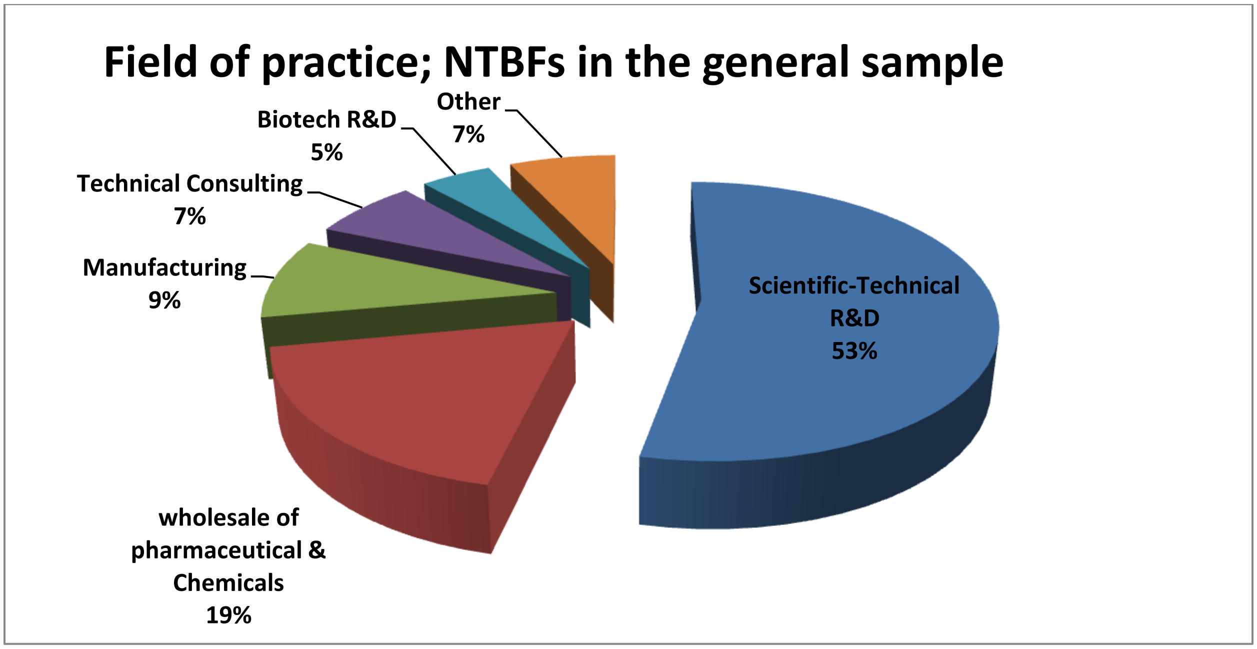
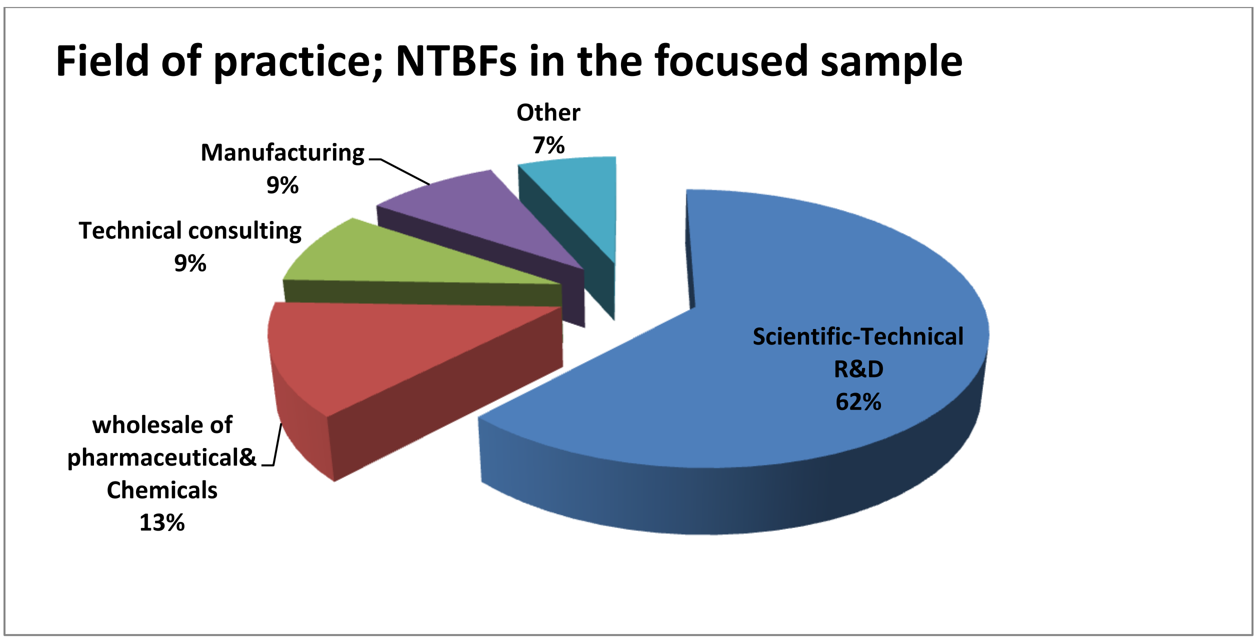


