UPTEC X08 046

Examensarbete 20 p
Maj 2008

A benchmarking study of the Swedish and British life science innovation systems

Helena Bergqvist

UPPSALA UNIVERSITET

Molecular Biotechnology Programme

Uppsala University School of Engineering

UPTEC X 08 046	Date of issue 2008-05

Author

Helena Bergqvist

Title (English)

A benchmarking study of the Swedish and British life science innovation systems

Title (Swedish)

Abstract

In this study, the Swedish life science innovation system has been compared to the British. Due to the discrepancy in size, Sweden has been compared not only to the UK but also to Scotland. In addition, a micro-level comparison has been performed. The study also includes a full mapping of the life science industry in Sweden and an analysis of how the industry has evolved. The most striking result is the stagnation in terms of employees that has occurred in 2003-2006. There are interesting differences in the policies in Sweden and in the UK. In several respects, the British life science innovation system is better suited to support a growing life science industry. In particular, the case of Scotland is one for take home lessons.

Keywords

Innovation system, policies, industry structure, global competition, benchmarking

Supervisors

Anna Sandström
VINNOVA

Scientific reviewer

Jens Laage-Hellman
Chalmers University of Technology

Project name	Sponsors
Language **English**	Security
ISSN 1401-2138	Classification
Supplementary bibliographical information	Pages **213**

Biology Education Centre Biomedical Center Husargatan 3 Uppsala
Box 592 S-75124 Uppsala Tel +46 (0)18 4710000 Fax +46 (0)18 555217

A benchmarking study of the Swedish and British life science innovation systems

Helena Bergqvist

Sammanfattning

För att Sveriges life science bransch skall kunna stå sig i den globala konkurrensen om duktiga forskare, investeringar och företagsetableringar är det viktigt att förstå vilka styrkor branschen har och vad vi kan lära av andra länder. Ett viktigt land för jämförelse är Storbritannien. I den här studien har det svenska innovationssystemet inom life science jämförts på makro-nivå, med Storbritannien och Skottland, samt på mikro-nivå, där Uppsala jämfördes med Cambridge.

Inom ramen för studien analyserades den svenska life science industrins utveckling med avseende på ett antal nyckeltal över tidsperioden 1997-2006. Mot bakgrund av att branschen stagnerat i Sverige på senare år, mätt i antal anställda, är de frågor som lyfts i rapporten kring skillnader i kompetensutveckling, finansiering och policies bland beslutsfattare viktiga. I flera avseenden är Storbritannien bättre rustat i den globala konkurrensen. Inte minst p.g.a. den beslutsamhet från myndigheter och departement som avspeglas i resursfördelningen till forskningsområden inom life science samt åtgärder som skall underlätta för företagens tillväxt. Särskilt intressant att följa fortsättningsvis för Sveriges del är Skottland. Liksom Sverige är det ett land som brottas med att uppnå kritisk massa i innovationssystemet samtidigt som ambitionerna att sätta Skottland på life science kartan är höga. Skottlands vägval skiljer sig dock från Sveriges på flera områden.

Examensarbete 20p
Civilingenjörsprogrammet Molekylär bioteknik
Uppsala universitet maj 2008

A benchmarking study of the Swedish and British life science innovation systems

Comparison of policies and funding

Uppsala University

VINNOVA

Master´s Thesis

February 2008

Helena Bergqvist 8204281441

Tutor at Chalmers University of Technology:

Jens Laage-Hellman

Tutor at VINNOVA:

Anna Sandström

1 Introduction

1.1 Background

This report is one of the consequences of the task commissioned by the Swedish Government to Vinnova to perform an international benchmarking of the Swedish Life Science innovation system. In the commission, it is stated that the competitiveness of Sweden in an international comparison should be in focus. Also, the study should provide knowledge about trends and initiatives in other countries and regions[1]. This very report constitutes one part of this overarching study, managed by Anna Sandström (Vinnova) and provides a case study of the life science innovation system of Sweden compared to the British. The ambition has been to full fill the request for knowledge about trends and initiatives for the case of UK and the request to analyse the Swedish competitiveness. The theoretical model and approach chosen hopefully gives a satisfactory exhaustive description of the systems to function as a solid basis for comparison and analysis of the competitiveness. Trends and initiatives of relevant actors have been given particular attention. Yet another consequence of the commission was to perform an updated version of the report National and regional cluster profiles, for the entire life science industry. The updated report, made by Anna Sandström and Helena Bergqvist (Vinnova) and Tage Dolk (Addendi) has also been linked to this very report, since it provides information that is vital for a relatively updated picture of the Swedish system's competitiveness. In the innovation system analysis of Sweden, material from the National and regional cluster profiles 2007 constitutes a foundation that has been further analysed.

The report includes one macro-level comparison, including the UK, Scotland and Sweden, as well as one micro-level comparison, Cambridge and Uppsala. The competitiveness of the Swedish system is based on results and experiences from both the macro and micro-level and on their interconnectedness.

1.2 Objective

There are two main objectives of this report:

> -To make a survey of the Swedish Life Science Business' industrial structure and to illustrate how it has evolved during the last ten years

[1] Ministry of Enterprise, Energy and Communications, 2006

-To analyse the competitiveness of the Swedish innovation system for the Life Science Business, in relation to the British.

There are four main issues, further divided into sub questions, to be answered. The first question relates to the first objective whereas the following three predominantly relates to the second objective. The questions related to the second objective naturally build on the outcome of the first question to some extent. That is; an analysis of the competitiveness of the Swedish life science innovation system takes into account the current status of the industry structure and how it has evolved. The issues are as follows;

- What is the overall structure and development of the Swedish Life Science Industry
    - What does the industry structure look like?
    - What has the growth of the industry been like for the last ten years in terms of number of employees?
    - What has the production and result development of the Swedish industry been like?

- What does the British and Swedish Life Science innovation systems look like and function regarding certain aspects or activities of importance for an innovation system?
    - What is the knowledge development like in the British and Swedish innovation systems?
    - How does the financial support system function for innovative companies?
    - What are the main policies of the public authorities in Sweden and in Britain?

- What is the performance of the Swedish and British Life Science innovation systems?
    - Comparison of strengths and weaknesses

- What can we learn from the British innovation system in order to increase the competitiveness of the Swedish Life Science Innovation System?

1.3 Spatial delimitation

The number one priority in this work has been to perform a comparative innovation systems analysis of the Swedish and British innovation systems. It was thought necessary to handle the discrepancy in size of the two nations and this has been addressed by conducting the comparative analysis of innovation systems on different levels in the innovation system. Sweden is not only compared to the UK but also to Scotland. The comparison with Scotland adds an innovation system that is much like the Swedish in terms of size. Not only is the number of inhabitants in the same range as Sweden (approx. 5 million[2] compared to over 60 million in the UK[3]), but also the life science industry is about the same size in terms of number of employees and number of companies. Scotland, although part of the United Kingdom, is in several aspects an independent region in the Union. Therefore, the Scottish innovation system can be addressed as both connected to the overall UK innovation system, but could also be compared as the innovation system of a country to another country's innovation system.

In this work, it is recognised that much of the important initiatives and innovation takes place on a more local level. As an instrument to provide depth to the study, innovation systems on a sub-regional level was also compared; Cambridge and Uppsala. The reason for choosing these specific examples to compare is outlined in section 7.1.1 It has been discussed in many reports whether the nature of a biotechnology industry is best described as biotech clusters and cluster theory, or if it is best described on a regional level or if it should be described by theories like Global Commodity Chains and/or Global Production Networks. These theoretical approaches have been studied. However, the conclusion was that given the task to perform an international benchmarking study and in the same time deal with innovation systems in various spatial levels, choosing to stick to one of them would be too complex and delimiting. In this study, the primary focus is not on exploring the spatial nature of the life science innovation system or what spatial approach that gives the best suited description. Nevertheless, the approach chosen creates interesting questions. In addition to comparing Uppsala to Cambridge, the connections between each sub-region and the national level above the sub-regional level have been described. These interconnections could then be an issue to compare in itself. This was taken into consideration when describing the sub-regional innovation systems and is dealt with separately in chapter 11. The innovation systems of Cambridge and Uppsala are described and compared in the micro-level block and the innovation systems of the UK, Scotland and Sweden are described in the macro-level block. The final analysis of the competitiveness of the Swedish innovation system compared to the British takes into account the results and experiences from all innovation systems studied.

[2] http://sv.wikipedia.org/wiki/Skottland
[3] http://sv.wikipedia.org/wiki/Storbritannien

2 Choice of analytical model and approach

The choice of theoretical approach in this report is a combination of the functional analysis, developed at Chalmers University of Technology, and the approach used by The Centre for Business and Policy Studies in their study of the Swedish life science industry and innovation system. The overall aim and logic is similar to the functional analysis in that sense that the analysis builds on a successive processing of information, from facts and rather extensive descriptions to a refined analysis. Several aspects of the functional analysis are not included though in the approach of this report mainly due to time limits. The logic of the approach used in this report is described by the approach model in figure 2.1[4]. The industry survey of the Swedish life science industry provides an information base of the characteristics of the industry. A snapshot of what the industry actually looks like as at 2006 and the development over time is presented. In the system structure, the actors within the innovation system are presented. With a point of departure in the actors of the system, the activities within the system are then described. The activities in turn forms the basis of yet another "level" in the pyramid of information processing, the strengths and weaknesses identified within each activity and innovation system. The discussion of these strengths and weaknesses is the primary basis for the comparison between the Swedish and British systems and also the final perception of the Swedish systems´ competitiveness. Each of the levels of the pyramid is described further individually.

[4]Author

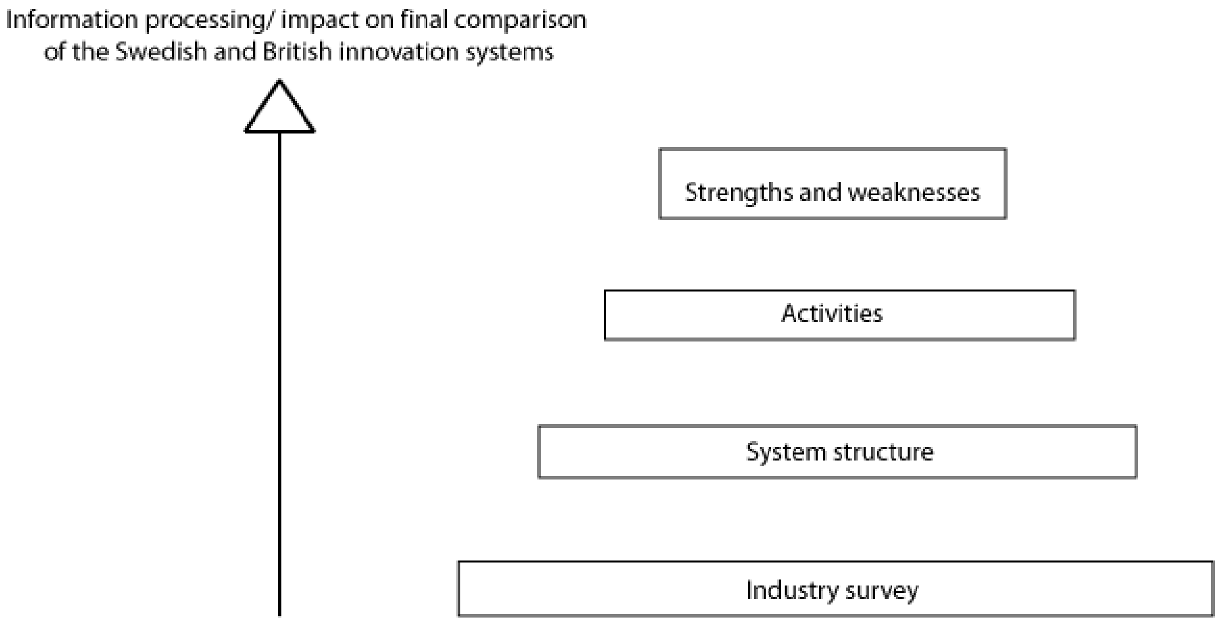


Figure 2.1. The approach model to identify strengths and weaknesses in an innovation system

2.1.1 Industry survey

The industry survey is performed thoroughly for the case of Sweden; the industry structure, the employment development and the development of results and productivity are outlined for the life science industry. A corresponding industry survey is not performed for the UK. A more delimited survey was performed for Cambridge as a basis for comparison with the Uppsala life science innovation system. The generation of the industry survey of Sweden is described more in detail in the industry survey section.

2.1.2 System structure

The system structure, that is the actors or components of the innovation system, have been outlined with inspiration from the functional analysis[5]. The categories of actors looked into was also determined by initial bibliometric studies of the major actors in the innovation systems. The different categories chosen are the public authorities, the industry partnerships and associations, the research institutes and universities, the innovation centres, science parks, incubators and networks/funding networks.

2.1.3 Activities

In this report, specific activities was identified and described instead of the functions used in a functional analysis. The activities are "what affect the

---

[5] Perez. E, Oltander. G, 2005

development, spread and use of innovations"[6]. The activities are also the determinants of the innovation system which *we* can affect, in order to affect the innovation processes[7]. The similarities and differences of the activities and functions are outlined in table 2.1 and table 2.2.

Similarities:

Functions	The functions in a functional analysis analyse the functional pattern of the system, the dynamics[8].
Activities	Analysing and comparing innovation system by using activities focuses on what it is that happens in the systems and how the systems change[9].

Differences:

Functions	The functions answers questions like "why has the system evolved in a certain way" to a larger extent than the activities[10]. Since the static components are described by the system structure in the functional analysis[11],
Activities	The activities are more descriptive of the status of the innovation system and compared to the functions, they contain less analysis of why the systems developed in certain ways. The questions associated with the activities are more of "what does the system look like" and "how has it changed" than "why has it changed". There is no corresponding system structure where components of the system are dealt with separately. As a consequence, the activities are more inclusive of such information[12].

The use of activities was inspired by the innovation system analysis approach used in a report from The Centre for Business and Policy Studies (Medicin för Sverige). As described in table 2.1, the activities are much like the functions but were chosen based on the assumption that they are well suited when the focus is on comparisons of different countries sectorial innovation systems instead of being analysing one specific, national innovation system[13]. In this report, explicit examples of initiatives or programmes currently in place in the system have been used to give a

[6] Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, Page 30
[7] Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007. Page 30
[8] Perez. E, Oltander. G, 2005, page 17
[9] Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, Page 30.
[10] Author´s conclusion
[11] Perez. E, Oltander. G, 2005, page 17
[12] Author´s conclusion
[13] Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, Page 37

descriptive picture of how the activity is dealt with and performed. A more analytic discussion about the strengths and weaknesses identified within the activity then follows. This approach was chosen based on the extensive comparisons that lay ahead of the *status* of different innovation system and the competitiveness of the system's life science industries.

Comparisons of innovation systems ideally should be very comprehensive as well as detailed[14] and much effort has been put into this work in order to achieve this. The framework that the activities present aim to focus on comparable important aspects of the innovation system and is backed up by the underlying descriptions of the system structure and (for some systems) the industry structure.

The focus of this benchmarking study has been on the financial and policy aspects of the life science innovation systems and only partly coincides with the activities defined in The Centre for Business and Policy Studies report[15]. Due to restrictions in time, several important activities of the innovation system, like the regulatory and organisational environment for instance, has not been covered. The demand is defined as externally determined and is not described. However, the effect of such aspects of the innovation system is not completely neglected though when concluding strengths and weaknesses in other activities. The aspects covered by the functions in an ordinary functional analysis have had an impact on how the activities were chosen. The activities used in this report also differ somewhat between the different innovation systems studied. This is because some flexibility is needed in order to capture what is predominantly affecting the innovation system at hand. The activities that are included in all innovation systems are as follow;

Knowledge development:
In the knowledge development, the knowledge generation is described in terms of what affects the direction of research and how the funding of university research and all research is performed by public and private actors. The access to knowledge is also described in the knowledge development and includes the technological knowledgebase and market related knowledgebase. Finally, the knowledge transfer within the system is considered. The focus is on knowledge transfer between academia and industry and is also connected to commercialisation activities.

Financial Support Systems:
In the financial support system, it is described how different actors contribute to the access of capital. Both the general access to capital and more specific access from private sources and public sources are described.

[14] Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, Page 35
[15] Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, Page 32-33

Policy Development
The policies of public authorities and to some extent also of other organisations as well as how these actors implement their policies in concrete terms were considered vital in a report like this that sets out to compare the strengths and weaknesses in two national innovation systems in a global context. Therefore, this has been treated as one of the activities in the innovation system under the heading policy evolvement.

The basis for the activity descriptions is formed by reports, strategy documents and previous studies. Extensive examination of the websites of the actors in the system structure has been used to update and follow up on information given in the reports and strategies. In addition, interviews has been performed with actors situated in London (or Swindon), Stockholm, Cambridge and Uppsala (for a full list, see references). Specific question related to the activities have also largely been handled by mail conversations.

2.1.4 Strengths and weaknesses identified

In each activity section, of each innovation system, the strengths and weaknesses identified that are related to that particular activity are described and discussed. The discussion focuses on the activity and innovation system at hand but in the analysis, connections to results and experiences from other innovation systems are also taken into consideration. The results from "lower" levels in the information pyramid naturally could affect the analysis of particular strengths and weaknesses as well, for instance how the employment development might be connected to certain weaknesses or strengths related to an activity.

2.1.5 The interconnectedness of innovation systems

In this report, a specific section is attributed to a discussion of the interconnectedness between the spatial levels. The discussion is based on the results and experiences gained from comparing different levels. The comparison focuses on the policies among actors in the innovation systems, their relative strength and how these policies are implemented.

2.1.6 Innovation system comparison

One of the questions to be answered in this report is what the competitiveness of the Swedish life science innovation system is like compared to the British. This is the final question to be answered, and is based on the industry surveys, the system structures and the activities of the innovation systems considered. However, the comparison takes its point of departure predominantly in the top level of the information pyramid (see figure 2.1). It is the conclusions drawn from the strengths and weaknesses related to the activities that are compared in order to answer the question of the competitiveness. The approach used to handle the outcome of the different innovation systems on micro- and macro-levels is outlined in figure 2.2. On the micro-level, the life science innovation systems of Uppsala and Cambridge are analysed and compared. The industry survey is restricted to the industry structure. Development over time of employees, results and productivity is not described. On the macro-level, a full industry survey is performed for the case of Sweden. There is no industry survey for Scotland and the UK due to data limitations and the system structure is also absent on the macro-level. This is because a full system structure for all macro level innovation systems would have been very time consuming and it was reasoned that a detailed study could be limited to the sub-regional comparison. The strength and weaknesses identified among the activities in the three macro-level systems are used as a basis for a macro-level comparison; Sweden-Scotland and Sweden-UK. The macro and micro-level comparisons together with the interconnectedness of the spatial levels then form the basis sought after to address the questions of the relative competitiveness of the Swedish life science innovation system and what there is to learn from the British way.