Figure 5.2 Fields of practice for NTBFs in the focused sample



Figures 5.1 and 5.2 show activities of firms residing in both groups. The activities are extracted from the annual reports of each firm which contains a specific code and name that is recognized by the system and the source database. Although these differentiations don't specify in detail the day to day activities of the firms, they could be utilized to point out to differences in the overall structure of the two samples. As expected, majority of NTBFs in both samples are involved in high-tech research and development with 62% in the focused parks sample and 53% in the general sample.

Grouping firms in the category 'wholesale of medicine and pharmaceutical goods' might be a bit misleading as firms in this category also rely on intense R&D; like many medical companies, most of these NTBFs are established solely on one or very few (perhaps patented) products which is usually achieved by their owner/entrepreneurs work and research. So although these companies act as production lines for their products they are also involved in R&D for incremental or radical improvements and even modifications according to needs of their customers. Nevertheless, a larger percentage of firms in the general sample correspond to this categorization. Products related to firms in this category include cosmetics, cancer related medicine and computer software for reading and analyzing medical data.

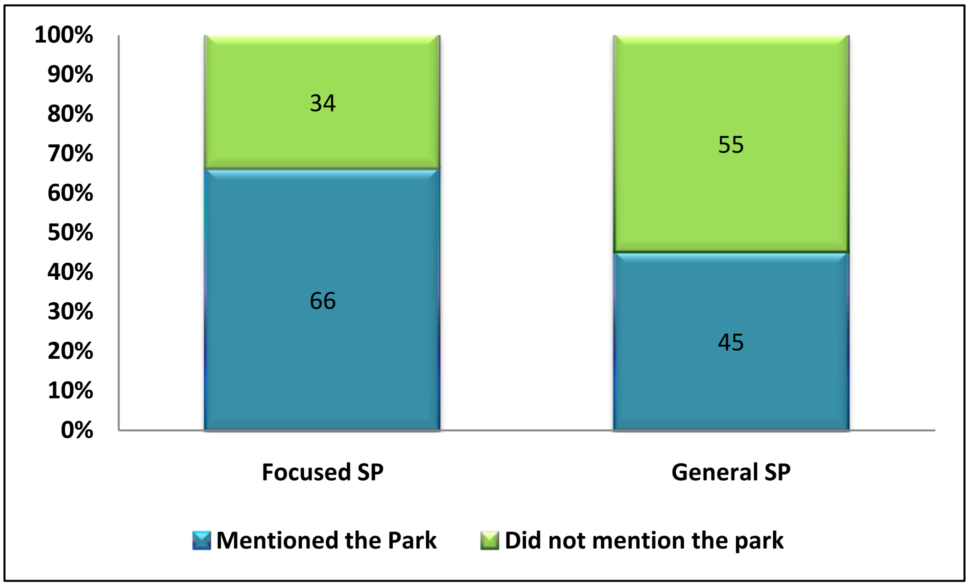
Identical results are seen in the manufacturing section which mostly contains firms who develop medical and electrical equipment or measuring instruments that are to be used in hospitals or other health care centers.

The fourth category is technical consulting and includes firms who provide their clients with scientific staff, researchers, laboratory experts and even related experiences in specific fields of life-sciences. Many of these firms work on contract based projects and most of their clients are in fact located inside the park itself. Both groups manifest similar percentage of consulting firms with 9 and 7 percent for focused and general groups respectively.

In order to further magnify the differences in characteristics of firms in the two samples a list was created of those firms who have mentioned the name of their hosting science park inside their website against those who have not. This is crucial since it would reveal information on how important *address* or *image* is for firms in different groups. As shown in figure 5.2, 66 percent of firms in the focused sample have mentioned their hosting park in their homepage compared to 45 percent of firms in the general sample.

An interesting point that was noticed during checking of firms' website was that only a handful of firms in the whole sample have mentioned any sort of involvement with the university in their proximity. Although this cannot necessarily be an evidence to a lack (or low levels) of involvement with the university, it can in fact raise some concern.

Figure 5.3 Percentage of firms which mentioned their host park



Results of the independent T-test are shown in table 5.4. Given the exploratory nature of this study, and to balance the risk of incorrectly reject the null hypothesis of no effect (a Type I error) and falsely not rejecting the null hypothesis (a Type II error), a 10% level of significance was chosen (e.g. Dana, 1985, p.69; Westhead, Ucbasaran & Wright, 2005, p. 399).

As mentioned in the methodology section, the performance dimensions and their indicators are taken from Murphy's study and based on the popularity or frequency of usage of each indicator in performance studies. For the efficiency dimension there were no statistically significant differences available. Note that both groups manifest negative percentage values for their return indicators which in case of the focused group is rather large.

In the second dimension we can observe interesting results. There are statistically significant differences between the two groups. Focused science parks manifest 28.01 percent growth in sales as opposed to only 10.4 percent in the general sample. Standard deviation of both groups is almost equal with 46.26 and 43.78 for focused and general parks respectively. Similarly in employment growth value, focused parks manifest better results with 28.37 % compared to their counterparts in the general grouping with only 1.68 percent.

Both indicators are significant at $p < 0.10$, with 0.075 for sales growth and 0.002 percent for employment growth. Thus, here sales and employment growth rates point to the statistically significant differences in the growth dimension in favor of the focused group.

With regard to the third dimension only one of the three indicators turned out to be statistically significant. Focused science parked scored a surprisingly low score of -3704.90 in 'cash flow from operations' while NTBFs in the general group tallied -511.05 in scale of thousand Swedish crowns. The difference here is rather large especially compared to other indicators where both groups' scores are in a close range.

The other two indicators in the liquidity dimension manifest no sign of significance. Similar can be said about the last dimension where none of the three indicators related to *profit* show significant results. However, in the profit section interestingly both groups depict large negative numbers followed by considerably large values in their standard deviation.

Table 5.2 Results of the independent T-Test

Dimensions	Indicators	Mean		SD		T-test [a]
Efficiency		Focused	General	Focused	General	P value
	Return on Assets ¥	-27.88	-16.37	51.20	42.15	0.262
	Return on Equity ¥	-51.93	-34.92	97.48	90.39	0.407
	Sales/Employee[e]	644.10	622.36	648.23	594.35	0.872
	Personnel cost/employee[e]	352.88	338.64	145.17	136.32	0.642
Growth						
	Sales Growth ¥	28.01	10.40	46.26	43.78	0.075+
	Employment Growth ¥	28.37	1.68	49.73	23.30	0.002*
Liquidity						
	Sales level [e]	3424.55	3553.14	6577.95	6418.67	0.928
	Cash flow from operations [e]	-3704.90	-511.05	5827.49	4863.38	0.007*
	Cash Liquidity [e]	405.74	439.21	409.37	550.83	0.751
Profit						
	Return on sales £	-2858.94	-2248.43	7603.47	7361.79	0.708
	Net profit margin £	-2900.36	-2343.48	7631.26	7673.01	0.738
	Gross margin[e]	-2893.05	-1633.44	7694.01	5903.88	0.400

[a] Independent two sample T-test + significant at p <. 0.10, * significant at p < 0.01
[e] in thousand crowns (TSEK)
¥ Percentage (%)
£ Percentage of total turnover

Chapter 6

6. Discussion

In this section the outcome of the comparisons done on the two groups are analyzed. This is accompanied by implications of the results and, if applicable, recommendations are also given to relevant actors. Finally, implications for future studies are introduced based on the observations done throughout this study.

Analyzing the differences

As mentioned in the results section, before the two groups were compared on the basis of their financial performances several illustrations were performed on them. This was done in order to detect differences in the characteristic of NTBFs residing in each group. Some of these characteristics can be said to have been induced by the environment the firms reside in. But one should take a precautionary approach before making conclusions, as there might not be a solid base for such causality. Altogether, these illustrations point out to similarities between the two groups despite minor exceptions.

Both groups manifested similar results in the *age* and *size* comparison and none stood out substantially based on either of the factors. However, the link between the two factors is rather interpretable. Ferguson and Olofsson (2004) claim that the combination of age and size is crucial in explaining firm growth (p. 8). Data showed that firms in focused science parks tend to be younger than firms in the general sample whilst they are in fact slightly bigger in size. This fits with Monck et al's (1988) claim that "in proportionate terms younger firms grow faster than older firms" (p. 213).

This however, does not rule out the influence of factors external to the firm such as characteristics of their locating environment (internal factor being firm's own age in this case). The fact that NTBFs in the focused sample show statistically significant higher rate of employment growth can be used to explain why they manifest larger employment number (size) compared to their counterparts in the general sample even though they are younger.

One point to have in mind here is that as firms grow in size or employment number, they would need larger space whether it is laboratory or office. Science parks then should provide their expanding tenants with a possibility to move into larger spaces. The provision of this task by the park management helps 'stabilize firms' location' (Massey et al. 1992, p.41) which is important for the firm as well as for the park itself. It is undesirable for a firm to be forced to move outside a park merely due to a need of acquiring larger space. On the other hand it is undesirable for the park as it would be a disfavor to their image especially if the firm is a successful one (in relative terms). Of course it seems natural for established firms to move to other locations so that smaller expanding firms (or larger relocating firms) in the park get to replace them and have the opportunity to grow. However, one cannot rule out the park management's agenda and perhaps their preference towards keeping some firms over others.

In this sense, the fact that firms in the focused sample manifest higher employment growth suggests that their hosting park can provide them with more opportunity to expand and grow in size. This becomes more evident when one has the expansion of the park itself in mind. Expansion of a focused science park (for instance involved in life-sciences) through constructing new buildings means opportunity for expanding tenant firms within the life-sciences to move to bigger premises i.e. possibility for all expanding firms within that science park.