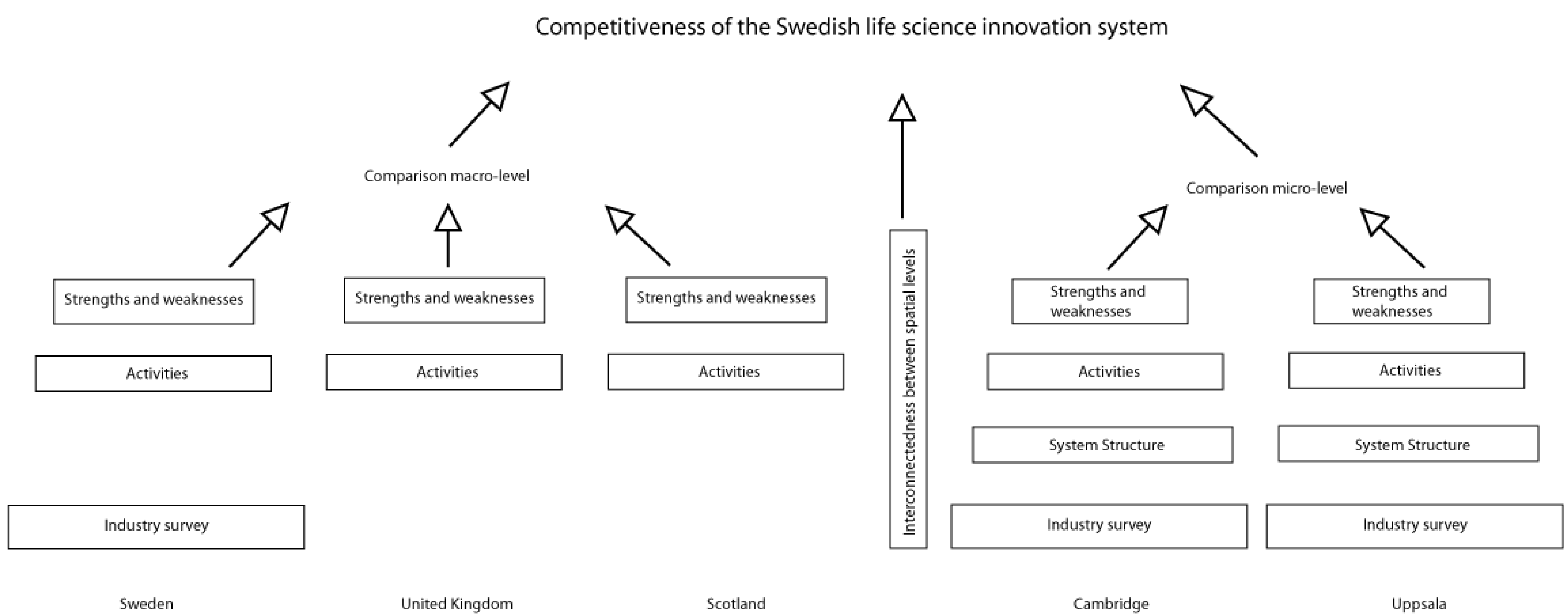


Figure 2.2. The approach model for innovation system comparison

3 The Swedish life science innovation system

3.1 Industry survey

In this section, certain quantitative features of the life science sector are outlined. The overall industry structure is described. This presents a snapshot of the industry as at 2006 and also show the structure of the business segments that have been identified to together make up the life science industry. The regional distributions as well as the size of the individual companies are shown. Other features that are interesting in order to get a grip on the industry are the foreign ownership and the results of the industry, in terms of positive and negative results. Then, the employment development of the industry and the different business segments is described, which provides vital information of how the industry is performing. The employment development naturally is important in a such perspective, and the result has been used as a point of departure in several discussions later on in the report. The development of production and relative results is also outlined and finally a discussion of the overall result. Initially, the classification and scope of the industry are described followed by a description of the individual business segments. The industry survey presented here was also presented in a previous report, called National and Regional Cluster profiles by Anna Sandström and Helena Bergqvist (Vinnova) and Tage Dolk (Addendi)[16]. The texts below are to a large extent derived from this report and were written by Helena Bergqvist and Anna Sandström.

Today, life science is considered a critical foundation for long term innovation and growth in many countries' industry and society. The life science industry is an important branch of industry, of economic and political significance to today's Swedish society. Accurate knowledge of the extent, structure and development of this industry is essential for sound policy decisions.

3.1.1 Classification and scope

The present study focuses on companies but does not account for other parts of the innovation system, such as the healthcare sector, public authorities, universities or other research organisations which are important players in the life science innovation system.
The overview presents different aspects of the Swedish life science industry and is based on the life science company database created and categorised

[16] VINNOVA VA 2007:16

by VINNOVA. Data has been compiled because the official NACE categories (usually used to classify companies by industry) cannot easily be used for life science companies, as they are scattered among many categories. NACE categories can thus be used to identify some of the relevant companies and in the present study have been combined with other sources of information to obtain the total company population. It should be noted that there is a delay between registering a new company and the company sending in its first annual report to the Swedish Companies Registration Office. Also, other changes due to mergers, acquisitions and liquidations appear with some delay in the statistics. The companies have been classified into different sectors, business segments and core activities. The sectors are defined as the medical technology sector, the biotechnology sector and the pharmaceutical sector and the companies are also further divided into business segments. The companies' activities are categorised into the following activities: manufacturing, consultancy, product development and research and development (R&D) as shown by figure 3.1.

Activity category

Broad research & development
Companies with exploratory research and development within a broad field of expertise or with several parallel development projects/product lines. Within some companies there is also sales and marketing activity and manufacturing.

Companies without products on the market are shown in a separate field. In this context, co-operative agreements and licensing providing revenue have also been counted as "products on the market".

Narrow research & development
Companies with exploratory research and development within a narrow field of expertise or concentrating on one development project/product line. Within some companies there is also sales and marketing activity and manufacturing.

Companies without products on the market are shown in a separate field. In this context, co-operative agreements and licensing providing revenue have also been counted as "products on the market".

Product development
Companies which principally develop their own products/services, i.e. incremental product development without elements of exploratory research.

Consultancy
Companies which principally carry out consultancy and commission activity. All CRO companies are included here.

Manufacturing
Manufacturing of biotech products, drugs or medicotechnical products. Including companies specialised in manufacturing but also the production units of integrated companies with more than 500 employees.

Figure 3.1 Companies are classified into the activity categories described

The analysis includes cluster profiles, development of employment and the economic development. The cluster profile is based on the distribution of individual companies in sectors, the size of the companies in terms of employees, business segments, geographical location and activities. In addition, R&D-intensive companies are classified based on whether they have a product, service or licence on the market and are conducting broad or narrow R&D. The firm development describes how the number of employees has developed for the life science industry, included sectors and business segments over a ten-year period, 1997-2006. The economic development analysis investigates production in terms of net turnover per employee and value added per employee. The latter is described in order to indicate the contribution of the life science industry to the Swedish GDP. The development of relative results describes the results after financial items relative to the net turnover. Together, these three aspects: the cluster profiles, development of employment and economic development, aim to give insights into the size, structure, development and performance of the Swedish life science industry between 1997 and 2006.

Each company has individually been categorised into both a business segment and what sector or sectors the company belongs to according to each company's main business. Companies with their main activity in business segments other than those listed below are not included in the study. There are companies whose activity can be categorised as belonging to more than one sector, due to the definitions of the three sectors. For instance, there are many companies within drug discovery that could be defined neither as exclusively pharmaceutical nor as exclusively biotechnology companies. Therefore, each company has been classified into one specific business segment, whereas there is an overlap between the three sectors. The characteristics of companies falling into the medical technology sector are that they develop medical products that are not drugs. The characteristics of companies falling into the pharmaceutical sector are that they develop drugs and various other kinds of therapeutic products or methods. The pharmaceutical sector also includes diagnostics. The biotechnology sector is characterised by companies developing the application of science and technology to living organisms as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services. In the sector categorisation of each individual company, the approach or method used to solve a problem or satisfy a customer or patient need was often crucial to this categorisation. Together, these three sectors constitute what is known as the life science industry. The business segments included in this study are described below. The sectors under which companies in a particular business segment may have been categorised are also indicated below. The OECD definition of biotechnology activities has been used to identify biotech companies.

Business segments

Drug discovery and development

Companies can be found in *Pharmaceuticals* and *Biotechnology.*
-Research and development of new drugs and therapies. Very few pharmaceutical companies develop new drugs without using biotechnological tools. However, not all companies have the development of biopharmaceuticals, i.e. drugs based on large biological molecules such as

proteins, as their goal. Rather, the large biological molecules are targets for the drugs developed. The drugs are often small molecules produced by organic chemical synthesis. In some cases, manufacturing, sales and marketing is also included in the individual company. The companies seek to develop new therapies to put on the market or license to pharma companies generating up-front and milestone payments, royalties and possibly revenues from sales on divided markets, depending on the agreement.

Drug delivery

Companies can be found in *Pharmaceuticals* and *Biotechnology.*
- Companies in the drug delivery business segment are conducting research on how the active substances in medicines can be made to reach their target molecules in the body and how a satisfactory uptake of these substances can be ensured. Their clients are mainly biotech and pharma companies involved in drug discovery and development. An increasing business area includes developing new formulations for existing drug substances so that they can be used for new indications. Using existing substances reduces development time, as they have already passed the regulatory process for another indication. The field of nanobiotechnology is expected to generate new solutions on how to administer drugs more specifically. Polymer chemistry, nanotechnology and surface chemistry are examples of possible required expertise.

Biotech medical technology

Companies can be found in *Biotechnology* and *Medical technology.*
- Provides health services with that part of medical technology which has a biotech basis according to the OECD definition, including equipment and instruments for in-vitro fertilisation, cell cultivation, substitute plasma, blood management, plus the use of biodegradable biomaterials to replace or repair damaged tissue.

Diagnostics

Companies can be found in *Pharmaceuticals*, *Biotechnology* and/or *Medical technology.*
- The companies develop tools and techniques for diagnostics and most of their customers are healthcare sector, clinical laboratory analysis companies and end consumers for home use. In the company population at hand, all biotechnology diagnostic companies, often developing antibody-based tests, also fall into the pharmaceutical classification. Medical technology diagnostic products can be technical appliances for measuring or visualising diagnostic results or in-vitro diagnostic tests. A difference compared to companies developing new drugs is that the process from idea to commercialisation of diagnostic products, processes and services is usually shorter.

CRO companies

Companies can be found in *Pharmaceuticals* and/or *Biotechnology.*
- CRO (Contract Research Organisation) companies include clinical research organisations dealing with products and services for assisting other companies in clinical trials and regulatory processes. Clinical research organisations need to be familiar with international regulations and regulatory bodies as well as having well-developed contacts in clinical research, hospitals and authorities. Some CROs have developed a technology platform or analysis system that is managed within the company and accessible to companies in the pharmaceuticals and/or biotechnology sectors by contract research.

Drug production (not biotech)
Companies can be found in *Pharmaceuticals.*
- Companies specialising in drug production and which do not have their own research operations are included in this business segment. The use of biotechnology in the manufacturing of drugs is not included. Instead, those companies are found in the Bioproduction category. Important issues include development of cost-effective process and production technology as well as regulatory requirements.

Biotech tools and supplies
Companies can be found in *Biotechnology.*
- The companies develop products and services for use in production, processes, research and development. This includes equipment for bioseparation, biosensors, biomolecular analyses and bioinformatics. Their customers mainly consist of other biotechnology companies, the pharmaceutical and medical technology sector and university research teams but also other industries basing their products on biological raw materials, for instance in the food, forestry and agricultural sectors. Their expertise lies within application of interdisciplinary expertise combining technologies such as electronics, ICT, mechanics, optics and materials engineering with life science to develop their products and services.

Bioproduction (healthcare related)
Companies can be found in *Biotechnology* and *Pharmaceuticals.*
- Biotech production of drugs, biomolecules, cells or microorganisms for use in healthcare related products such as diagnostics and pharmaceuticals. These are specialised manufacturing companies whose clients include the pharmaceutical sector, other biotech companies or research groups. The biomolecules are often enzymes or antibodies. The companies' core expertise is development of cost-effective production solutions - adapting their activity to internationally stipulated regulatory requirements on quality and safety, plus an ability to adapt to customer requirements.

Agricultural biotechnology
Companies can be found in *Biotechnology.*

- Plant-related products. Plant or tree breeding utilising biotech methods as tools in the cultivation work. Few companies, however, use gene technology as a method for obtaining specific properties in the end products (genetic modification). Also included is plant protection based on naturally occurring microorganisms or biomolecules as well as the processing of land-based raw materials with the aid of biotechnology. Companies working with genetic modification for agricultural purposes need to be aware of, and have a strategy for addressing, attitudes in society regarding the use of gene technology in plant cultivation.

Environmental biotechnology

Companies can be found in *Biotechnology.*

- Biotech solutions to environmental issues such as water purification, land decontamination (bioremediation) and waste management, and laboratory analysis. Their customers include municipalities, construction companies, and industries requiring purification of water used in manufacturing processes. Companies within this field have very diverse focuses and it is therefore difficult to highlight a common core expertise. Some of these companies use non-pathogenic, naturally occurring microorganisms and the laboratory analysis companies develop specific testing methods and analytical measurement tools, to measure toxic substances for instance. However, biosensors are included in the Biotech tools and supplies business segment.

Food-related biotechnology

Companies can be found in *Biotechnology.*

-The products of companies in the field of food-related biotechnology include biotechnically-produced components or ingredients for the development of foods with positive health benefits, e.g. probiotics. The term functional food denotes a product with a documented, well-defined, product specific diethealth relationship. The aim of these products is to reduce the risk of developing diseases rather than cure them.

Industrial biotechnology

Companies can be found in *Biotechnology.*

- Process development of biotechnology applied to industrial processes for large-scale biotechnological production, e.g. designing an organism to produce a useful chemical or using enzymes as industrial catalysts to produce valuable chemicals. Industrial biotechnology solutions tend to consume fewer resources than traditional processes used to produce industrial goods. The forest, pulp and paper industry and the food industry has not been included since the core competence in those companies is not biotechnology even if the technology is used to some extent.

Healthcare equipment

Companies can be found in *Medical technology.*

- Companies producing fittings and furniture for health services such as lighting, patient lifts, examination couches and treatment tables. To be included, their major business must be products for the healthcare sector. The companies are often manufacturing companies with an understanding of needs within the healthcare sector.

Active and non-active implantable devices

Companies can be found in *Medical technology.*

- Companies producing fittings and furniture for health services such as lighting, patient lifts, examination couches and treatment tables. To be included, their major business must be products for the healthcare sector. The companies are often manufacturing companies with an understanding of needs within the healthcare sector.

Anaesthetic/Respiratory Equipment

Companies can be found in *Medical technology.*

- Development of anaesthetic equipment and solutions for supervision or control of respiration. The products are mainly used for critically ill patients i.e. within the intensive care unit (respiratory equipment) and in the operating room (anaesthetic and/or respiratory equipment). Anaesthetics may be delivered to the patient intravenously or by inhalation. Products are developed in a combination of medical expertise, including expertise in the anaesthetic qualities of different gases, as well as expertise in a number of engineering fields such as mechanics and electronics for pneumatic systems, and valves and sensor technology and computer programming for monitoring and control systems.

Dental devices

Companies can be found in *Medical technology.*

- Develops instruments and technical appliances used by dentists. Development of dental implants, screws and the manufacturing of disposables and supplies for use in dental clinics are also included. Dental laboratories on the other hand, are not included.

Electromedical and imaging equipment

Companies can be found in *Medical technology.*

- Technical equipment used for patient care and supervision or visualising of conditions. This business segment includes a broad range of products used in many medical fields such as magnetic resonance imaging, computed tomography, positron emission tomography and dialysis equipment. Many companies are large with diversified business and may also develop products falling into other business segments. The companies identified require technical as well as medical expertise, in such fields as radiotherapy, haematology, cardiology, dialysis and oncology.

Ophthalmic devices

Companies can be found in *Medical technology.*

- Companies dedicated to surgery or medical appliances within the field of ophthalmology. The required expertise ranges from ophthalmic surgical technology like cataract surgery. Products include laser vision products, cataract products and computer software for imaging the inside of the eye. The latter may be used for diagnosing eye conditions.

Surgical instruments and supplies for electromedical and imaging applications

Companies can be found in *Medical technology.*

- Includes instruments and tools used in patient care or surgery, and accessories for electromedical and imaging equipment. This business segment includes companies that develop products that may facilitate different medical procedures, i.e. scalpels, forceps, dissectors and clamps. The required expertise ranges from production of instruments to knowledge within the different surgical fields. There are also companies developing products connected to surgery, such as hypothermia products.

Medical disposables

Companies can be found in *Medical technology.*

- Disposable products used in patient care, such as dosage cups, hypodermic needles, sponges, contrast agents, wound care products etc. Some of the products can be used in research and at clinical laboratories. These companies are often manufacturing companies. Knowledge of industrial processes, sterilisation techniques and material chemistry is important. Characteristic of some companies is knowledge of the processes behind wound healing and the optimal conditions for wound care.

CRO medtech

Companies can be found in *Medical technology.*

- Medical technology contract research organisations provide services for development, manufacturing and quality control of medical technology products. They often develop software or IT solutions for problems arising within the medical technology sector or provide expertise in developing medical products and devices. However, instead of selling a product, they provide a service based on their technical platform or other expertise. The expertise of some companies includes knowledge about regulatory requirements and how to achieve market approval.

IT and training

Companies can be found in *Medical technology.*

- Companies developing software and IT solutions for patient care or supervision etc. Training software for patients and personnel in the healthcare sector is also included. The products often facilitate the handling and integration of large volumes of information or provide analytical tools for clinicians that could function as diagnostic support.

The companies are also categorised into different activities, according to the scheme below[17].

3.1.2 Industry structure

Results

Overall industry structure

The overall industry structure is shown in figure 3.2. The total number of companies active in research and development, product development, consulting or manufacturing within the included business segments of biotechnology, pharmaceuticals and medical technology in Sweden is approximately 620 with a total of almost 34,500 employees. This does not include the companies focusing on marketing and sales. Those companies have over 7,200 employees distributed among about 210 companies. This leads to a total size of the industry amounting to 830 companies and 41,700 employees. There are also many companies with no employees that are still active according to Swedish Companies Registration Office and not included in the figures of this chapter. One business segment not included is laboratory equipment not specifically designed for use in the biotechnology, pharmaceuticals or medical technology sectors. If these were also included, the total number of employees and number of companies would be approximately 42,400 and 850 respectively. Research-intensive companies and manufacturing companies far outnumber the companies in other activities and jointly make up more than 80% of all included life science companies. Among the companies with broad R&D, the vast majority has a product or license on the market. Companies with narrow R&D have a product or license on the market to a much lesser extent. There are some cases of very small companies conducting broad R&D. The information obtained during the categorisation process implies that they often collaborate with a university or are spin-offs from university departments. It should be kept in mind that the business segments add up to the total number of employees whereas the three different sectors do not. This is because there are overlaps between the sectors.