However, in a general science park this is not the case as there are firms from other sectors competing for those areas. Furthermore, the new area or building would most probably be assigned to one certain field rather than hosting firms from multiple industries. This is specially the case if that building is to come with the related equipments. So expansion in a focused science parks means harder competition for expanding firms to get the new space but in a general park it could mean having no chance at all except for firms from a certain field. This is especially unfortunate for life-science firms in general science parks who are constantly being overshadowed by sectors such as IT[5] and the new building might be in fact 'yet another IT building'.

[5] An example would be in Ideon science park where initially life sciences were dominant but as of 1999 they are more centered on Information Technology (source: http://www.ideon.se/en/foeretag/)

This information could be crucial for entrepreneurs or CEOs with intentions to grow in size who would want to know which park provides them with better opportunities to execute their expansion plans.

From a discussion point of view there is an important factor which one should bear in mind when talking about employment growth and that is whether growth was via acquisition or organic. McKelvie and Wiklund (2010) refer to studies where acquisition of other firms was the main cause of increase in employment growth as opposed to stemming from ‘internal organic growth’ and suggests that through the former jobs are rather “simply added” but through the latter they are internally created (p. 266). But further he claims that growth via acquisition is almost exclusive to large and old firms hence does not correspond to firms in this study which are all small and young.

An important question here is whether or not this higher rate of employment growth means focused parks are more successful at employment creation than the general parks sample. Massey et al. (1992) analyzed a similar dilemma regarding higher rate of employment growth in their science park sample opposed to off-park firms all within the UK; they argued against the notion saying that the total park employment could in fact be affected by ‘a few firms’ who ‘relocate’ to the park and have not been established there initially and thus distorting the employment number and growth rate (p. 41). However this is not the case in this paper; firstly, as noted before this is a study of norms and not exceptions and through the filtering process it was made sure that no single or few firms would have unnecessary leverage on the overall outcome. And secondly, it was observed that except only four, all NTBFs in the sample showed no sign of relocation during the study period.

Therefore one can argue that focused science parks are in fact better stimulants for employment creation. This serves as an important finding for policy makers and local authorities as it points to focused science parks as better tools for carrying out employment objectives in their regions of interest. Moreover, it should be mentioned that this is even more significant in case of Sweden as firms’ employment growth is considered more contributive than establishing new firms (Löfsten & Lindelöf, 2001, p. 314).

Another statistically significant finding from the independent T-test revealed that NTBFs in the focused sample have a considerably higher rate of sales growth compared to NTBFs in general science parks. Brush et al. (2000) point out to the importance of sales growth for firms as they “influence factors that range from internal motivation to promotion and retention of talented employees all the way to the implied opportunities for investments in new equipment and technologies that upgrade the production process as a whole” (p. 456). Weinzimmer et al. (1998) link firms’ growth in sales to increase in their productivity level (p. 252). However they did not rule out other factors such as use of marketing strategies by firms which causes fluctuations in their sales level and ultimately sales growth (Ibid).

Whether higher sales growth of NTBFs in the focused parks mean in any way that they are more ‘successful’ than their counterparts in the general sample is quite a controversial question. Davidsson et al. (2009) rather sarcastically start their paper by saying “firms [sales] growth is almost universally portrayed as a good thing, and is commonly used as a measure of success” (p. 388). Based on resource-based views, they argued that achieving high sales growth without securing high profits does not lead to sustainable growth, improvements in profitability or increase in performance (Ibid, p. 400). Therefore, they recommend that managers instead of fixating on ‘maximizing growth’ should “be eager to build and identify the uniqueness of their resource endowments and transform them into product/market offerings that enable them to generate sufficient profits.” (Ibid)

Rather more positively, Brush et al. (2000) also investigated this matter and found enough evidence to support the notion that sales growth in fact leads to an increase in firms’ performance (p. 469). However, they concluded that this is only in case of firms who have low amounts of Free Cash Flow[6] circulating inside them and firms with ‘owner-managers’ who implement solid ‘governance’ within the firm in order to align shareholders and managers interest together to secure profits from the achieved sales growth (Ibid, P.470). McKelvie and Wiklund (2010) claim that accomplishing growth can act as a stimulus for future growth “similar to an entrepreneur getting a taste of success and being enticed into future growth” (p. 265).

Although these studies don’t draw a straight line between sales growth and increase in firms’ performance and profitability, they do unanimously magnify the importance of inner firm management and their role in turning sales growth into improvements of some sort. One thing to

[6] “undistributed cash flow in Excess of that needed for positive net present Value (NPV) projects” (Brush et al. 2000 P. 456)

have in mind is that constant and heavy demands are placed on firms' management. This pressure is mainly from investors, shareholders and venture capitalists that have provided them with funds and expect returns perhaps in a short-term period. Although high sales growth could be taken as a promising indication for these actors, it is probable that firms won't start achieving [high] profitability until several years later (Lindelöf & Löfsten, 2003, p. 257).