[17] Bergqvist. H, Dolk. T, Sandström. A, 2007, page 11

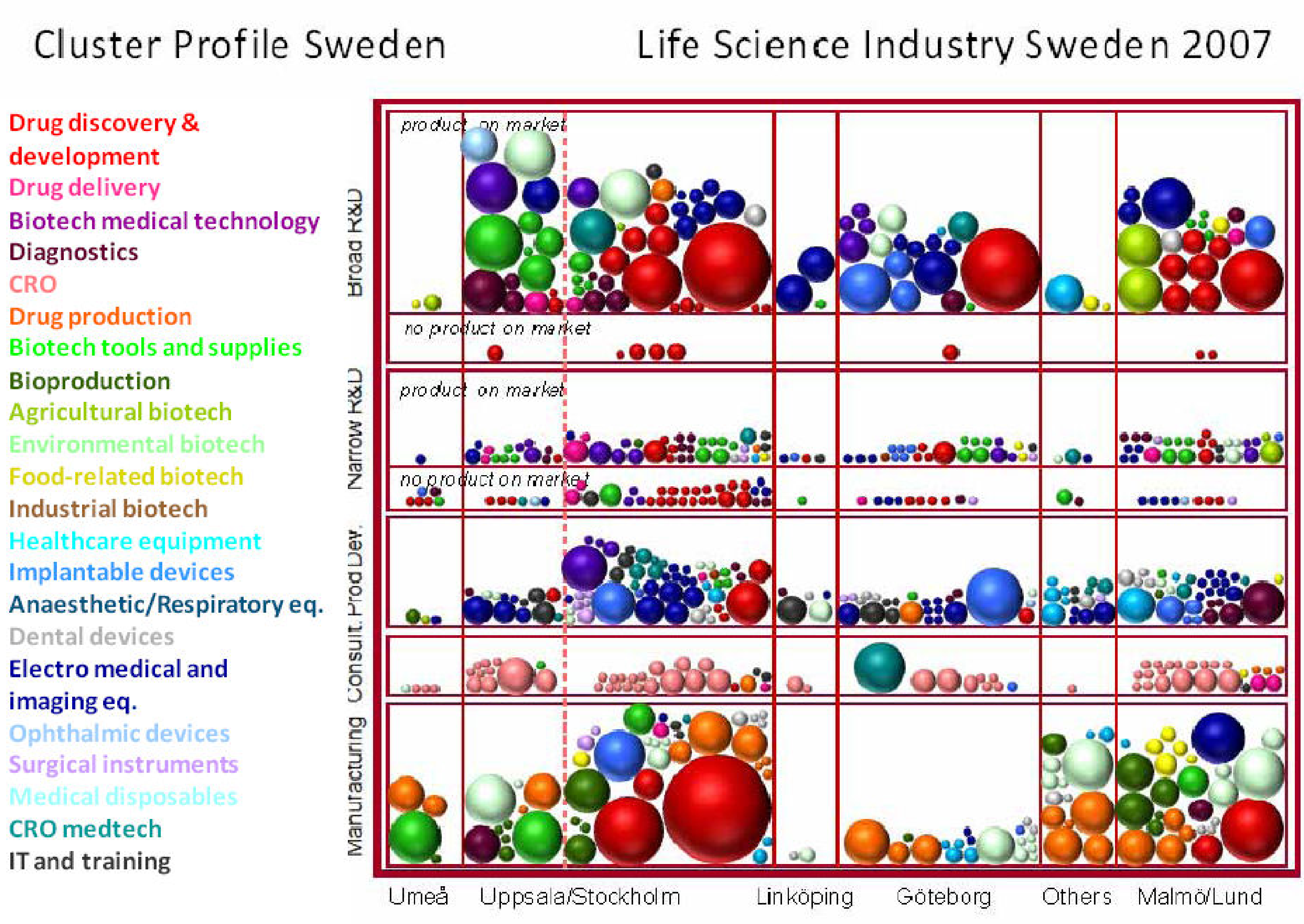


Figure 3.2. The life science industry Sweden 2006/ National and Regional Cluster Profiles, Anna Sandström and Helena Bergqvist (Vinnova) and Tage Dolk (Addendi), 2007.

Parent company nationality

In figure 3.3 and 3.4, the parent company nationality is shown. Foreign-owned (in terms of parent company nationality) life science companies are often large companies active within broad R&D or manufacturing. With almost no exceptions, they are companies that have managed to put a product on the market. Companies with narrow R&D, either with or without products on the market, are unlikely to be foreign-owned. The consultancy sector is also underrepresented among the foreign-owned companies. There is a similar distribution between the different sectors when it comes to foreign ownership among the companies. Companies with a non-majority foreign ownership are not included in the foreign-owned companies. Foreign-owned pharmaceutical companies are often US-owned, Swiss or British. There are also several Dutch-owned companies, like Qpharma and Polypeptides laboratories, plus Danish-owned Novozymes Biopharma AB and NeuroSearch Sweden AB. In terms of number of employees, British ownership dominates due to AstraZeneca.

Among the foreign-owned biotech companies, parent companies from the US are well-represented; the largest are GE Healthcare Biosciences AB and Pfizer Health AB. Parent companies in the Netherlands own DSM AntiInfectives Sweden AB, EuroDiagnostica and LTP Lipid Technologies Provider AB. Parent companies in Switzerland own Syngenta Seeds AB and Ferring AB. Most of the foreign-owned medical technology companies are owned by parent companies from the US. They are often medium-sized (50-249 employees) or large companies (>249), like Cederroth International AB, Becton Dickinson Infusion Therapy AB, St. Jude Medical AB, Advanced Medical Optics Uppsala AB, GE Medical Systems Sverige AB. The largest British-owned companies are Astra Tech AB and PaperPak Sweden AB. Luxemburg is also relatively well-represented, which is not the case for the other two sectors. The largest Luxemburg-owned companies are Phadia, Allergon and Ascendia MedTech AB.

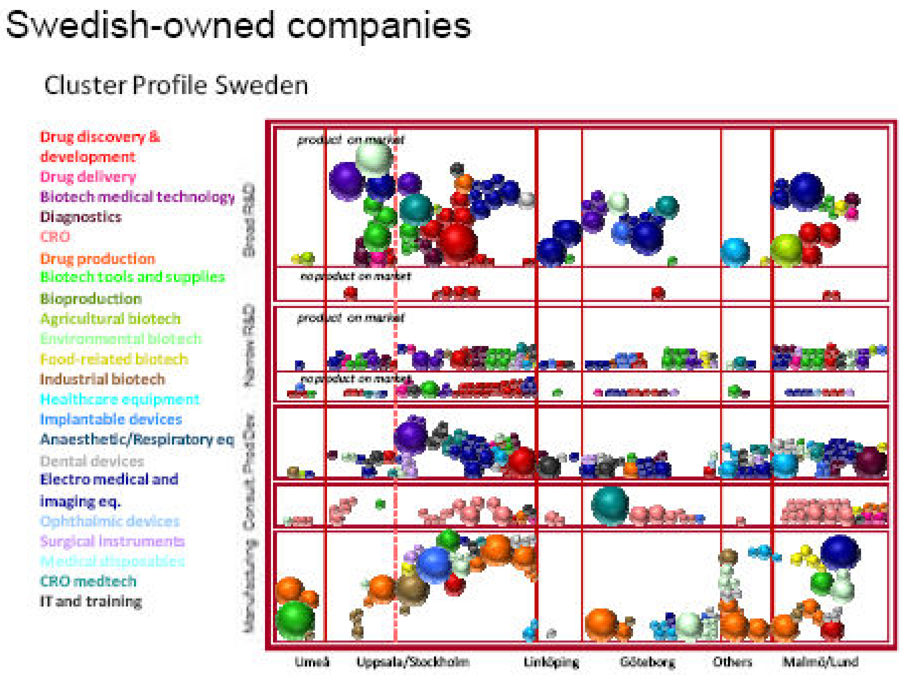


Figure 3.3. Parent company nationality: Swedish-owned companies

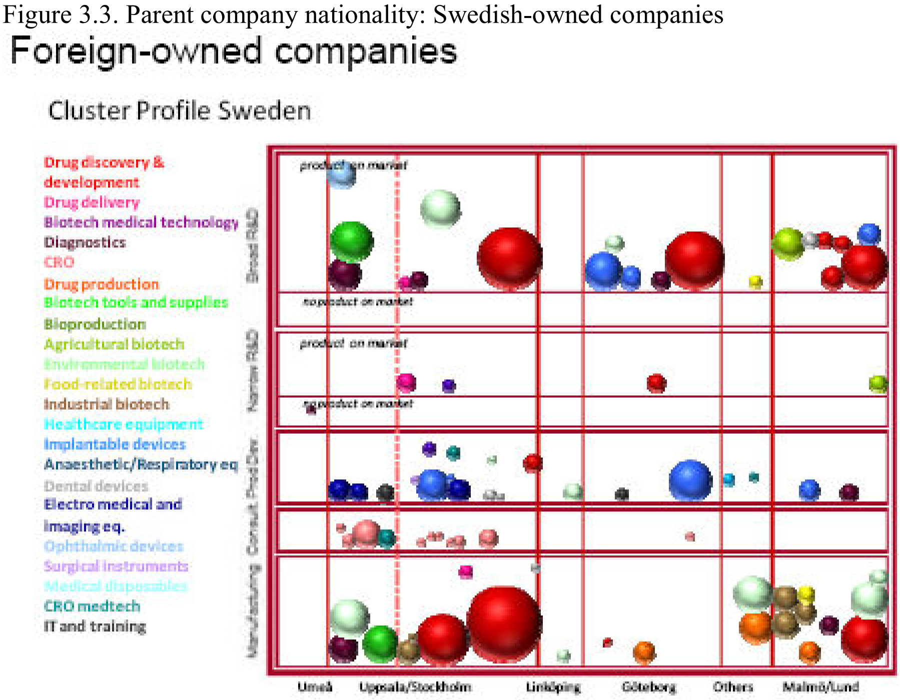


Figure 3.4. Parent company nationality: Foreign-owned companies

Positive and negative results

The companies with positive results after financial items in 2006 are shown in figure 3.5. The large companies are overrepresented among the companies with positive results. Companies that perform broad R&D also mainly show positive results. Within the group of companies with a product on the market, the companies that perform broad R&D predominantly have positive figures whereas those that perform narrow R&D mainly are on the negative side. Manufacturing companies mostly show positive results. Companies with a zero result appear in the above ball diagram of companies with positive business results.

The companies with negative results after financial items are shown in figure 3.6. The small companies are overrepresented among the companies with negative results. Small drug discovery companies often show negative results. Of the companies that perform narrow R&D, more show negative results in comparison to those that perform broad R&D. Many of the consultancy companies show negative results. Also, many recently started small companies number among those with negative results.

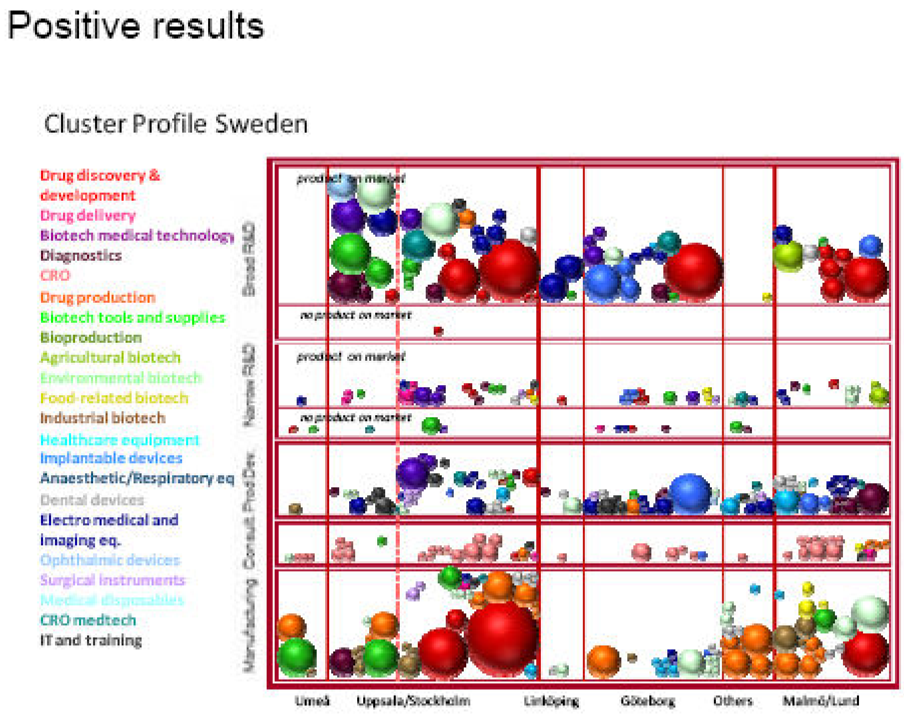


Figure 3.5. Cluster profile Sweden; only companies that had positive results in 2006[18]

[18] National and Regional Cluster Profiles, Anna Sandström and Helena Bergqvist (Vinnova) and Tage Dolk (Addendi), 2007.

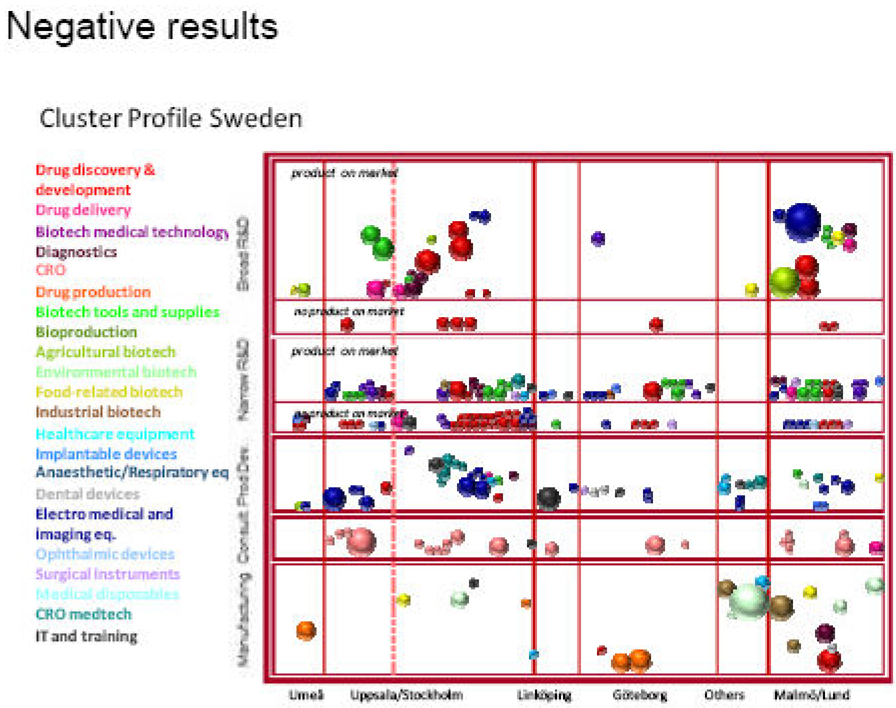


Figure 3.6. Cluster profile Sweden; only companies that had negative results in 2006[19]

Discussion of results in industry structure

The results from the industry structure show that life science is still a very important industry for Sweden in a socioeconomic perspective since it employs so many people. It is also interesting to note that there are several sectors or activities connected to life science which also adds to the socioeconomic importance in terms of employees. One striking feature about the industry structure is the very large amount of very small companies. These were paid special attention in the data management and will be further discussed in the employment development.

The socioeconomic benefit for society does not solely lie in the employment provided by the industry. Naturally, it is also important that the industry show positive results. Among the research companies, this in turn is to a large extent determined by whether the company has a product on the market or not. The result show how important it is for society that the companies can develop beyond the early stages and eventually reach the market. It is also striking that among the largest companies, many are foreign owned. An evident risk with foreign ownership is that new investments and localisation decisions might not turn out to Sweden's advantage since the connection to Sweden might be weakened. On the other

[19] National and Regional Cluster Profiles, Anna Sandström and Helena Bergqvist (Vinnova) and Tage Dolk (Addendi), 2007.

hand, attracting capital from abroad to the Swedish industry is very beneficial for the industry in several ways.

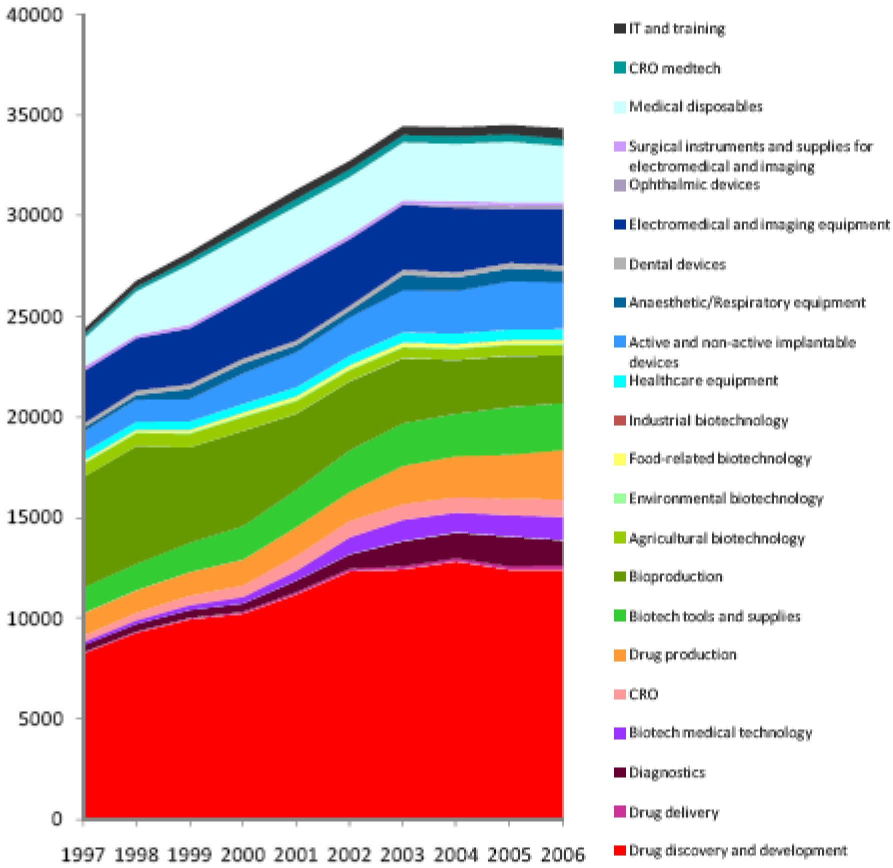
Life science is a heterogeneous sector, as shown by the classification used. Many companies overlap different business segments and there is an increasingly diffuse border between the pharmaceutical sector and the biotechnology sector. This is much due to the biotech methods used in the pharmaceutical research and the biotech companies concerned with drug discovery, or other research areas once associated with pharmacy.

3.1.3 Employment development

Results

Growth of the sectors and business segments over the periods 1997-2006 and 2003-2006.

The collection of data to build the company database was initiated in 1997 for the biotechnology sector and in 2003 for the medical technology and pharmaceutical sectors. Thus, the 1997-2003 result of the two latter sectors as well as the data from the total life science industry over the period 1997-2003 should be interpreted with caution since one underlying factor of the growth is that the firm population for 1997-2003 may be incomplete. Thus, an unknown share of the over 80% increase for the medical technology sector is likely to be due to companies with medical technology activities before 2003 being absent from the database. The error is likely to be smaller for the pharmaceutical sector since many of the smaller companies are also found in the biotechnology sector; these were included in the 1997 biotechnology database, as were the major players like Astra and Pharmacia. With this in mind, however, all three sectors have grown since 1997, as shown in figure 3.7. The life science industry in total has grown with more than ten thousand employees over the ten year period 1997-2006. The small and medium sized companies (SMEs) are primarily responsible for the growth. Excluding companies larger than 500 employees, the SMEs still stand behind the vast majority of the increase in terms of employees. One explanation for this is that although some large companies have increased in terms of employees, others have had large declines. The R&D-intensive companies, large companies included, also make out the vast majority of the increase in terms of employees, meaning that predominantly R&D-intensive companies are responsible for the large increase of the entire life science industry. However, over the period 2003-2006, the life science sector has remained practically unchanged in terms of employment. The medical technology and biotechnology sectors have declined, whereas the pharmaceutical sector has increased. The non-R&D-intensive biotech companies show a decline of 20.5% whilst the R&D-intensive companies have increased by 2.7%. The R&D-intensive medical technology companies also slightly declined, whereas the non-R&D-intensive companies increased by 3.4%.



`Figure 3.7. The employment development of the life science industry[20]

Another way of analysing the expansion is to focus on the companies that have grown and show their characteristics. It turns out that over the ten-year period, the population of growing companies has increased by over 100% overall. In the group of growing companies, R&D-intensive companies are responsible for 64% of the increase. It should be noted that among the companies having more employees in 2006 than they did in 1997, many have decreased their number of employees since 2003.

Decline

Over the ten-year period, about 80 companies ceased to have employees (according to what was known in 2007). However, the majority of these companies are still registered with the Swedish Companies Registration Office. Fifteen companies have gone through liquidation or bankruptcy, including Melacure, UmanGenomics and Virtual Genetics Laboratory. About 20 companies have merged with, or been acquired by other companies, such as Bioglan (W.Sonesson) and Cresco Ti Systems AB (Astra Tech) in 2002, Neopharma (Solvay Pharmaceuticals AB) in 2004,

[20] Bergqvist. H, Dolk. T, Sandström. A, 2007.

Carmetec AB (NNE) and Arexis (Biovitrum) in 2005, Pfizer Consumer Healthcare (Mc Neil) and Biacore (GE Healthcare Biosciences) in 2006 and recently Biolipox (Orexo). Medscand Medical AB moved its entire business to the US in 2005. In 2003, Siemens-Elema ceased to exist. One division was moved to the US, another merged with Dräger and moved to Germany, and yet another division was sold to the Getinge group (Maquet Critical Care), which still has 360 employees in Sweden. Most of the companies which ceased having employees during the period were firms with fewer than ten employees. Medical technology companies are underrepresented among the disappearing companies compared to biotechnology and pharmaceutical companies in relative terms. The pharmaceutical companies are overrepresented among the disappearing companies and the business segments of drug discovery and development and diagnostics have the highest relative shares of disappearances on a business segment level. Several business segments within medical technology have relatively low disappearance rates; for instance, aids for disabled people, electromedical and imaging equipment and medical disposables. Among the biotechnology business segments, biotech tools and supplies have a relatively low disappearance rate.
Turning to the activities of the disappearing companies, manufacturing and consulting are underrepresented whereas R&D is overrepresented. Apart from companies disappearing from the population of companies with employees, there are about 70 companies that have decreased their number of employees over the 1997-2006 period, half being medium-sized companies. Characteristic for the latter group is that the R&D-intensive companies are underrepresented relative to their share of the total population. The decreasing medium-sized companies also show a strong peak in the number of employees in year 2002.

Stagnation

Among the very small life science companies with 1-5 employees, the expansion in terms of number of employees is quit low, also among those established several years ago. The vast majority of the very small life science companies that are more than six years old and held 1-5 employees during the 1997-2000 periods had not grown over 8 employees in the year 2006.

Discussion of results in the employment development

The results from the employment development are interesting. If one chooses to talk about success stories, the 1997-2006 development is encouraging. However, this would give a simplified picture of the development. The industry showed in the end of the 90´s and the very beginning of the new century that the Swedish life science industry was an industry with strong potential to grow. Since 2003 the expansion was replaced by stagnation, and for some business segments there has been a decline. It is therefore very important when conclusions are drawn that the different results that are generated with different time periods considered are highlighted.

In 2002, there was a decline in the overall state of the market. As will be shown in a following section, this was reflected in the development of relative results. At least, there was a sharp decline in the result measure chosen coinciding with the recession. The 2002 dip seem to have affected the employment development with one year of delay. The expansion of the industry stagnated in 2003 and many companies were found to peak in 2002 in terms of employees, thereafter decreasing.

The results show that the increase over the 1997-2006 period for the industry is predominantly explained by an increase in SMEs. It is also the R&D intensive companies that lie behind the increase. The policy implications to derive from this result could be that the efforts to support R&D in existing companies are very important and in addition, specifically SME companies seem to have a strong connection between growth in terms of employees and research.

It is important to understand why so many very small companies have not increased in terms of employees. There are also many companies that have seized to have employees however still registered. In addition, the companies that since the very start have not had any employees are not included in the study. Only those that at least one year in the 1997-2006 period had at least one employee have been included. Together, these companies make out an interesting population for further studies on constraints to growth.

3.1.4 Development of production and relative results 1997 – 2006

Results

To understand the economic development of a highly research-intensive and dynamic industry, it is interesting to trace the production and relative results development for the life science industry in the ten years 1997-2006. The production development is described as net turnover per employee, as well as productivity (value added per employee) and value added. The latter is described in order to indicate the life science industry's contribution to the Swedish GDP. The development of relative results is defined as the results after financial items divided by net turnover. Items affecting comparability have been addressed and are subtracted from the results after financial items, thus generating a relative result ratio linked to the core activity. The chosen business ratios show the development of the entire life science industry, as that industry's three sectors: pharmaceuticals, biotechnology and medical technology. Since the number of companies increases over the period, the net turnover of the different sub-sets of the life science population has also been calculated in relation to the total number of employees of that particular subset. Table 3.1 explains how the business ratios are defined and how they were generated.

Table 3.1 The business ratios used

Terminology used	**Calculated according to:**
Relative result	Σ (results after financial posts - items affecting comparability)/Σnet turnover
Net turnover / employee	Σ deflated net turnover / Σ employee
Value added	Σ deflated value added in absolute terms
Productivity	Σ deflated value added / Σ employee
ITPI (Price index for domestic supply)	1997 = 100
Medical technology sector	ITPI for medical, surgical and orthopeadic equipment, directly derived from Bolagsverket
The biotechnology and the pharmaceutical sector	ITPI for drugs and other pharmaceutical products, directly derived from Bolagsverket
The life science industry	$\left(\frac{\sum_{\textit{Med tech companies}}^{\textit{Net turnover all}}}{\sum_{\textit{Life science companies}}^{\textit{Net turnover all}}} * \textit{ITPI Medical products}\right) + \left(\frac{\sum_{\textit{Med tech companies}}^{\textit{Net turnover all non}}}{\sum_{\textit{Life science companies}}^{\textit{Net turnover all}}} * \textit{ITPI Pharma products}\right)$
Σ	All companies within the group of companies considered
Additional terminology used	**Definitions**
Financial posts	Revenue from interest - costs of interest = net interest income
	Dividend
	Capital gain
Items affecting comparability	Occurrences and transactions that are not extraordinary but may cause a problem when comparing different accounting periods. For instance, selling fixed capital assets.

The net turnover value of each company and year has been deflated. The biotechnology and pharmaceutical sector was deflated by ITPI (Price index for domestic supply) for drugs and other pharmaceutical products and the medical technology sector was deflated by ITPI for medical, surgical and orthopaedic products. A weighted average of these ITPI deflators was used for the different life science industry sub-sets. This was weighted according to the relative volumes of medical and non-medical technology companies, relative to the total volume. By deflating the values, the effect of pricing inflation is taken into account. However, increased product quality could also be a reason for increased prices, but this has not been taken into account. The figures illustrating the chosen business ratios follows in order of relative results (figure 3.8), net turnover per employee (figure 3.9), productivity and value added (figure 3.10). The text, on the other hand, describes each sector starting with the entire life science industry and then describes the biotechnology, pharmaceutical and medical technology sectors.

The life science industry

The development of the relative result (results after financial items relative to net turnover) of the life science industry has followed a bumpy road since 1997. There are three distinct peaks in the relative result development. Over the ten-year period, the relative results of the life science industry range from 10% to 60%. The relative result is lower when excluding larger companies. 2002 is generally known as a bad year on the stock market. This is also the case for the life science industry, particularly for the SMEs. The development for SMEs turned around and peaked in 2004, whereas the peak occurred in 2005 when larger companies are included. Including larger companies, the R&D intensive companies have higher levels of relative results than non- R&D intensive companies. However, the situation is reversed for the SMEs, which show negative results until 2003, with a large dip in 2002. In both populations, the fluctuations are significantly higher for R&D intensive companies. The net turnover per employee has increased over the ten-year period. The 2002 decline also appears in this data. The SMEs have had a lower increase until a few years ago. The R&D-intensive life science companies show a clear positive trend, whereas the non-R&D-intensive companies are more or less stagnated over the same period. Initially, in 1997, the R&D-intensive companies had much lower levels of net turnover per employee, but are now far ahead of the non-R&D-intensive companies. The former group has had a strong development particularly in the last years. The SMEs also show this kind of pattern. R&D-intensive companies started off at lower levels in 1997 than the non-R&D-intensive companies but caught up to almost the same level in 2006. The value added in absolute terms increased strongly over the period. This is also the case for productivity, indicating that the increase is not only a consequence of sector growth in terms of number of companies and employees. R&D-intensive companies show the strongest increase both in absolute and relative terms. Based on the productivity values for 1997-2006, an estimated average growth of productivity has been derived for the ten-year period and reaches almost 9%. For the entire life science industry, this value can be compared to the estimated average growth of all industries; 6.5%. When calculating the ratio of value added in absolute terms for the life science industry relative to the GDP of all industries, this ratio is shown to have increased over the ten-year period, from approx. 10% to almost 25%. Thus, the development of the life science industry in terms of productivity turned out to be significantly stronger than for all industries in Sweden.

The biotechnology sector

The biotechnology sector is associated with volatility, at least on the stock market, which is in accordance with the fluctuations of the relative result of the biotech SMEs. The fluctuations of both medical technology and pharmaceutical SMEs are lower. Including larger companies, the relative results fluctuate moderately and the biotechnology sector shows a slightly increasing trend over the ten-year period. However, it is important to note that a decline has occurred since 2004. In 2006, there was only a weak increase compared to 2005. Nevertheless, biotech SMEs have had a substantial increase since 2005, but nowhere near *their* record year of 2003. The R&D intensive SMEs fell to their lowest level of the ten-year period in 2002, coinciding with the stock market's lowest quotation for the biotechnology sector. The non-R&D-intensive SMEs were also affected but have shown positive relative results for the most part of the period. Including larger companies, the R&D-intensive biotech companies have grown to the same level of relative results as in 2003, constituting an exception to the other biotech sub-sets mentioned. However, the level of relative results for non-R&D intensive biotech companies is significantly higher. The net turnover per employee has increased since 1997. There was a peak in 2001 and a low point in 2003. The 2006 value exceeds the peak value. The R&D intensive companies have not quite fully recovered to the 2001 peak value, whereas the non-R&D intensive companies are far ahead of their highest peak value, which occurred in 2002 and was followed by a sharp decline in 2003. The R&D intensive companies show a stronger increase over the ten-year period than the non-R&D intensive companies. The value added in absolute terms for the biotechnology sector has increased sequentially, with a peak in 2001 followed by a dip in 2002. The curve seems to level away from 2005. This is also the case for productivity. The R&D intensive companies have caught up with the non-R&D intensive companies in later years in terms of value added in absolute terms. This is not the case for productivity.

The pharmaceutical sector
The development of the relative results of the pharmaceutical sector is strongly consistent with that of the entire life science sector, both in terms of the level of relative results and in time, when larger companies are included. This is due to the large impact of AstraZeneca. When considering the diagrams, it should be kept in mind that AstraZeneca has been categorised as an R&D intensive company in this material. Turning to the SMEs, the pharmaceutical sector mainly presents negative results over the ten-year period. Just like the corresponding biotechnology population, they are largely overlapping company populations. The relative result of pharmaceutical SMEs fell drastically in 2002. Over the 2002-2006 period, both the R&D-intensive and non-R&D-intensive SME populations have increased. Including larger companies, there is a decline between 2005 and 2006 irrespective of R&D intensity, but all relative results are positive. The pharmaceutical sector shows a strong development of net turnover per employee out of the three sectors considered. A low point occurred in 2002 but in the last years all the sectors have grown considerably in terms of net turnover per employee and in 2006 reached the highest level over the ten-year period. When excluding the larger companies, the levels are slightly lower over the period and the increase is not as strong as it is when larger companies are included. The R&D-intensive companies have had a stronger development than the non-R&D-intensive companies, just like the biotechnology sector. The 2006 value of the R&D-intensive companies is higher than the corresponding value of the non-R&D intensive companies. However, the SMEs have had a different development. The overall development has been increasing but turning to the R&D intensive companies, their values were higher at the beginning of the period. The value added of AstraZeneca in 2000 has been exchanged for an average of

the preceding and following year due to a large deviation in the value added that year compared to the other years. This also concerns the pharmaceutical sector and the R&D intensive companies. The pharmaceutical sector has had the largest increase in productivity among the three sectors. Both value added and productivity show a stronger increase for R&D-intensive companies than the non-R&D intensive companies. In the later years, the value added in absolute terms and the value added per employee has shown a particularly strong development for R&D intensive companies whilst both measures have declined for non-R&D intensive companies.

The medical technology sector

Compared to the pharmaceutical and biotechnology sectors, the medical technology sector fluctuates less and has had positive relative results. This, regardless of what sub-set of companies one chooses to look at in terms of R&D intensity and size of companies included. The medical technology sector shows higher results for R&D-intensive companies than non-R&D-intensive companies. This holds true both for SMEs and when larger companies are included. This sector, like the pharmaceutical sector, is characterised by a few larger companies such as the Getinge group, Phadia, Astra Tech, Gambro and Elekta. However, the development of SMEs strongly resembles that of the entire medical technology sector. One important exception is the results after financial items for Gambro in 2000, which has such a large impact on the overall result that particular year that it has been excluded from the data. The net turnover of the medical technology sector has been on a high level since 1997 compared to the other sectors. The low point in 2003 has been more than recovered. It is interesting to note that the R&D intensive companies had lower levels of net turnover per employee than non-R&D intensive companies at the beginning of the period and that at the end of the period, the situation is reversed. Both the value added in absolute terms and the productivity for medical technology are lower overall than for the other two sectors and the increase has not been quite as strong. The R&D intensive and non-R&D intensive companies started out on the same levels in 1997. The R&D intensive companies are now significantly ahead.

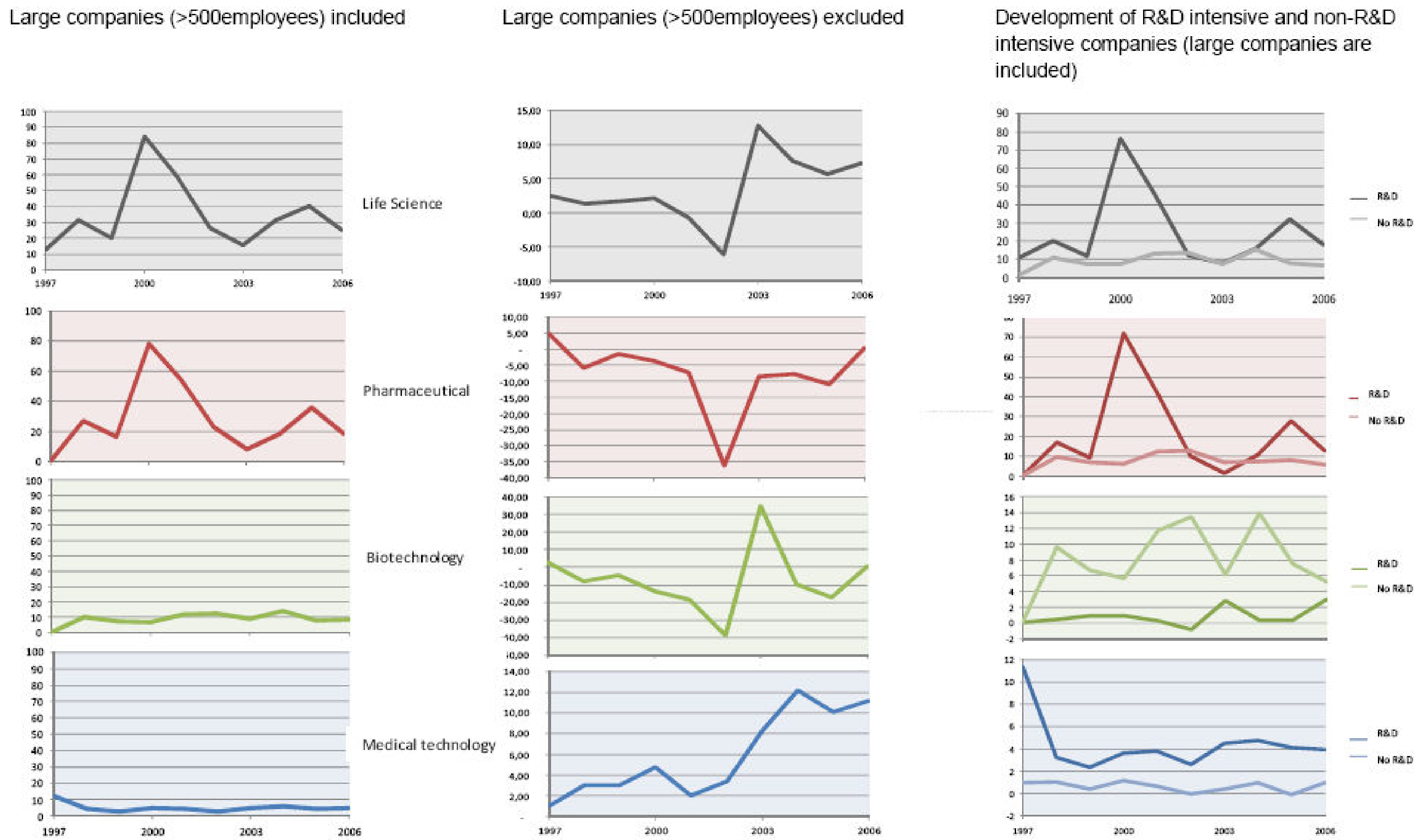


Figure 3.8. Relative result (%) / National and Regional Cluster Profiles, Anna Sandström and Helena Bergqvist (Vinnova) and Tage Dolk (Addendi), 2007.