It is then recommended that investors and venture capitalists (VCs) should restrain themselves from encouraging firms to achieve high amount of sales growth (Davidsson et al. 2009, p. 389). This, on the long run threatens their profits and consistency of the firm itself. Science parks could hold annual informatory meetings and seminars in order to increase awareness about the risks and consequences of this matter to both firms and their investors. Moreover, parks' management should take precautionary measures to ensure that their residents' aims and goals are not altered by expectations of their VCs or investors. This is more serious in case of NTBFs in the focused sample as they have significantly lower amount of operational cash flow which suggests that they are currently producing less cash in return for performing their businesses. This perhaps makes them more vulnerable to having their main goals altered.

Considering the fact that a multidirectional approach was taken in this study, logically any conclusion about firms' financial behavior should be based on more than a single indicator within a certain dimension. Thus despite 'cash flow from operation' turned out to be statistically significant, no conclusion can be made regarding the *liquidity* dimension as there were no statistically significant differences in 'sales' and 'liquidity ratio'.

Similarly, there were no statistically significant results seen in other dimensions and as this is a comparison study, there is almost no point in dwelling on manifested numbers on individual basis. Thus it is concluded that there are no statistically significant differences between NTBFs in the focused and general science parks in terms of *efficiency, liquidity* and *profitability.*

Continuing on the illustrations done, interesting outcome can be seen in comparing fields of practice between firms in each sample. Both groups drew a similar overall portrait with signs of heavy reliance on research and development. This reliance on R&D however, is more prevalence in the focused group which points out once again to their stronger *concentration* *characteristic* which is exclusive in term of sector (life science) and dominant in field of practice.

The fact that there is preponderance of R&D in the focused sample does not in any way indicate more research and development efficiency nor higher R&D expenditure. Such interpretation cannot be done without analyzing R&D output measures such as number of patents and new products launched (Massey et al. 1992, p. 47). It should also be noted that this category could contain firms who are R&D oriented as well as firms who do R&D in terms of contract based projects for other firms.

Investigating firms' websites to check naming of their hosting parks revealed fascinating information as a bigger proportion of firms in the focused sample did so compared to their counterparts in the general sample. As noted earlier in table 2.1, science parks provide their tenants with a [prestigious] image or address that can help them in establishing themselves in the market which is specifically important for newly established firms. Since NTBFs in the focused sample are younger in average, they are assumed to be more prone to *liabilities of newness* that ultimately makes them more in need of having to capitalize on the image and address value provided by their hosting park. It would be rather ambitious, if not fallacious, to conclude that focused science parks provide a better value added in this regard. But assuredly it can be said that NTBFs in the focused sample are keener on utilizing the so called 'image effect' (Ferguson & Olofsson, 2004, p. 5).

Rather disappointingly only a few firms have mentioned in their website their collaboration with the university in their proximity. This of course does not indicate the level of interaction between them but shows that no NTBF in either of the groups takes pride in mentioning their affiliating university. This is more surprising considering the excellence of universities mentioned in the paper as almost all of them rank high not only in Scandinavia but in Europe.

Conclusion and Summary

This thesis aimed to investigate if there are any differences in performance of firms stemming from the type of science park they reside in. Two groupings were proposed namely focused and general. This was to see if the two can be categorized as two 'types' of science parks. The literature leaned in favor of focused science parks and thus the hypothesis was formed to see if focused science parks provide a better environment for their tenants' performance compared to general science parks. In this sense, financial performance of NTBFs residing in both groups was analyzed along with several illustrations to reveal differences between their hosting parks. Initially a literature review was done to explore the concept of a science park without discriminating them based on their types.

The two groups were compared on the basis of *efficiency, liquidity, profit* and *growth.* There were no statistically significant differences seen in the first three dimensions. However, NTBFs in the focused sample scored higher in both indicators belonging to the *growth* dimension. Considering that the selection and filtering criteria in this paper was structured to narrow down the differentiating factors between firms to the type of park they reside in, it is argued that this empirical result is supportive evidence of an added value of focused science parks' location compared to general ones. Thus it is concluded that focused science parks provide a more desirable environment for their tenants' performance in terms of growth.

The illustrations done to compare the two groups also showed differences that can be used to distinguish the two groups from one another. In this sense, findings in this study point to visible and distinguishable differences between the two groups of science parks, both on their overall characteristics and their effects on performance of their tenants. Thus it can be argued that the two groups can in fact be used as different 'types of science parks.'

Hopefully insights from this study on the types of science parks can come to assist regional and local authorities to better form their policy guidelines and resources in order to more efficiently address their needs and objectives.

Implication for future studies

This study focused on measures of output of performance to examine if the type of science park has any effect on their residing NTBFs. This was achieved through a 2nd hand data collection procedure using firms' annual financial reports. It is then reasonable to dig deeper into this concept as the results were in fact positive. This could be achieved by examining in detail what exactly is done differently inside focused parks that make for the provided growth potential. A first hand data collection from the parks' management and residing NTBFs through a series of interviews would help collect information in greater details on this matter.