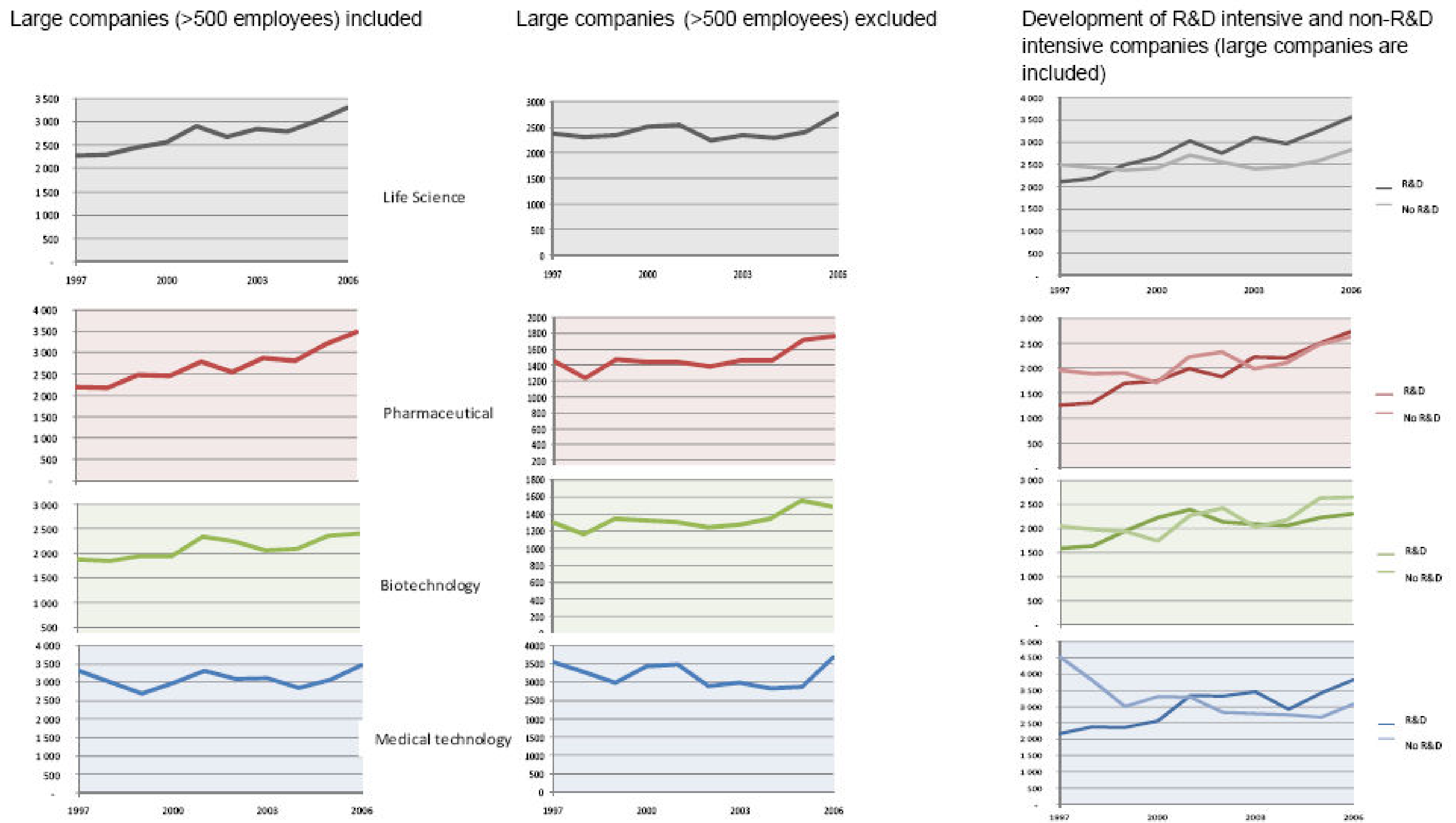
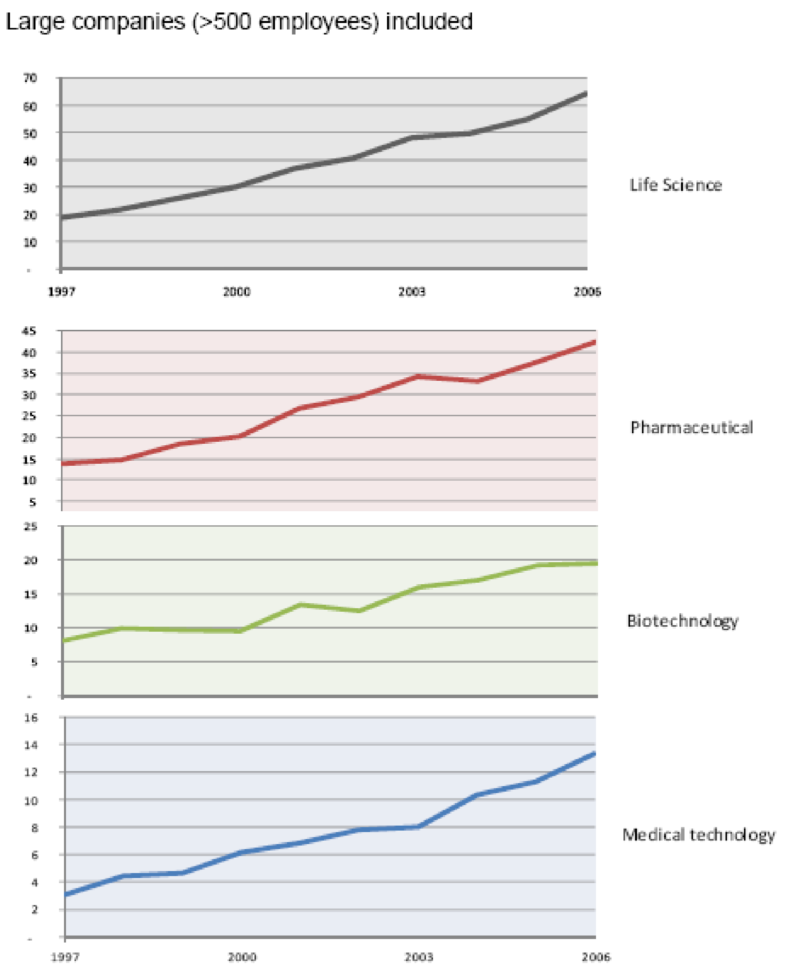


Figure 3.9 . Net turnover per employee (TSEK)/ / National and Regional Cluster Profiles, Anna Sandström and Helena Bergqvist (Vinnova) and Tage Dolk (Addendi), 2007.



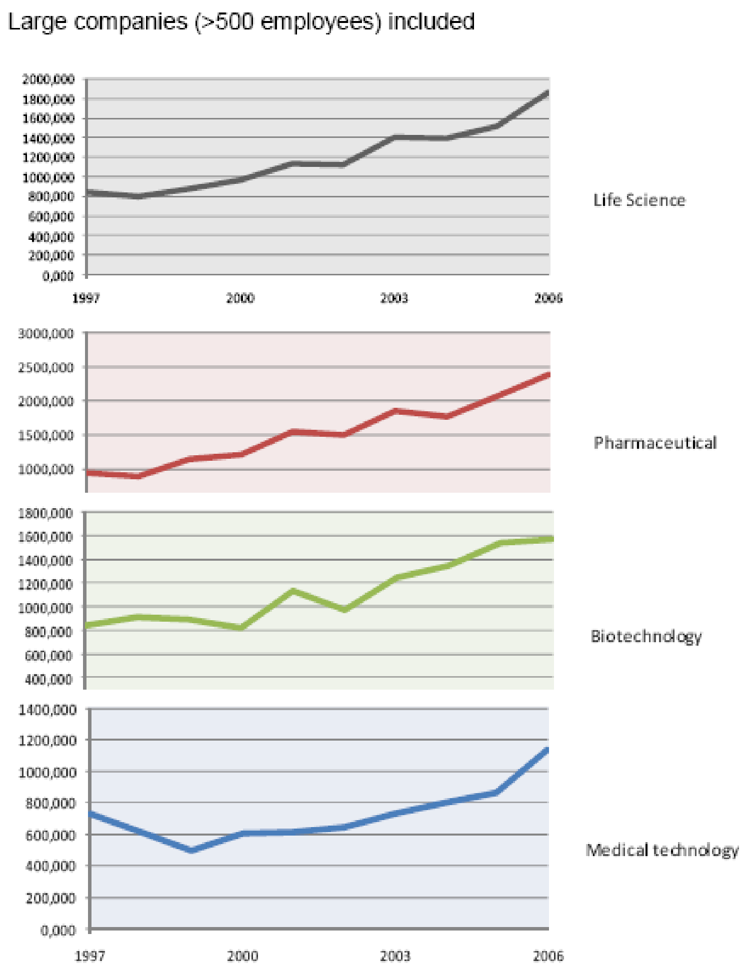


Figure 3.10 . Value added in absolute terms (BSEK) and value added per employee (TSEK)/ / National and Regional Cluster Profiles, Anna Sandström and Helena Bergqvist (Vinnova) and Tage Dolk (Addendi), 2007.

Discussion of results

The development of relative results, value added and productivity is more encouraging for the life science industry than the employment development. When considering biotechnology however, there has been a decline in the relative result in 2004-2006. The relative result of SME biotech companies have increased since 2005, but this increase should be viewed in the perspective of the very low levels of previous years. It is still not near the levels of 2003, which was the record year for biotech SMEs. The 2002 dip on the stock market seem to correspond more to the situation of the SMEs to than that of the large companies. On explanation could be problems for the SMEs to access venture capital. Also, the fluctuations on the stock market seem to be affected to a larger extent by the R&D intensive companies than the non R&D intensive companies.

The results from considering the development of net turnover show not only a positive trend but also that the R&D intensive companies are the winners in terms of this measure. The biotechnology sector constitutes an exception. One explanation for this could be that within this sector, the non-R&D intensive companies decreased in terms of employees by over 20% from 2003 to 2006. This might imply that many of the unsuccessful non-R&D intensive companies are no longer around or that they to a higher extent have cut the number of employees to handle downturns in their business. It should be held in mind that the net turnover is calculated per employee of the entire sector.

The value added per employee and the productivity was also compared for R&D intensive and non-R&D intensive companies. Just like the net turnover results, the R&D intensive companies came out the highest in the comparison. The exception was the productivity development for biotechnology. As described above, the decrease in number of employees among the non-R&D intensive biotech companies could partially explain for this.

The high productivity development compared to all other industries show the potential of this industry. Together with the positive trend in value added, both in real terms and per employee shows the importance the industry could play in a knowledge economy. Since several measures were calculated per employee, the positive trends could not solely be attributed to the growth of the sector in terms of employees. Particularly since the trends for net turnover and value added are positive also over the 2003-2006 period, when the employment development stagnated. The positive trends and yet stagnated employment development would be an interesting issue for future studies to explain.

The importance of AstraZeneca is demonstrated by the large effect their relative results, value added and productivity have on the total sector. This implies that it is the very large companies that are the driving force in the Swedish life science industry. The result of the pharmaceutical sector's development is particularly a consequence of the AstraZeneca development.

3.2 Activities

The three activities chosen for the focus of this report will be outlined one by one for the Swedish life science innovation system (SLIS). First, the knowledge development of SLIS will be described; secondly the financial support system and finally the policy development.

3.2.1 Knowledge development

Generation of knowledge elements

Factors affecting the direction of research

The discussion in later years about the factors that affect the direction of research has circulated a lot around the commercialisation of university research and the industrial funding of university research. Many of the participators in the debate were linked to life science. In 2002 there were many worries about the effect of commercial interests on the future of the "free research". It was claimed that the commercial interests would have a negative impact on the direction of research and would create ethical conflicts[21]. Several actors reacted more or less against this and in support of a development towards more entrepreneurship in the academy and needs-driven research[22]. Vinnova, having the task to fund needs-driven research, advocated the view that both research types were necessary[23]. In the debate it was pinpointed that research groups with strong links to the industry in many cases are the most productive research environments[24]. As far as life science is concerned, the discussion climate has turned into much more positive attitudes towards the commercialisation of research. For instance did the policies turn at the Karolinska Institute[25] in the 90´s, with Professor Hans Wigzell as president[26]. The lack of grants to researchers was seen as a larger problem than potential conflicts of interest[27].

---

[21] Ullenius. C, 2002
[22] Hällsten. M, Sandström. U, 2003, page 11-13
[23] http://www.vinnova.se/In-English/About-VINNOVA/
[24] Laredo 1999, Darby och Zucker 1995, 1998, jfr. Sandström 2003
[25] Interview Sandström, Anna; VINNOVA; 200801??
[26] Interview Sandström, Anna; VINNOVA; 200801??
[27] Wallberg-Henriksson, 2002

Among the largest currently debated issues debated today related to the direction of research within life science is the selection of key technologies. The selection of key technologies is discussed in the policy section (3.2.3).

Public Research funding

University research is financed either by public grants, external funding or interest from own capital funds. The sources of external funding includes research councils, foundations, EC, companies etc. and most often has to be applied for by the researchers themselves. There are different views on what should be defined as public funding among the different types of external funding. The public external funding includes the funding from research councils (The Swedish Research Council, FAS and FORMAS), public authorities (Vinnova) and EC framework programmes[28]. The views are parted when it comes to foundations like the Knowledge Foundation and Swedish foundation for Strategic Research

The Swedish Research Council is the largest external financer and allocated 500 million SEK to medical research in 2005[29] and approx. 580 million SEK in 2006. They support basic research by peer review[30]. Characteristic for financing of medical research is that funding could be sought from many different sources but at the same time relatively small sources[31].

The Swedish R&D expenses in 2005 at the different life science related university institutions are outlined in figure 3.11[32]. The public funding constitutes about 50% out of the allocation to the universities. The public grants to medical faculties decreased with 20% over the period 1993 to 2001.This has been heavily criticized and leads to a large dependence on external funding. The share of public external funding from research foundations to medical faculties also decreased with 20% over the period[33].

Public and civil R&D expenses relative the GNP currently augment to 0.79% which is below the EC 1% target but higher than most countries[34].

---

[28] Drammeh. B, 2005, page 3.
[29] Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, page 40.
[30] Drammeh. B, 2005, Page 5
[31] Hällsten. M, Sandström. U, 2003, page 7
[32] Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, page 41/ SCB 2007
[33] Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, page 43 and 45
[34] Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, page 39

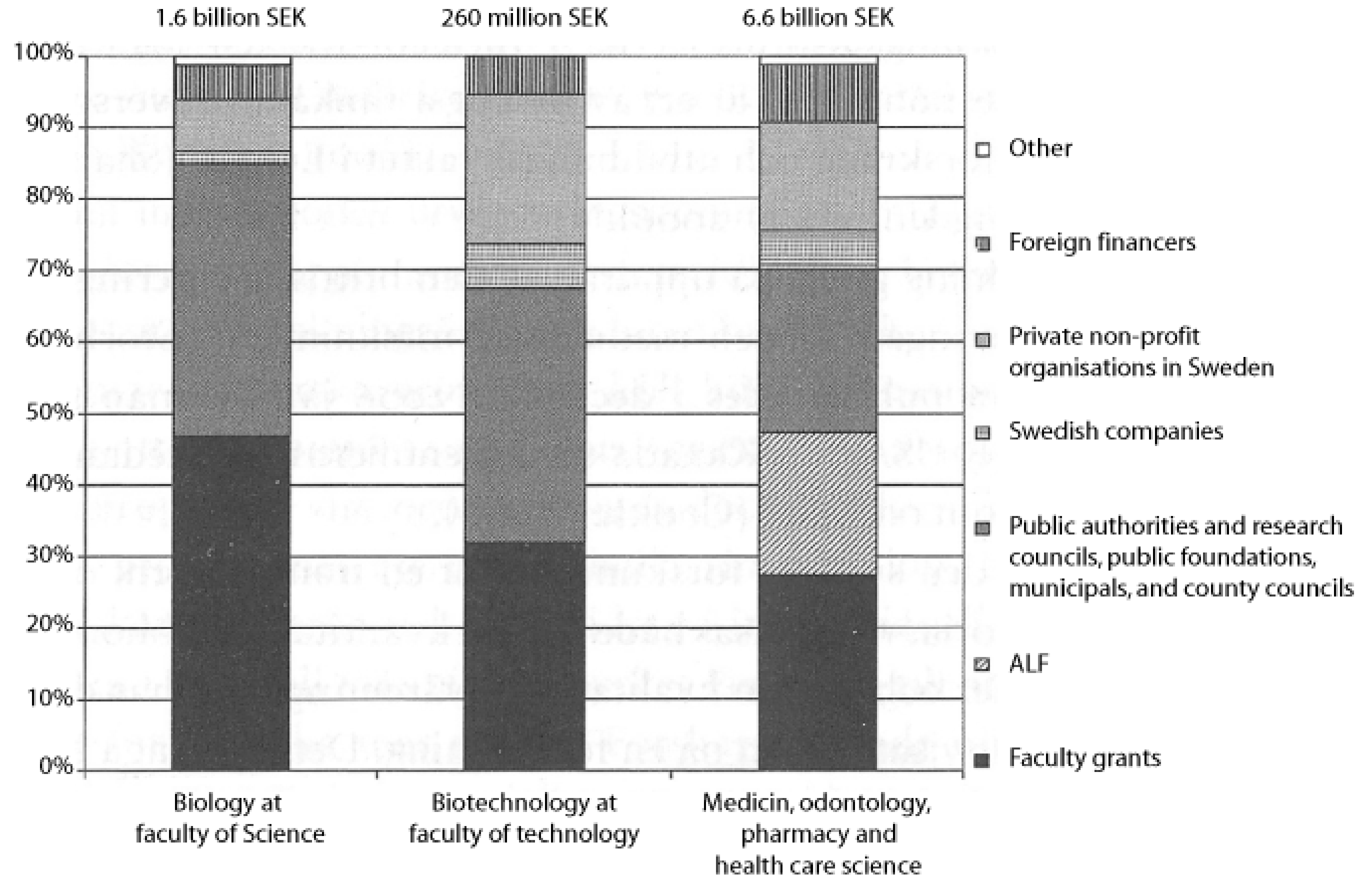


Figure 3.11. The resources and sources of resources for research within medicine and biotechnology in 2005[35]

Industrial R&D expenses and other private R&D funding

When it comes to industrial funding of university research, the medical research achieves relatively high shares from industry. The shares of industrial funding of university R&D also increased strongly over the 1995-2001 period. Behind the increase stand foreign companies whereas the Swedish companies have had practically unchanged contributions to university research over the same period[36].

Private funding is very important in Sweden, particularly for the research fields of proteomics and functional genomics. The Knut and Alice Wallenberg foundation has allocated 240 million SEK to the Human Proteome Resource over four years and 800 million SEK to functional genomics over five years[37]. The foundation for cancer research annually

[35] Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, page 41
[36] Hällsten. M, Sandström. U, 2003, page 9
[37] Invest in Sweden Agency, 2003, page 24

allocates about 300 million SEK to cancer research[38]. The overall Swedish R&D expenses in 2005 were 102 billion SEK and out of this, the industry stood for 75% or 76 billion[39]. It is also claimed that the share of funding from the industry to medical research is relatively high[40]. However, compared to technical faculties, the industrial funding is not particularly high. In 2005, companies and foreign sources other than EC funding financed 11.5% of the research income at the technical faculties and 11% at the medical faculties[41]. The total R&D expenses out of the GNP is shown in figure 3.12 and augments to about 3.9%[42]. It should be noted though that this is for the most part a result of private funding[43], and within life science AstraZeneca obviously stand for the largest share[44]. The R&D expenses of AstraZeneca also constitute a significant share out of the total R&D expenses[45].

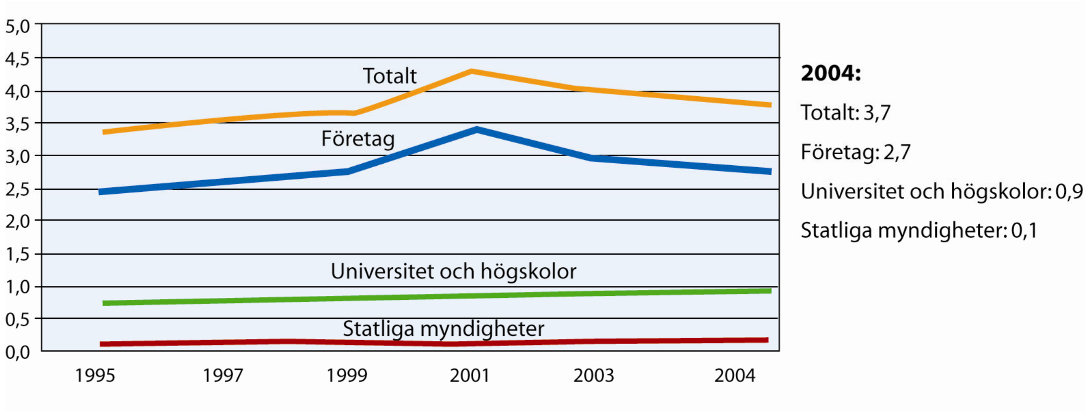


Figure 3.12. The share of total R&D expenses out of GNP and the contribution per sector over time[46]. From the top: Total, Companies, Universities and last public authorities.

Access to knowledge elements

Technological knowledge base

---

38 Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, page 40
39 Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, page 39
40 Hällsten. M, Sandström. U, 2003, page 7
41 http://www.scb.se/templates/PlanerPublicerat/ViewInfo.aspx?publobjid=1519&lang=SV
42 Main science and Technology Indicators 2005-1/ Congress of Swedish Association of Scientists 2006
43 Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, page 39
44 Bergqvist. H, Dolk. T, Sandström. A, 2007
45 Anvret. M, 2008
46 Main science and Technology Indicators 2005-1/ Congress of Swedish Association of Scientists 2006

Historically, Sweden has had a strong tradition within life sciences. Clinical research has had, and still has some prominent features in Sweden such as fastness and transparency in the process[47]. The development of new methods within biotechnology research also builds on historical strengths. A great deal of world-class research has been produced with limited resources[48]. Today, about 40% of all research undertaken at Swedish universities is within biosciences and biotechnology, which is comparable to the share in other countries[49]. In some research fields, such as functional genomics, proteomics, regenerative medicine, stem cells and technology platform development, Sweden conduct internationally renowned research[50]. It should be noted that several among these research fields where Sweden excels receives large funding from private financiers, for instance the Wallenberg foundation.