Moreover, based on the literature review done for this dissertation and experiences gained throughout the process of writing, it seems necessary for science park studies to move on to a different setting. This concept has been around for more than half a century and yet they are being treated like a new born concept. This is evident as science parks are still commonly featured in studies where their existence is being examined i.e. whether they have any positive impact on their tenants or not. A large number of studies in form of on-park vs. off-park can bear witness to this trend. Like most maturing concepts, science park should also branch out to types and categories. As this study showed, science parks can be divided up into different types based on the number of industries they host. Such studies would help better acknowledging their potentials and ultimately utilizing them. Future studies to further categorize science parks can be helpful to achieve this goal.

Bibliography

Amirahamdi, H., & Saff, G. (1993, November). Science Parks: A Critical Assessment. *Journal of Planning Literature, 8 (2)* , 107-123.

Asheim, B. (2007). Differentiated Knowledge Bases and Varieties of Regional Innovation Systems. *Innovation, 20 (3)* , 223-241.

Asheim, B. T., & Gertler, M. (2005). The geography of innovation: regional innovation systems. In J. Fagerberg, D. Mowery, & R. Nelson, *(eds): The Oxford Handbook of Innovation* (pp. 291-317). Oxford: Oxford University Press.

Asheim, B., & Coenen, L. (2005). Knowledge bases and regional innovation systems:. *Research Policy, 34* , 1173–1190.

Barney, J. (1999). Firm Resources and Sustained Competitive Advatnage. *Journal of Management, 17 (1)* , 99-120.

Bigliardi, B., Dormio, A. I., Nosella, A., & Petroni, G. (2006). Assessing science parks' performances: directions from selected Italian case studies. *Technovation, 26* , 489–505.

Biotech Umeå, 2010. (n.d.). Retrieved July 26, 2010, from Biotech Umeå: http://www.biotechumea.se/biotech-umea

Brush, T. H., Bromiley, P., & Hendrickx, M. (2000). THE FREE CASH FLOW HYPOTHESIS FOR SALES GROWTH AND FIRM PERFORMANCE. *Strategic Management Journal, 21* , 455-472.

Business Region Göteborg, 2010. (n.d.). Retrieved July 17, 2010, from Business Region Göteborg: http://www.businessregiongoteborg.com/huvudmeny/clusters/biomedicine.4.5fa77c281050b998c5c800034.html

Cabral, R. (1998). The Cabral-Dahab Science Park Management Paradigm: an introduction. *International Journal of Technology Management, 16 (8)* , 721-726.

Cassiman, B., Colombo, M. G., & Veugelers, R. (2005). The impact of M&A on the R&D process, An empirical analysis of the role of technological- and market-relatedness. *ResearchPolicy 34* , 195–220.

Chan, K., & Pretorius, M. (2007). Developing Technological Capabilities in Science Parks: a Networking model approach. *PICMET '07 - 2007 Portland International Conference on Management of Engineering and Technology* , 565-573.

Chan, K., Oerlemans, L., & Pretorius, M. (2008). A Conceptual Model of the Impacts of Networking on Innovative Performance of New Technology-Based Firms. *picmet 2008 Portland International Conference on Management of Engineering and Technology* , 443-453.

Chan, K., Oerlemans, L., & Pretorius, M. (2010). Knowledge exchange behaviours of science park firms: the innovative hub case. *Technology Analysis & Strategic Management, 22 (2)* , 207-228.

Chen, C.-J. (2009). Technology commercialization, incubator and venture capital, and new venture performance. *Journal of Business Research, 62* , 93-103.

Christopherson, S., Kitson, M., & Michie, J. (2008). Innovation, networks and knowledge exchange. *Cambridge Journa lof Regions, Economy and Society, 1* , 165-173.

Coenen, L. (2007). The role o funiversities in the regional innovation systems of the North East of England and Scania, Sweden: providing missing links? *Environment and Planning C: Government and Policy, 25* , 803-821.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly, 35 (1)* , 128-152.

Colombo, M. G. (2003). ALLIANCE FORM: A TEST OF THE CONTRACTUAL AND COMPETENCE PERSPECTIVES. *Strategic Management Journal,24* , 1209-1229.

Dahlstrand, Å. L. (2007). Technology-based entrepreneurship and regional development: the case of Sweden. *European Business Review, 19 (5)* , 373-386.

Dana, L. (1985). On the internationalization of a discipline: research and methodology in cross-cultural entrepreneurship and small-business studies . *Journal of Small Business and Entrepreneurship, 4* , 61-100.

Davidsson, P., Steffens, P., & Fitzsimmons, J. (2009). Growing profitable or growing from profits: Putting the horse in front of the cart? *Journal of Business Venturing, 24* , 388-406.

Desrochers, P. (2001). Geographical Proximity and the Transmission of Tacit Knowledge. *The Review of Austrian Economics, 14 (1)* , 25-46.

Ferguson, R., & Olofsson, C. (2004). Science Parks and the Development of NTBFs- Location, Survival and Growth. *Journal of Technology Transfer, 29* , 5-17.

Fukugawa, N. (2006). Science parks in Japan and their value-added contributions t onew technology-based firms. *International Journal of Industrial Organization, 24* , 381-400.

Fukugawa, N. (2006). Science parks in Japan and their value-added contributions to new technology-based firms. *International Journal of Industrial Organization, 24* , 381–400.

Gilbert, B. A., McDouhall, P. P., & Audresch, D. B. (2008). Clusters, knowledge spillovers and new venture performance: An empirical examination. *Journal of Business Venturing, 23* , 405-422.

GöteborgBIO, 2010. (n.d.). Retrieved July 17, 2010, from GöteborgBIO: http://www.goteborgbio.se/toppmeny/aboutgoteborgbio.4.4d2ad09a108e7eaa80c800027452.html

Hansonn, F. (2007). Science parks as knowledge organizations –the “ba” in action? *European Journal of Innovation Management, 10 (3)* , 348-266.

Howells, J. (2005). Innovation and regional economic development: A matter of perspective? *Research Policy, 34* , 1220–1234.

IASP, 2002. (n.d.). Retrieved 8 20, 2010, from International Association of Science Parks: http://www.iasp.ws/publico/index.jsp?enl=2

IASP, 2010. (n.d.). Retrieved 8 18, 2010, from International Association of Science Parks: http://www.iasp.ws/publico/index.jsp?enl=2

Ideon, 2010. (n.d.). Retrieved June 17, 2010, from Ideon Science park: http://www.ideon.se/en/

Karolinska institutet, 2010. (n.d.). Retrieved July 17, 2010, from Karolinska Institutet science park AB: http://sciencepark.ki.se/index.php

Knoben, J., & Oerlemans, L. (2006). Proximity and inter-organizational collaboration: A literature review. *International Journal of Management Reviews, 8 (2)* , 71-89.

Lindelöf, P., & Löfsten, H. (2004). Proximity as a Resource Base for Competitive Advantage:University–Industry Links for Technology Transfer. *Journal of Technology Transfer, 29* , 311-326.

Lindelöf, P., & Löfsten, H. (2003). Science Park Location and New Technology-Based Firms in Sweden – Implications for Strategy and Performance. *Small Business Economics, 20* , 245-258.

LU, 2010. (n.d.). Retrieved June 17, 2010, from Lund University Faculty of Medicine: http://www.med.lu.se/english/about_the_faculty/organisation/departments

Lundvall, B., & Borrás, S. (2005). Science, Technology and Innovation Policy. In J. Fagerberg, D. Mowery, & R. Nelson, *(eds): The Oxford Handbook of Innovation* (pp. 599-631). Oxford: Oxford University Press.

Lundvall, B., & Borrás, S. (1999). *The Globalising Learning Economy: Implications for Innovation Policy.* DGXII-TSER, The European Commission.

Löfsten, H., & Lindelöf, P. (2005). R&D networks and product innovation patterns—academic and non-academic new technology-based firms on Science Parks. *Technovation, 25* , 1025–1037.

Löfsten, H., & Lindelöf, P. (2002). Science Parks and the growth of new technology-based firms—academic- industry links, innovation and markets. *Research Policy, 31* , 859-876.

Löfsten, H., & Lindelöf, P. (2001). Science parks in Sweden - Industrial renewal and development? *R&D Management, 31 (3)* , 309-322.

Löwegren, M. (2003). NTBFs and Science Parks in the Literature. New Technology-Based Firms in Science Parks - A Study of Resources and Absorptive Capacity. *Dissertation (PhD) Lund: Lund University Press* .

Malairaja, C., & Zawdie, G. (2008). Science parks and university–industry collabortaion in Malaysia. *Technology Analysis & Strategic Management, 20 (6)* , 727-739.

Maskell, P., & Malmberg, A. (1999). Localized learning and Industrial competitiveness. *Cambridge Journal of Economics, 23 (2)* , 167-185.

Massey, D., Quintas, P., & Wield, D. (1992). *High-Tech Fantasies: Science Parks In Society, Science And Space.* London: Routledge.

MBBNET, 2010. (n.d.). Retrieved June 20, 2010, from http://www.mbbnet.umn.edu/scmap/biotechmap.html

McKelvie, A., & Wiklund, J. (2010). Advancing Firm Growth Research: A Focus on Growth Mode Instead of Growth Rate. *Entrepreneurship: Theory and Practice, 34 (2)* , 261-288.

Medeon, 2010. (n.d.). Retrieved June 20, 2010, from Medeon science park for life sciences : http://medeon.inka.se/en/HOME/tabid/253/language/sv-SE/Default.aspx

Medicon Valley Online, 2010. (n.d.). Retrieved June 16, 2010, from http://www.mediconvalleyonline.com

Monck, C. S., Porter, R. B., Quintas, P., Storey, D. J., & Wynarczyk, P. (1988). *Science Parks and the Growth of High Technology Firms.* London: Croom Helm in association with Peat Marwick McLintock.