On the other hand, there are several research fields where Sweden used to have a strong technological knowledge base but now lags behind. Clinical research has already been widely discussed in this context, but unfortunately, there are more examples. It has been claimed that there is a certain lack of competence within cell culturing for instance. In this particular field, the demands of existing companies as well as foreign companies that potentially could be established in Sweden are not matched by the current competence base[51]. Although there are risks in listening too much to the short term demands of industry, not listening is also taking a large risk[52]. Many different actors agree on the need for more of pull-thinking and less push-thinking in this matter[53]. According to Sweden Bio, it is the demand from students that impacts the accessible educations to a larger extent than the demand from industry. This kind of student-pull instead of market pull may mislead students if their competence is not requested by the industry[54].

There might be connections between lack of competence in some science fields that have been of particular interest for the industry and the investment decisions made by the companies. Since the merge of the Swedish company Astra and the British company Zeneca, more investments and establishments have been allocated to the UK than Sweden[55].

---

[47] Interview, Williams Ylva, Invest in Sweden Agency, 200705
[48] VINNOVA, 2005, page 37
[49] VINNOVA, 2005, page 33
[50] Invest in Sweden Agency, 2004, page 2.
[51] Norrman Bo, The Karolinska Institute, 200705
[52] Interview, Norrman Bo, The Karolinska Institute, 200705
[53] Meeting at Vinnova with representatives from the bioregions of Sweden, Interview, Norrman Bo, The Karolinska Institute, 200705
[54] Sweden BIO, page 7-9
[55] http://www.astrazeneca.com/node/pressreleaselist.aspx,, press releases 1998-2008

AstraZeneca has been building on the strong knowledge base already existing in certain regions in the UK[56]. It should be noted that his statement is based on the information gathered from all press releases at the AstraZeneca website over the period 1998-2008. In Sweden, 1300 people will be or already has been given notice in Södertälje[57]. On the other hand, some investments were made also in Sweden by AstraZeneca over that period of time. Naturally, investment decisions take into account many aspects, apart from the technological knowledge base. The localisation of a European establishment for production of influenza vaccine is also dependent on a matching competence base[58]. Another example is the company GlaxoSmithKline (GSK) that declined the location of a specific establishment in Sweden based on the lack of a specific kind of competence they needed; cell culturing[59]. This is a competence that is required by most biotech companies but it is too expensive for individual SMEs to build a large scale production entity.

Within medical technology on the other hand, as well as within the business area biotech tools and supplies, relevant competence is easy to access according to the companies, which might indicate a well-functioning exchange between university and industry[60].

Market related knowledge base

A survey has shown that the Swedish life science companies demand personnel that is much specialised within a biosciences field directly applicable for the company. They also have a demand for personnel that combines specialist competence with skills in marketing, economics etc. It has been claimed that there is a lack of competence within international business development in Sweden and particularly when it comes to competence about business development in smaller companies[61].

Characteristic for the life science industry is that a strong knowledge base within intellectual property (IP) protection is crucial. The importance of a strong IP protection, particularly on the Chinese, US and Japanese markets, increases as does the recognition within industry of the importance of this knowledgebase[62]. The knowledge about industrial and intellectual property

---

[56] http://www.astrazeneca.com/node/pressreleaselist.aspx,, press releases 1998-2008
[57] http://ekonominyheterna.se/va/magasin/2007/13/sverige-forlorare-i-hjarn/index.xml
[58] Interview, Williams Ylva, Invest in Sweden Agency, 200705, Interview, Norrman Bo, The Karolinska Institute, 200705
[59] Interview, Williams Ylva, Invest in Sweden Agency, 200705, Interview, Norrman Bo, The Karolinska Institute, 200705
[60] Sweden BIO, page 5-6.
[61] VINNOVA, 2005, page 71-72
[62] Awapatent, 2007, page 15

rights is considered to be a matter of leadership within the companies more than a matter for the product development divisions to deal with, unlike many other industries. The knowledgebase is relatively strong compared to other industries, according to a survey with respondents in a managerial position within life science[63]. It has been claimed though that researchers do not have enough time, money or knowledge to manage filing patents[64].The discussion of whether the teacher's privilege should be removed or not will not be dealt with in this report due to limits in time and the complexity of the question.

Initiatives to specifically increase the market related knowledge base has been difficult to find. The Knowledge Foundation has allocated 60 million SEK over seven years to a program aiming to increase the general competence level in biotech and food SMEs[65]. The programme is a collaboration between a number of universities and the Swedish Institute for Food and Biotechnology[66].

Knowledge transfer

An international committee showed in 2003 that the research groups allocated funding by the Swedish Research Council through a particular programme held high international standard as far as the research was concerned but fell short in terms of commercialisation activities. The researchers were not very interested in commercialising their research[67]. The 2005 life science strategy holds commercialisation of research and increased collaboration between academy and industry as key areas to address[68]. As a consequence, Vinnova was given the task to initiate a programme to increase this collaboration as well as a programme to increase versatility of people between academy and industry, in order to increase the knowledge transfer[69]. However, Vinnova states in 2008 that the versatility between industry, academy and public authorities is low and that there are much too few research contracts from industry to the academy[70]. A current Vinnova programme dealing with knowledge transfer is the research schools. The research schools will have a strong collaboration with industry and are together allocated 200 million SEK over the next eight years.

---

[63] Awapatent, 2007, page 10
[64] Tryggvason. K, 2002
[65] Rydell. I, Wiqvist. E, Zingmark. A, 2007, page 17
[66] http://www.kks.se/templates/ProgramPage.aspx?id=524
[67] Vetenskapsrådet 2003
[68] Ministry of Enterprise, Energy and Communicatios, 2005, page 17.
[69] Government Decision N2006/3329/ITFoU and Government Decision N2006/3328/ITFoU
[70] Vinnova, 2007, page 1

Biomaterials and brain research are among the ten areas selected for the research schools[71].

The institute sector has been found to play an important part in the commercialisation of research for SMEs in particular but is very small in Sweden[72]. Within life science, there is a dominance of a few very large companies and therefore the collaboration between AstraZeneca as well as Pfizer with public research organisations is vital.

There are indications though that the knowledge transfer situation has shifted in a positive direction, at least as far as the Uppsala region is concerned. Uppsala Bio has struggled with the task of changing attitudes towards commercialisation within academia and they now perceive that "attitudes have shifted all the way"[73]. Another indication of life science knowledge transfer between academy and industry is the strong correlation between the regional distribution of research (measured in R&D expenses for biosciences 2003) and the distribution of life science industries[74].

Weaknesses and strengths

The fact that private funding constitutes such a large share of the overall R&D expenses[75] means that the research community, and Sweden as a knowledge economy, also depends on these private investments, which present a risk. It is important to note that this is the case particularly within life science. A few very large companies, most importantly AstraZeneca, affects the situation largely and Sweden therefore depends on their agenda and where they choose to invest. This is shown not only by the large AstraZeneca share out of the total R&D expenses, AstraZeneca also holds almost 30% of the total employment within life science industry and 50% within the pharmaceutical sector, as demonstrated in the industry survey. This means that the employment within the Swedish life science industry is largely dependent on AstraZeneca. It also means that a large share of the Swedish technological knowledgebase within life science is a part of AstraZeneca. Thus, the future decisions of AstraZeneca could impact the Swedish competitiveness on the global arena in several ways. There have been large cuts in AstraZeneca Södertälje in production and sales, due to several clinical failures[76]. Historically, this is where the R&D intensive large companies decrease the number of employees first, since the resources

[71] http://www.vinnova.se/misc/menyer-och-funktioner/Nyheter/Nyheter-2007/071220-Forskarskolor/
[72] Vinnova, 2007, page 1
[73] Interview, Sanders Rhiannon, Uppsala Bio, 200705
[74] Vinnova ,2005b, page 63
[75] Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, page 39
[76] Dagens industri 2007-03-20

are needed for even more research[77]. If the situation for AstraZeneca cannot be turned around, the next step will probably be to cut R&D expenses. This was the case for Ericsson just a few years ago. Half of the R&D expenses were cut. This situation was considered so alarming by the government that emergency actions was required. Vinnova was then given the task to analyse the situation and came up with a 3.5 billion SEK over five year action plan called Vinnitel. Not much happened though and the 3.5 billion SEK became 100 million SEK[78]. Important lessons could be learnt from the IT sector and from other industries. The process that took place in Uppsala Life Science Innovation System (ULSIS), with core activities relocated from Pharmacia could also add to the current picture. There is a discussion in ULSIS about to what extent the development following the Pharmacia move out was really as positive as it was described in media[79]. Some claim that the positive picture was largely exaggerated[80] whereas others claim that the media picture helped attract investors[81]. It could be an interesting subject for further investigation to analyse how the connections of AstraZeneca to the local innovation system differ from the connections that Pharmacia had at the time prevailing the relocations.

In Sweden there seem to be a consensus among actors that more market pull is needed in the technological knowledge base[82]. The difficulties arise when this market-pull is to be translated into concrete rearrangements in the formation of education and research[83]. Too much market pull on the other hand would present a risk of short term decisions.

Suggestions on how to solve the problem of deficient competence within cell culturing in Sweden include collaborative efforts like an institute, where companies in return of a membership fee could have access to a cell bank and the operational competence needed[84], or a flexible solution consisting of a movable laboratory with accessible competence for biotech companies[85]. It has been claimed that the informal collaborations between individuals at different public authorities are well functioning but are weak without economic instruments like larger partnerships with a shared budget[86].

[77] Gergils. H, 2006, page 275.
[78] Gergils. H, 2006. page 275
[79] Waxell. A, 2005, page 57-58
[80] Waluszewski 2003
[81] Jonsson. L, 2003
[82] The Teknik och Tillväxt conference, Royal Institute of Technology, 20071115, Meeting at Vinnova with representatives from the Bioregions of Sweden, Interview, Norrman Bo, The Karolinska Institute, 200705
[83] Sweden BIO, page 7-9
[84] Interview, Williams Ylva, Invest in Sweden Agency, 200705
[85] Interview, Norrman Bo, The Karolinska Institute, 200705
[86] Interview, Williams Ylva, Invest in Sweden Agency, 200705

The technological knowledgebase plays an important part in localisation and investment decisions and deficits in the technological knowledge base seem to have scared off foreign direct investments in some cases. This would implye a serious weakness in the Swedish life science innovation system. One obvious negative effect of loosing out on foreign direct investments is the missed job opportunities. Over the 1999-2006 period, AstraZeneca's investment in the UK approaches 1£ billion and has created 550 science related jobs. In Dunkerque, France, a 114£ million investment created 150 jobs and there are numerous investments in Asia to add to the list[87]. As mentioned before, there were investments also in Sweden during the same period. However, based on the stagnated employment development of the Swedish life science industry[88], it is important to analyse what potential there is to increase foreign direct investments in Sweden.

3.2.2 Financial support systems for innovation

Access to Venture Capital

General access to venture capital

The access to venture capital to biotechnology in Sweden was exceptionally high in 2006 according to Ernst &Young. An increased risk willingness on the stock market and among venture capitalists in addition to a more mature biotech sector lied behind the record level of venture capital to biotech companies[89]. Over the period 2001 to 2003, the access to venture capital in Sweden declined overall[90]. In 2005, a clear positive view of the business cycle particularly affected the medical technology and biotechnology sectors and the access to venture capital increased[91] although the increase should be considered against the very low levels of 2004[92]. New regions captured the interest of investors and particularly the Swedish part of the Öresund region[93]. The investments have also shifted towards more growth investments (seed, start-up and expansion)[94] although the activity within buyout is still very strong[95]. It has aslo been claimed that the owner commitment development efforts has improved in later years[96].

[87] http://www.astrazeneca.com/node/pressreleaselist.aspx, press releases 1998-2007, particularly 2005.
[88] Bergqvist. H, Dolk. T, Sandström. A, 2007.
[89] http://www.e24.se/branscher/lakemedelbiotech/artikel_30637.e24.
[90] Invest in Sweden Agency, 2003, page 22.
[91] Press release 20051202 Swedish Private Equity & Venture Capital Association (SVCA)
[92] NyTeknik 2005-08-23
[93] NyTeknik 2005-08-23
[94] http://www.svca.se/home/news.asp?sid=337&mid=3&NewsId=9357&Page=9 and http://www.biotechumea.se/default.asp?id=4122&ptid=
[95] http://www.apfond6.se/Page.aspx?id=10
[96] http://www.svca.se/home/news.asp?sid=337&mid=3&NewsId=9357&Page=9

Still, a mismatch is perceived in the Swedish life science sector between the investors and the industry. This is due to the large number of small or very small life science companies in Sweden[97]. Their businesses and requirements for venture capital do not correspond to the size of the investments that foreign venture capitalists are seeking to make. Often, the product portfolios are to narrow to present the volume required to capture the interest of investors even though the R&D performed or products are impressive to the investors. Foreign investors are surprised to see that there are companies which conduct approximately the same type of research and develop similar products and still are not merging into one company[98].

Sweden attracts more foreign venture capital than direct industrial investments. Compared to the UK, the Swedish level of R&D related new establishments and expansion investments within life science is modest; 8% and 3% respectively[99]. The foreign capital constitutes significant shares in many biotech companies however, and is often introduced to the companies by Swedish channels, such as private equity funds[100]. The share out of all Swedish biotech companies that are foreign owned is 12.5%[101]

Other sources of non-public venture capital

The business angel market is small in Sweden compared to the venture capital based systems in the Anglo-Saxon countries[102]. Out of the total venture capital market in Sweden, the business angel market constitutes a third[103]. Business angels plays and have played an important role for the life science sector, especially early on in the drug development process. The media interest for this market is claimed by some to have exaggerated the importance though of the business angels [104].

Public Funding

The largest share of venture capital accessible to Swedish life science companies is private, but there are also public financers like the sixth AP fund, Industrifonden and actors connected to the universities[105]. The sixth AP fund holds a total of 15 billion SEK and the largest share, 40%, is allocated to life science companies. Industrifonden allocates about half of its sector specific investments to life science companies[106]. The capital from

---

97 Bergqvist. H, Dolk. T, Sandström. A, 2007
98 Interview, Williams Ylva, Invest in Sweden Agency, 200705
99 Invest in Sweden Agency, 2003, page 13.
100 Invest in Sweden Agency, 2003, page 17.
101 Invest in Sweden Agency, 2003, page 17
102 http://www.esbri.se/referat_visa_b.asp?id=62
103 Braunerhjem. P, Wiklund. J, 2006, page 9-10
104 Interview, Williams Ylva, Invest in Sweden Agency, 200705
105 Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, page 83
106 Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, page 86

the teknikbro foundations has been overtaken by Innovationsbron and will be used as seed capital for early stage companies[107]. The Private financers tend to avoid the early phases due to the higher risk compared to late stages where the commercial potential is easier to predict. Therefore, the public financers like Almi and Industrifonden that provides loans to companies in the seed stage or other early stages can play an important part and sometimes contribute to success stories such as Losec[108]. The public providers of venture capital in pre-seeding, seeding, start-up and expansion stages are outlined in 3.13[109]. (This is an approximate description, the funding previously held in TBS 7 is now pooled in innovationsbron and the "kick-start" funding does not exist) . The figure is divided into pre-commercial (left) and commercial (right) stages of company development.

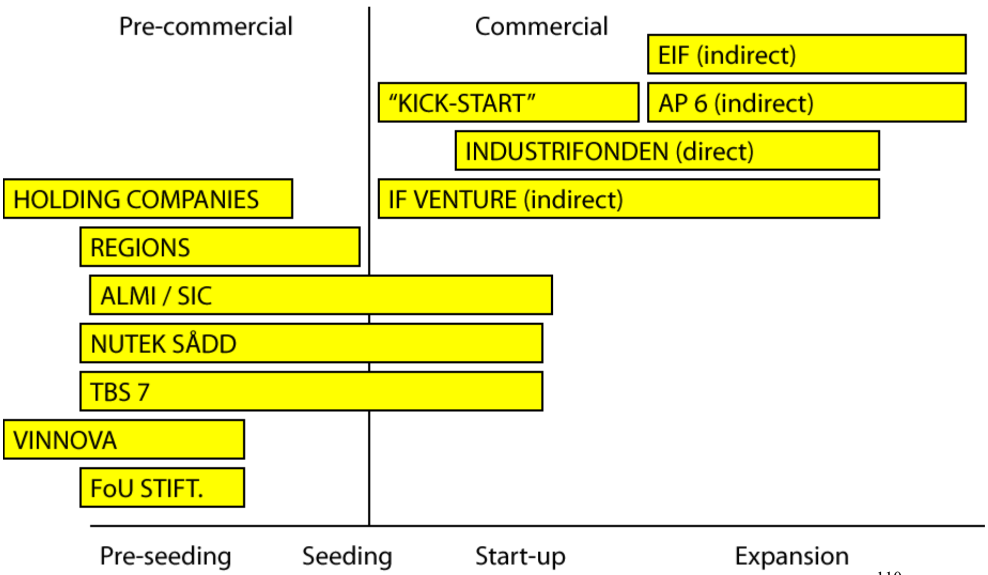


Figure 3.13. The Swedish public landscape for seed and early stage private equity[110].

Weaknesses and strengths identified

In the competition for foreign venture capital, Sweden keeps up with UK when it comes to creating an interest in the life science industry. The Swedish life science industry generally gets good grades by foreign investors. It is the technological height in the company, more than the type or amount of previous received funding that captures the genuine interest of investors[111]. The dilemma occurs in the next phase, when investors seek Swedish objects for their 500 million SEK investments. The Swedish

[107] http://www.teknikbrostiftelsenilund.se/pages_sv/aktuellt/news/050221.html
[108] Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, page 84
[109] Claes de Neergard, 2004, page 19
[110] Claes de Neergard, 2004, page 19
[111] Interview, Williams Ylva, Invest in Sweden Agency, 200705

companies in life science more often seek a venture capitalist willing to invest about 20 million. It is not really a matter of a critical mass in terms of the relative smallness of the Swedish market. The individual companies´ IP portfolios are too small, which presents a problem. Even though their technological height is competitive internationally, the business is usually built on a single patent or family of patents[112]. It is attested that the absence of Swedish candidates for AstraZeneca purchases is also due to the small product portfolios[113]. This is the seamy side of the teachers privilege, which makes it possible to build a company on a single idea, one or a few patents. Cultural barriers between researchers that for a long time have been competitors could prevent a joint of similar businesses into one company. If the entrepreneurial role is played by the researcher, who previously fought with other researchers in the same field for funding, this might disrupt the possibilities for collaboration. With a broader approach to the medical need, the probability of receiving venture capital investment would likely increase[114].

The access to venture capital is fairly good. A deficit could lead to Swedish companies being sold to abroad. Foreign ownership and interests presents both a risk and an opportunity. It could lead to increased foreign investments in Sweden and an inflow of capital[115] but at the same time the foreign interest also presents a risk that the location of the company activity, future investments or revenue from the venture will be in other countries. Therefore it follows as a consequence of increasing foreign capital shares in the life science sector that the relations to the foreign investors are well taken care of on a follow on basis, to ensure future economic benefit to the region/country. The low level of direct investment compared to the UK is a weakness.