Moodysson, J. (2007). Sites and Modes of Knowledge Creation: On the Spatial Organization of Biotechnology Innovation. *Dissertation (PhD) Lund: Lund University* .

Moodysson, J., Coenen, L., & Asheim, B. (2008). Explaining spatial patterns of innovation: analytical and synthetic modes of knowledge creation in the Medicon Valley life-science cluster. *Environment and Planning A 2008, 40* , 1040-1056.

Mowery, D. C., Oxley, J. E., & Silverman, B. S. (1996). Alliances and Interfirm Knowledge Transfer. *Strategic Management Journal, 17* , 77-91.

MU, 2010. (n.d.). Retrieved June 18, 2010, from Malmö University: http://www.mah.se/english/

Murphy, G. B., Traile, J. W., & Hill, R. C. (1996). Measuring Performance in Entrepreneurship Research. *Journal of Business Research, 36* , 15-23.

Sahlgrenska, 2010. (n.d.). Retrieved July 18, 2010, from Sahlgrenska Science park: http://www.sahlgrenskasciencepark.se/index.php

SiSP, 2010. (n.d.). Retrieved April 23, 2010, from Swedish incubators and Science Parks: http://www.sisp.se/web/Hem.aspx

Soo, C., & Devinney, T. (2003). The Role of Knowledge Quality in Firm Performance. In H. Tsoukas, & N. Mylonopoulo, *(eds) Organizations as. Knowledge Systems: Knowledge, Learning and Dynamic Capabilitie.* London: Palgrave. Retrieved 3 July, 2010 from http://www2.warwick.ac.uk/fac/soc/wbs/conf/olkc/archive/oklc3/papers/id179.pdf.

Squicciarini, M. (2009). Science parks: seedbeds of innovation? A duration analysis of firms' patenting activity. *Small Business Economics, 32* , 169-190.

Squicciarini, M. (2008). Science Parks' tenants versus out-of-Park firms: who innovates more? A duration model. *Journal of Technology Transfer, 33* , 45-71.

SSCF, 2010. (n.d.). Retrieved July 15, 2010, from Stckholm Science city Foundation: http://www.stockholmsciencecity.se/en/About-us/Our-story---Life-Science/

Stockholm Business Region, 2010. (n.d.). Retrieved June 20, 2010, from http://www.stockholmbusinessregion.se/templates/page____39140.aspx?epslanguage=EN

Storey, D., & Tether, B. (1998). New technology-based firms in the European union: an introduction. *Research Policy, 26* , 933–946.

SULS, 2010. (n.d.). Retrieved June 20, 2010, from Stockholm Uppsala Life Science: http://www.suls.se/converis/area/290

Tidd, J., Bessant, J., & Pavitt, K. (2005). *Managing innovation: integrating technological, market and organizational change (3rd ed.).* Hoboken: Wiley.

Umeå University, 2010. (n.d.). Retrieved August 18, 2010, from Umeå University: http://www.teknat.umu.se/english/about-the-faculty/news/newsdetailpage/umea-university-ranked-4th-best-workplace-outside-the-us-for-postdocs.cid121401

UmeåBIO, 2010. (n.d.). Retrieved August 20, 2010, from Umeå Biotech Industry Organization: http://www.umeabio.org/index.php?option=com_content&view=category&layout=blog&id=35&Itemid=53

Uminova, 2010. (n.d.). Retrieved august 20, 2010, from Uminova Science park: http://www.uminova.se/sciencepark/

Weinzimmer, L. G., Nystrom, P. C., & Freeman, S. J. (1998). Measuring Organizational Growth: Issues, Consequences and Guidelines . *Journal of Managemen, 24 (2)* , 235-262.

Venkatraman, N., & Ramanujam, V. (1986). Measurement of Business Performance in Strategy Research: A Comparison of Approaches. *The Academy of Management Review, 11* , 801-814.

Westhead, P. (1997). R&D inputs and outputs of technology-based firms located on and off Science Parks. *R&D Management, 27 (1)* , 45-62.

Westhead, P., & Batstone, S. (1999). Perceived benefits of a managed science park location. *ENTREPRENEURSHIP & REGIONAL DEVELOPMENT, 11* , 129-154.

Westhead, P., Ucbasaran, D. .., & Wright, M. (2005). Decisions, actions, and performance: Do novice, serial, and portfolio entrepreneurs differ? *Journal of Small Business Management, 43 (4)* , 393- 417.

VIA, 2010. (n.d.). Retrieved August 10, 2010, from Västerbotten Investment Agency: http://viavasterbotten.se/about/

Yang, C.-H., Motohashi, K., & Chen, J.-R. (2009). Are new technology-based firms located on science parks really more innovative? Evidence from Taiwan. *Research Policy, 38* , 77–85.

Zhang, Y. (2008). Related and supporting industries: the macro dimension of science park management. *Int. J. Entrepreneurship and Innovation Management, 8 (1)* , 57-73.