The small size of the business angel market is a weakness according to some, particularly for the small companies[116]. The financing that business angels represent allows for a more organic growth for small companies than other types of financing. Small companies often lack the resources to grow by acquisition[117]. Again, the stagnation in employment within the life science industry makes it necessary to look into weaknesses that might be related to constraints to growth. On the other hand, a certain lack of financing in the early-stages might be beneficial for the innovation process. Small companies often have more radical innovation than larger companies

[112] Interview, Williams Ylva, Invest in Sweden Agency, 200705
[113] http://www.e24.se/branscher/lakemedelbiotech/artikel_38819.e24
[114] Interview, Williams Ylva, Invest in Sweden Agency, 200705
[115] Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, page 85
[116] Swedish Foundation for Small Business Research, 2006
[117] http://www.esbri.se/referat_visa_b.asp?id=62

but are also knocked out to a higher extent[118], creating an evolutionary process within the industry that is not entirely objectionable. Among the Swedish life science companies with 1-5 employees before 2002, the vast majority had not grown over 8 employees in 2006[119]. It would be an interesting subject for further studies to examine what effect increased capital would have had on these companies. It could be argued that supporting start-up companies is not as beneficial to achieving critical mass in the sector as it would be to support existing and more mature companies in larger projects[120]. On the other hand, it could be argued that the early-stage, very small companies play a vital role in the development of new knowledge and in the commercialisation process and if a lack of financing constitutes a bottleneck, these important processes are halted[121].

The initiatives towards commercialisation of research in Swedish universities predominantly focus in creating start ups and to a less extent on the prevailing industry[122].. However, since the employment development within life science has stagnated there might be a mismatch that constitutes a hindrance for small companies to access the private venture capital, it could be considered to increase the focus of the public business support products in the company value chain towards later stages, at least to some extent. Initiatives such as the Vinnova programme Forska och Väx probably could play an important role in increasing the growth of small life science companies. Addressing constraints to growth in later stages by business support products is complex however. This is related to the question of when public initiatives should be used not to interfere with market forces. "Public initiatives should for instance not compete with what business enterprises such as consultancies do. Public initiatives are better used in early phases of business development, e.g. reducing the technological risk through R&D incentives or seed financing when the market forces may fail to promote the innovation process. Business support from public authorities to companies is also complicated due to state subsidy regulations. These issues have to be taken into account when trying to address constraints to growth with public initiatives" [123].

---

118 http://www.esbri.se/referat_visa_b.asp?id=62
119 Bergqvist. H, Dolk. T, Sandström. A, 2007
120 Interview, Williams Ylva, Invest in Sweden Agency, 200705
121 http://www.esbri.se/referat_visa_b.asp?id=62
122 http://www.vinnova.se/Press/Pressmeddelanden/2007/2007-03-29-Sju-universitet-finansieras-med-200-milliononer-kronor-for-battre-samverkan-med-naringslivet/
123 Interview, Sandström Anna; VINNOVA, 20080116

3.2.3 Policy evolvement

In this section, the policies regarding certain issues of importance for the innovation system are examined; addressing the global challenge, the collaboration between actors in the innovation system and finally identifying key technologies of strategic importance. These issues were selected since they were found to occur frequently in the UK innovation system and their occurrence is therefore also described in SLIS. The policy study takes a point of reference in the life science strategy that was launched in 2005 by the Ministry of Enterprise, Energy and Communications and how the recommendations given in the strategy has been managed. The strategy was supported by the entire reference group consisting of representatives from the industry, the academy, the government, the public authorities concerned and several other organisations.

Collaboration

Collaboration within the triple helix

In the strategy programme, it is stated that the collaboration between the government, the industry and other relevant actors should be developed and the aim is to increase synergies in different departmental proposals. The focus of the collaboration should be on the long term competitiveness of the Swedish life science industry as well as the current conditions for industry, including taxes and regulations etc[124].

SAMBIO and SAMPOST are consequences of the strategy and both aims to increase the collaboration between academy and industry. SAMBIO also aims to strengthen the conditions for life science companies to participate in 7th framework programme and SAMPOST will facilitate the qualification possibilities for young scientists that wish to collaborate with industry and conduct industry relevant research[125]. A national biotech council was proposed in the strategy in order to increase the power to act and the preparedness. No such council has been established. Nor has a national programme to increase the knowledge about life science been established[126].

Collaboration among financers

Vinnova requests a more efficient collaboration between public research financers and private investors in research, in order to make the public

---

[124] Ministry of Enterprise, Energy and Communications, 2005, page 18
[125] http://www.vinnova.se/Finansiering/Utlysningar---forteckning/Pagaende-utlysningar/SAMBIO-2007/, http://www.vinnova.se/Finansiering/Utlysningar---forteckning/Pagaende-utlysningar/SAMPOST-2007-2/
[126] Interview, Sandström Anna; VINNOVA, 20080116

investment in research more needs-driven[127]. More power to act among the financers and other actors is crucial as a consequence of the global challenge and synergies should be sought after by investors[128]. It has been shown that the Swedish allocations to research within life science are thinly spread compared to the other countries with which we wish to compete[129]. The collaboration between public financers could be improved, according to Vinnova. More common programmes are needed in the innovation system[130].

Among the programmes and business support products available from Vinnova, SAMPOST and SAMBIO requires co-financing from the companies that apply, which leads to total budgets of 70 and 170 million SEK respectively. Co-financing is normally a requirement in the Vinnova funding programmes[131].

International collaborations

Sweden needs to increase its participation in the international research collaborations, particularly within Europe and with America and Asia[132]. In the life science strategy, it is reported that there are bilateral collaboration agreements in place in order to strengthen collaboration with Japan, China and South Africa and there are plans to include India and USA. The agreements are meant to facilitate the collaboration between Swedish research funding or research conducting public authorities and the corresponding foreign public authorities[133].

Key technologies

In the national debate, the issue of selecting key technologies and the need to prioritise in order to achieve critical mass are frequently occurring. There seem to be a consensus among most actors that building on certain research areas of strength is necessary. At the same time it is highlighted that the full range of business support products, targeting different stages of the company development are absolutely necessary for the innovation system[134].

Examples of publicly funded selected key technologies

[127] Research and innovation strategy proposal 2009-20012 (Vinnova) page 2
[128] Research and innovation strategy proposal 2009-20012 (Vinnova), page 3
[129] Interview, Sandström Anna; VINNOVA, 20080116
[130] Vinnova, 2007, page3
[131] Vinnova, 2006, page 2
[132] Vinnova, 2007, page 3
[133] Ministry of Enterprise, Energy and Communicatios, 2005,, page 27
[134] The Teknik och Tillväxt conference, Royal Institute of Technology, 20071115

The pharmaceutical, biotech and medtech industry is acknowledged as a key industry by the Swedish government[135]. The (life science-) industry was one of the industries in the so called industry discussions with representatives from industry, academia and public authorities. VINNOVA gave a recommendation in the biotech strategy in 2005 that 2 billion SEK in additional funding should be allocated to initiatives aiming to support the life science industry and to some extent other high tech industries[136]. The outcome was about 200 million in five years for life science programmes and initiatives[137]. Vinnova identifies life science as a key industry and is not much more specific than that, although some strategic areas have been selected. However, there are certain initiatives like the centres of excellence which could be seen as prioritising means to selected key research areas. For instance, The Uppsala Berzelii Centra for Basic and Applied Research in BioNano Technology at Uppsala University was chosen as one of four strong research centres that were allocated 170 million SEK over ten years. A large share of the funding is allocated by Vinnova. The centre conducts cross scientific research on complex disorders like Alzheimer and Parkinson and develops biotech analytic methods[138].

Addressing the global challenge

In the Swedish science budget proposition of 2007 it is stated that Sweden should be "a leading knowledge economy that is characterised by high quality education and lifelong learning for growth and justice"[139]. It is also stated that there is a relatively high allocation to higher education to achieve this goal[140]. This is where the points of view are parted. It is commonly stated that Sweden *must* compete with knowledge, innovation and renewal[141]. But there are different ways to measure just how much is allocated to research and how much more should be allocated. It has been widely argued in 2007 that Sweden should allocate 1% of the GNP to civil research and this allocation should consist of public means[142].

In the life science strategy from 2005 mentioned initially, different areas were identified that called for action in order to create or keep up Swedish

[135] http://www.regeringen.se/sb/d/2954/a/45823
[136] Interview, Sandström Anna; VINNOVA, 20080116
[137] Interview, Sandström Anna; VINNOVA, 20080116
[138] http://www.vinnova.se/Verksamhet/Starka-forsknings--och-innovationsmillionoer/Berzelii-Centra/
[139] Ministry of Finance, 2007, page 35
[140] Ministry of Finance, 2007, page 38
[141] Ministry of Enterprise, Energy and Communications, 2005, foreword
[142] http://www.vinnova.se/misc/menyer-och-funktioner/Nyheter/Nyheter-2007/2007-12-20-FoI-strategi/, http://www.iva.se/templates/page.aspx?id=4909, http://www.vr.se/huvudmeny/pressochnyheter/nyhetsarkiv/nyheter2007/helaforskningssystemetmastestarkas.5.689ebdf7116f301a8858000685.html

competitive advantages. The importance of addressing the global challenge and ensuring competitive conditions was highlighted[143]. Competitive conditions not only include favourable tax regulations for research intensive companies, good conditions for research and access to venture capital, according to the strategy. It is also mentioned that there is a need for clear regulations to enable companies to adjust to the conditions. The need for clarity and predictability in the tax regulations is still pinpointed by ISA[144].

Explicit initiatives and programmes to address the global challenge

The strategy recommended certain actions in order to create internationally competitive company conditions. Some of these have been handled. For instance, a biotechnical renewal in Swedish basic industries was initiated. A national system for development within drug discovery, diagnostics and medical technology was proposed in the strategy and the outcome was a delegation with 30 million SEK budget to develop such a system. An international benchmarking of the Swedish life science innovation system was also recommended and is apparently addressed, since this very report is one such international benchmarking. The overall project has a 2 million SEK budget over 2 years and will for instance deal with the life science innovation systems of Denmark, India, Singapore and Canada among others.

There are also recommendations which were not addressed or to a less extent than was recommended in the strategy. For instance, the management competence in newly established companies was not supported in any specific programme. The participation of SMEs in EC framework programmes was not addressed within the 200 million SEK budget of public means. Instead, Sweden Bio has established an office in support of SME participation, partly financed by Vinnova. Vinnova also provides financial support during the application phase[145]. A consequence of the strategy was an analysis of the infrastructure for biotechnical production connected to clinical trials. The analysis identified a need for a pilot establishment for scale up that SMEs could access.

Since the Swedish export currently is very dependent on a number of very large companies[146], particularly within life science[147], it is important to support SMEs trying to enfer international markets. The SMEs are often restricted to grow internationally due to a lack of financing. Therefore, the

---

143 Ministry of Entreprises, Energy and Communications, 2005
144 Interview, Williams Ylva, Invest in Sweden Agency, 200705
145 http://www.swedenbio.se/templates/Links.aspx?id=1973
146 http://www.swedishtrade.se/dagensexportnyheter/?pageid=8026
147 Bergqvist. H, Dolk. T, Sandström. A, 2007

Swedish Trade Association has launched “export loans” that aim to reduce the risks for SMEs to export and close large business deals. These loans are the result of collaboration between several financers like Almi and Swedfund[148].

Weaknesses and strengths identified

One of the recommendations of the strategy that was not transformed into action was a national programme to establish a dialog with politics and community to increase the knowledge about life science[149]. As described in the technological knowledgebase section, the Swedish people already are relatively well informed about biotechnology. However, it could be argued that a strong knowledge base in the community will be increasingly important, therefore motivating such a programme. According to foresights of several actors, patients will play an increasing role as customers in the future[150]. The industry will have to address this and develop medicals with more customer focus than pure scientific approaches[151]. This means that the attitudes of the clients will affect the innovation process either limiting the development or creating a demand for new products. In this perspective, two consequences can be noted; the information level among the clients will be crucial. For instance, attitudes towards some research fields among the public based on deficit knowledge or misbelieves can affect the direction of research. On the other hand it is important that researchers listen to the concerns and opinions of the public community. The Swedish people have the highest fact knowledge about biosciences and biotechnology in the EC[152] and this is something that has to be maintained as a competitive advantage. In addition, the fact knowledge among politicians, media and other policy makers needs to be high. The other consequence of the development towards more of a client-pull within life science is that innovation in procurement will play an increasing role, since this will affect what products and treatments the public comes in contact with

The national biotech council that was proposed in the strategy in order to increase power to act and preparedness (and that has not yet been established), could play an important strategic role in Sweden. As will be described in UKLSIS, the Technology Strategy Board is a public authority which covers these functions for life science in the UK. Many actors in Sweden have pinpointed that the industry discussions need to be re-established. Thus, there seem to presently be a gap in SLIS, which could be

---

[148] http://www.swedishtrade.se/dagensexportnyheter/?pageid=8026
[149] Interview, Sandström Anna; VINNOVA, 20080116
[150] Royal Swedish Society of Engineering Sciences, 2007, page 28.
[151] Royal Swedish Society of Engineering Sciences, 2007, page 28
[152] Vinnova, 2005a, Page 58

filled by an actor that in a collaborative manner (with representatives from different parts of the triple helix) took on strategic responsibilities with a focus on life science. The global council has general strategic responsibilities[153].

Many actors seem to agree that we need to select key technologies but no one wants to do the pinpointing[154]. It is a delicate matter to focus efforts and consequently to decide who should be tasked with the responsibility of pinpointing[155]. A broad range of competence is needed and actors from industry, academia and public authorities etc need to share the responsibility. This is also a question of collaboration between actors and in this perspective, there is a potential for much improvements as described in the knowledge development section.

Sweden needs a consensus among actors on how to measure the size of publicly financed civil research. Naturally, there will always be a discussion going on whether enough money is allocated or not, but the discussion is constrained from both sides as long as there is a discrepancy in the definition of what is included in the 1% that is widely discussed. Some focus should be turned by Vinnova and other actors to the definitions of the Ministry of Finance as well as discrepancies in the basic assumptions, in order to achieve consensus in the discussion about a larger research budget. It must be demonstrated what economic benefits the increased research budget would have. In the 2007 budget proposition, the Ministry of Finance states that there might not be a connection between large investments in research and quality[156]. The economic benefits of a potential increased research budget should be analysed in a larger context than the most immediate effects.

---

[153] http://www.sweden.gov.se/content/1/c6/08/49/73/29f74bfa.pdf, page 5
[154] The Conference Teknik och Tillväxt, Royal Institute of Technology, 20071115 and Svt 24 debatt 20070912
[155] Meeting at Vinnova with representatives from the Bioregions of Sweden
[156] Ministry of Finance, 2007, page 38

4 The UK Life Science Innovation system

The UK life science innovation system (UKLIS) is described with a point of reference in the national activities. The ambition is that UKLIS, Cambridge Life Science Innovation System (CLIS) and Scottish Life Science Innovation System (ScLIS) together will give a full picture of the overall innovation system for life science in the UK, on different spatial levels. There are obvious differences between Sweden and the UK when it comes to life science market size, number of universities, inhabitants and other factors that introduces difficulties in the comparison of UKLIS and SLIS. As mentioned in the choice of analytic model and approach, this approach hopefully gives a more adequate comparison. Unlike SLIS, the industry survey is not outlined for UKLIS since corresponding data was not accessible for the UK. Since there has been large restructuring among public authorities as late as the summer of 2007, an additional section has been added to the policy development activity. These restructurings are important to analyse in order to understand the ambitions of the policy makers and interviews were therefore performed with representatives from a couple of the concerned public authorities.

4.1 Activities

Just like the SLIS, the activities chosen are knowledge development, financial support systems and the policy evolvement.

4.1.1 Knowledge development

Generation of knowledge elements

Public funding

The Barcelona European Council set a target that R&D should reach three per cent of GDP by 2010 for the European Union as a whole, with the public sector funding one third[157]. In the spending review ”UK innovation framework 2004-2014”, a target level of 2.5% of GDP by 2014 has been set out. An augmentation of £16.5 billion in real terms, 2004-2005 prices, will be required[158] and will be reached by an average annual growth rate of 5.8% in real terms over the Spending Review 2004 period[159] (2004-2008).

[157] Former Department of Trade and Investment, 2004, 4.4
[158] Former Department of Trade and Investment, 2004, 4.15
[159] Former Department of Trade and Investment, 2004, 4.11

According to the DTI Science Budget Allocation 2005, the Science Budget of DTI will increase with 26% to £3.45 billion in 2007-2008 compared to 2004-2005 (see table 4.1). During the period 1997-2007, the Science Budget will have more than doubled[160].

Table 4.1. The Science Budget will rise to £3.45 billion by 2007-2008[161]

£M	2004-05	2005-06	2006-07	2007-08
Science Budget	2734	3087	3235	3451
Of which				
Resource	2519	2883	3001	3197
Capital	215	204	234	254

The main public funders of life science research and their allocations are outlined in figure 4.1. This data has been gathered from Science and Innovation Investment Framework 2004-2014, budget reports and various other documents and was verified in interviews with DIUS and TSB representatives. The allocations do not only include pure life science related allocations. DIUS allocates funding to life science research through the research councils BBSRC and MRC and through the Higher Education Innovation Fund (HEIF) and the Technology Strategy Board. The Department of Health funds life science research through the National Institute for Health Research. The BBSRC is the UK's main founder of basic and strategic research[162]. The MRC allocates their largest share of funding to Molecular & Cellular Medicine.

[160] Former Department of Trade and Investment, 2005
[161] Former Department of Trade and Investment, 2005
[162] http://www.bbsrc.ac.uk/about/Welcome.html

	Department	Organisation	time period	CSR allocation from the science budget (m)	Allocation target
HM Treasury	DIUS	BBSRC	2005-2006	£326.5	BBSRC funds research that increases understanding of how living organisms function and behave, clinical sciences excluded.
			2006-2007	£386.5	
			2007-2008	£427	
			2010-2011	£471	
		TSB	2005-2006		Promote and support research, development and the exploitation of science, technology and new ideas to benefit business, increase economic growth and improve the quality of life
			2006-2007		
			2007-2008	£197	
			2010-2011	£267	
		HEIF	2006-2007	£85	Strengthen links between academia and business and help take R&D to market
			2007-2008	£85	
			2010-2011	£113	
		MRC	2005-2006	£224	Research and training support in universities and teaching hospitals.
				£238	Research and training support in MRC units and institutes.
				£50	Research training for post-graduate students and fellows
			2006-2007	£551.3	Improve human health through world-class medical R&D
			2007-2008	£543.4	
			2010-2011	£707	£1,7 bn — A single health research fund managed by OSCRH to support clinical trials etc.
	DH	NIHR		£1bn	
			2006-2007	£50	Capital Funding
				£703	Clinical research in the NHS, research commissioned for policy development, and the NHS costs incurred in supporting research funded by other bodies such as the Research Councils and charities, the UK Clinical Research Collaboration
			2007-2008		
			2005-2006		
Total DIUS science budget (bn)			2007-2008	£3.4	
			2010-2011	£4.0	

`Figure 4.1 The funding allocations to research from UK public authorities related to life science[163]

Industrial R&D expenses and other private R&D funding

In order to achieve the 2.5 % target, the government stresses that the private sector funding should stand for 1.7% of GNP. The government highlights the need for the private sector to match the framework ambition, since the

[163] Compiled by Helena Bergqvist (Vinnova) 2007

private sector contribution to research is relatively low[164]. As shown in figure 4.2, the level has also decreased significantly over the 1986-2000 period[165]. In 2005, business expenditures on R&D as a proportion of GDP were 1.08%. However, this is higher than the preceding years and the decline seem to have been arrested[166]. A relatively large share of the industrial R&D expenses is from affiliates of foreign companies, 45%. The Strategy for International Engagement highlights this as a strength that need to be recognised to remain attractive and to further increase the UK attractiveness of foreign business and research expertise[167]. Out of the total UK R&D funding, foreign-owned businesses stand for a third. In cash terms their investment increased from 4.7 billion dollars in 1997 to 8.5 billion dollars in 2001[168]. The data is general and not exclusive life science statistics. The BBSRC however confirms that the situation applies to life science and that they are working to get the industry involved to a larger extent and an increase of industrial funding. They also try to achieve a balance between this aim and the aim to focus on certain key technologies[169].

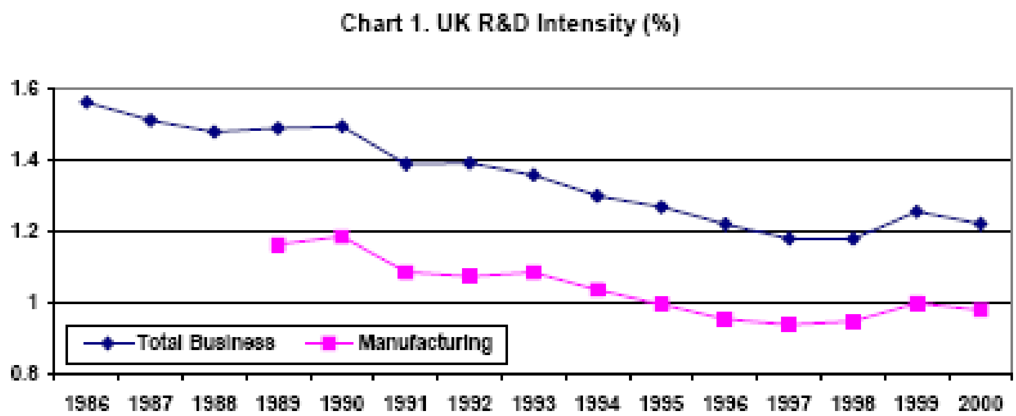


Figure 4.2. The total industrial R&D expenses as a share of UK GDP at market prices[170].

Access to knowledge elements

Technological knowledge base

The UK´s current position in the world when it comes to research excellence is second only to the USA, according to the Science and

[164] Former Department of Trade and Investment, 2004
[165] Becker. B, Pain, 2003, page 14
[166] Science and Innovation Investment Framework 2004-2014, Annual report 2007, page 26.
[167] Global Science and Innovation Forum, 2007
[168] Technology Strategy Board, 2006
[169] Interview, Williams Mari, BBSRC, 20071016
[170] Becker. B, Pain, 2003, page 14

Investment Framework. In those research areas where UK is not second, this gap should be closed in the coming years. As shown in figure 4.3, Bioscience is among the areas which are ranked as second.

Research field	World ranking	Trend 96-05	Highlights
Bioscience	2	↔	• UK increasing overall citation and highly cited share.
Business	2	↑	• UK very high on citation "productivity".
Clinical	2	↑	• Agile research base – second in seven out of ten broad research disciplines
Environmental sciences	2	↔	
Humanities	2	↔	
Pre-clinical	2	↔	
Social sciences	3	↑	
Mathematics	4	↔	
Physical sciences	4	↑	
Engineering	4	↔	

Figure 4.3. The world ranking of certain research areas in the UK based on PSA[171] target metrics[172]

The UK has had a steady grip on the second place since 1996 according to the figure. Pre-clinical and clinical research in the UK also are world second, the latter research area has been in the offering during the period and has augmented its position. A new set of indicators will be used departing from 2009 in order to simplify the metrics and increase focus on research quality[173]. Among the UK bioscience strengths are all underpinning sciences, like cell biology, molecular biology and biochemical research.

171 Public Service Agreement, for definitions see; http://www.berr.gov.uk/files/file38817.pdf
172 Department of Innovation, Universities and Skills, 2007a, page 12-13.
173 Department of Innovation, Universities and Skills, 2007a, page 12-13.

Genetics, stem-cells and nano-bio are coming up strong. Big Pharma is also strong in the UK according to BBSRC[174]. Agricultural biotechnology and food biotechnology are not as strong though. One reason for this is that it is easier to “sell medical R&D investments”. GMO in agriculture has faced lots of resistance in the UK which has affected these areas as well. There is a need for improvement in the science fields of bioinformatics, animal physiology and veterinary science. Overall, UK is internationally competitive when looking at citations and publication data[175]. Since the 90´s there has been a major shift towards more demands on BBSRC and other research councils to demonstrate the effects of their funding in terms of economic benefits to the society. The requirements have increased from politicians to show effects. One problem associated with this development is that such information is hard to access and therefore the availability to information might affect the work of the research councils[176].

Market related knowledge base

“Greater responsiveness to the needs of economy”[177] is the headline of one science and investment framework chapter. This ambition is linked to knowledge transfer and commercialisation, but it is also linked to the market related knowledge base among researchers, CEOs etc. New patents filed, licensing agreements and income from business through consultancy has increased, as shown in figure 4.4. The increase in absolute terms is given by table 4.2. According to the science and innovation investment framework 2004-2014: annual report 2007, the increase in licensing agreements and income from licensing in relation to the decrease of number of spin-outs since 2001 indicates that more focus is attributed to quality than quantity of spin-outs. Since the likelihood of success and financial returns are higher for licensing than spin-outs, the former is encouraged and the increase has been very significant in just a few years[178]. In the comparison between UK and the US, it should be noted that the absolute levels of the indicators used in figure 4.4 are many times higher in the US. For instance, in 2003-2004 the IP income from licensing was £632M whereas the corresponding UK value is £38M[179].

[174] Interview, Williams Mari, BBSRC, 20071016
[175] Interview, Williams Mari, BBSRC, 20071016
[176] Interview, Williams Mari, BBSRC, 20071016
[177] Department of Innovation, Universities and Skills, 2007a, page 19
[178] Department of Innovation, Universities and Skills, 2007a, page 19
[179] Department of Innovation, Universities and Skills, 2007a, page 20 and HEFCE 2006, page 30

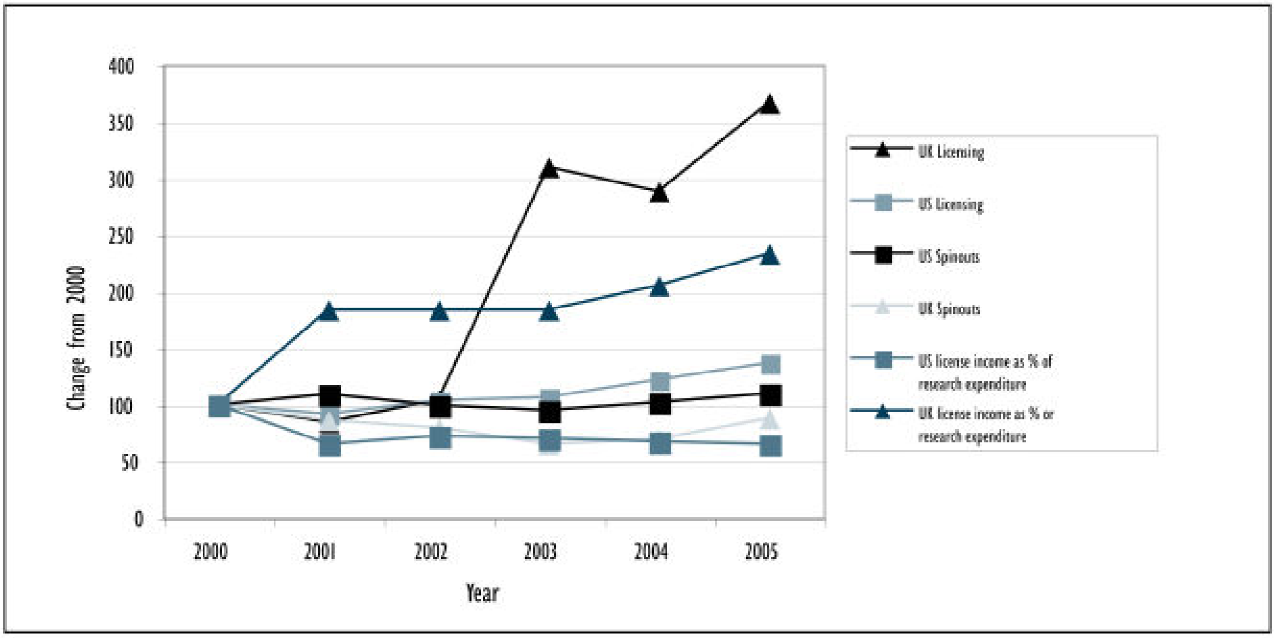


Figure 4.4. The relative changes of US and UK indicators[180]

Table 4.2. The absolute values of the Higher Education Business Community Indicators (HEB-CI) over the 2000-206 period[181].

Indicator - HEIs	2000-01	2001-02	2002-03	2003-04	2004-05	2005-06
Number of licensing agreements	728	615	758	2,256	2,099	2,699
Income from licensing intellectual property (£ million)	18	47	37	38	57	58
Number of spin-outs	248	213	197	161	148	187

There are some programmes and initiatives aiming to increase the market related knowledgebase. For instance, the industrial relevant Continuing Professional Development (CPD) training aims to update the skills of graduates working in the industry[182]. Additionally, there are several entrepreneurial encouraging schemes, such as the Enterprise Fellowship, Biotechnology Yes and the UK Bioscience Business Plan competition. The Bio-incubators of the UK are supported by a former DTI initiative; the Biotechnology Mentoring and Incubator Challenge (BMI), providing services and advice[183]. According to the BBSRC, there is a need to attract

[180] Department of Innovation, Universities and Skills, 2007a, page 20
[181] Department of Innovation, Universities and Skills, 2007a, page 20
[182] http://www.bbsrc.ac.uk/business/cpd/Welcome.html
[183] http://www.bbsrc.ac.uk/business/skills/Welcome.html

more skilled researchers within the research fields of bioinformatics and physiology[184].

Knowledge Transfer

The UK has struggled with the situation that even though much excellent research was produced, the production of new goods and services, steaming from the research, lagged behind. The importance of business pull has been emphasized in several reports (Lambert review, the innovation report) and in the Government's technology strategy, driven forward by the technology strategy board. In the 2007 annual report of the Science and Innovation Investment Framework, a positive trend in commercialization and knowledge transfer activities from the science base is stated. These activities however remain in the spotlight: "accelerating the translation of excellent research into new goods and services remains a key challenge"[185]. The DIUS will build on the progress achieved so far and take the agenda further[186]. This is demonstrated by the increased funding to knowledge transfer activities stated in the pre-budget report of 2007 as outlined in figure 4.5.

Total DEL[1]	**17,986**	**747**	**1,706**	**2,792**
	£ million			
	Estimate	**Projections**		
	2007-08	**2008-09**	**2009-10**	**2010-11**
Total UK science spending[2]	5,397	5,608	5,903	6,287
of which:				
DIUS science budget	*3,383*	*3,525*	*3,746*	*3,971*
DIUS funding for research and knowledge transfer in English Universities	*1,655*	*1,710*	*1,775*	*1,926*
UK science spending as a proportion of GDP (per cent)	**0.38**	**0.38**	**0.38**	**0.39**

[1] *Full resource budgeting basis, net of depreciation.*
[2] *Actual outturns are subject to spending decisions by the devolved administrations. Excludes non-cash items.*

Figure 4.5 . The total UK science spending and the DIUS funding for research and knowledge transfer in English Universities[187]

[184] Interview, Williams Mari, BBSRC, 20071016
[185] Department of Innovation, Universities and Skills, 2007a, page 5
[186] Department of Innovation, Universities and Skills, 2007a, page 7
[187] Department of Innovation, Universities and Skills, 2007b,

Knowledge Transfer within the bioscience community is a top rank issue on the UK innovation agenda[188]. Several actions have been made to create an environment that encourages translation of research and intellectual property into commercial products and projects[189]. The BBSRC should ensure that the research funded will make a maximized contribution to the British Society and that commercialization opportunities are sought after[190]. The BBSRC view is that commercial activity in biosciences is "best pursued by the research generator" and therefore the BBSRC merely supports the innovation process in universities and institutes, it does not hold the IP itself. In return, the universities should provide adequate means to support the commercialization process[191]. The MRC on the other hand owns the IP rights on discoveries made by research conducted in MRC units and institutes and provide translators that will help researchers to exploit these discoveries commercially[192].

Explicit programs and initiatives supporting commercialization and knowledge transfer

The major program to promote knowledge transfer is the technology program, consisting of the business support product Collaborative Research and the knowledge transfer initiative Knowledge Transfer Networks (KTNs). Collaborative Research, aiming at increasing collaboration and joint funding with industry, is supported by the BBSRC through the Link scheme and the Industrial Partnerships scheme. The Link Scheme is a governmental wide initiative that provides a 50% funding to collaborative projects in key scientific areas.

Important BBSRC initiatives, operated by the Business and Innovation Unit (BIU), to encourage knowledge transfer from the science base to the industry are outlined in table 2[193]. Emphasizing the importance of "people change" and networking, programs like the Industry Interchange Program, Knowledge Transfer Partnerships, Industry Fellowships and Faraday Partnerships are supported by BBSRC[194].

---

[188] Department of Innovation, Universities and Skills, 2007a, executive summary and chapter 3
[189] Department of Innovation, Universities and Skills, 2007a, executive summary and chapter 3
[190] http://www.bbsrc.ac.uk/business/biu.html
191 http://www.bbsrc.ac.uk/biobusiness_guide/Welcome.html, http://www.bbsrc.ac.uk/business/ip/Welcome.html
[192] http://www.mrc.ac.uk/OurResearch/Industrylinks/index.htm
[193] http://www.bbsrc.ac.uk/biobusiness_guide/Welcome.html
[194] http://www.bbsrc.ac.uk/business/knowledge/Welcome.html

The MRC has an 80 people strong MRC Technology group (MRCT) tasked with bringing discoveries to market. Their role is to identify and protect research with commercial potential and also to help out with patenting and licensing on the global arena[195]. The MRCT drug discovery initiative invests £10million in linking MRC research with industrial chemistry and drug screening[196]. Other MRC products for knowledge transfer and commercialization are notably the translators, mentioned above, that should "facilitate knowledge transfer across all stages of the research pipeline and in areas where the potential for commercial exploitation is not apparent"[197]. They serve as brokers of links between industry, researchers and healthcare organisations[198]. Collaborative studentships is another MRC product to facilitate links between an academic institution and a company[199]. In the clinical fields, there is a portfolio of MRC fellowship schemes to increase collaboration[200].

The Higher Education Innovation Fund (HEIF) promotes knowledge transfer between academia and industry and the academia engaging with business. In the strive to increase commercialization of research, the HEIF has played a vital role. Over the period 2006-2007, £238 million was provided to knowledge transfer activities.

Strengths and weaknesses in the knowledge development

In later years, the science budget has increased in the UK in contrast to the Swedish science budget. The increase has taken place with a clear target to provide research excellence that is second only to the US and has been accompanied by ambitious strategies. In areas where the UK is not currently second, measures will be undertaken to close the gap. The ambitions concerning life science are reflected in the budget allocations.

The declining business contribution to R&D expenses has been an issue of major concern, but the development is said to have turned around. It is interesting to note that in the UK, the increase of the relative share of foreign capital in the overall industrial R&D expenses is welcomed. The large share is seen as a proof of the attractiveness and competitiveness of the UK and it is highlighted that this is a strength that has to be continuously built on.

---

[195] http://www.mrc.ac.uk/OurResearch/Industrylinks/index.htm
[196] http://www.mrc.ac.uk/OurResearch/Industrylinks/index.htm
197 http://www.mrc.ac.uk/OurResearch/Industrylinks/index.htm
198 http://www.mrc.ac.uk/OurResearch/Industrylinks/index.htm
199 http://www.mrc.ac.uk/OurResearch/Industrylinks/index.htm
200 http://www.mrc.ac.uk/OurResearch/Industrylinks/index.htm

BBSRC points out the balance between focusing on priority areas by selecting key technologies and increasing the industrial funding and involvement[201]. It has been recognised in the British innovation system that policies of different countries are subject to competition. It seems like the industry is also submitted to competition by the public authorities based on both the technology strength and potential economic benefit to the society but also on the willingness of the industry to get involved and their willingness to increase their R&D budget. According to BBSRC, the agro-food industry used to have a higher priority but since there are few large companies that showed a R&D interest, agro-food is not a priority any more. Within a program called bioscience for industry, many SMEs wanted to get involved but did not have the resources. BBSRC therefore was the majority funder and industry funded 10-20%[202].

The technological knowledge base is an obvious strength within biosciences, with a ranking as second only to the US. It seems though like the UK strengths predominantly fall within traditional and basic life science research areas. In newer areas like bioinformatics, the UK has recognised their need for improvement.

The positive development of income on licensing could be a consequence of both stronger technological knowledgebase and stronger market related knowledge base. Interesting to note is the very large increase in number of licences as well since it has been a deliberate strategy from the government to increase consultancy and licensing due to the higher financial returns. This information is interesting in the context of the Cambridge development towards more consultancies in the life science industry (industry structure and financial support system, Cambridge). Apparently, the development could also be a consequence of a governmental strategy.

The development towards increased commercialisation of research and knowledge transfer also shows positive trends and some strong results, not least when it comes to licensing and income from licensing. This is still perceived as a challenge though and will remain in the spot light. The budget concerning these issues will increase slightly in the coming years. The work has been going on for a long time, the MRC technology group for instance has been around for 20 years. On the other hand the cultural barriers between academia and industry have been very strong in the UK. According to Hampden-Turner and Trompenaars, pure science is revered higher than the commercial applications in leading British universities[203]. Porter states that “an often noted by highly significant observation about

201 Interview, Williams Mari, BBSRC, 20071016
202 Interview, Williams Mari, BBSRC, 20071016
203 Hampden-Turner, Trompenaars, 1993

Britain is that the best talent has, by and large, avoided industry".[204] Social norms have defined certain occupations as acceptable, and others as "simply commerce"[205]. An analysis of the reasons for this cultural barrier should take into consideration that the establishment of British universities took place before the industrial revolution and in a strongly articulated class system. Some of the essence of the traditional view within the universities has been conserved[206].

4.1.2 Financial support systems for innovation

Access to Venture Capital

General access to venture capital

Access to finance is described to be good in the UK. In 2005, over half of the total annual European private equity investment could be attributed to the UK private equity industry. Funds raised from investors increased from £27.3 billion in 2005 to £34.3 billion in 2006[207]. The British venture capital market is claimed to be well developed compared to other European countries and is second only to the US[208]. This strength in financial access is also said to constitute a big advantage for the UK business in reaching full potential[209]. Likewise other European companies, the access is poorer when it comes to start up companies and those that lack a track record. The growth of the UK market has been accompanied by an increasing share of larger investments in well-established business. Management buy-out activities, for instance, have received a large share. Although making an important contribution to UK productivity, it is reasoned that in the long term these priorities will create a market structure that constitutes a barrier to business formation and growth[210]. Even small amounts of risk capital may be in short supply for smaller companies with growth potential[211]. This is an urgent issue in particular for the bioscience sector, where the risks are higher in general[212].

Other sources of non-public venture capital

In the UK, business angels has been around for much longer than in the rest of Europe, and particularly Sweden that is said to have "got on the

---

[204] Porter, 1990
[205] Almeida. P, Saunders S.B, 2002, National Innovation Systems and Patterns of Knowledge Flow: A Comparison of Diffusion of Biotechnology Innovations in the US and UK, page 7
[206] Hampden-Turner, Trompenaars, 1993
[207] British Venture Capital Association, 2007, page 1
[208] Former Department of Trade and Investment, 2003, paragraph 3.43.
[209] Former Department of Trade and Investment, 2003, paragraph 3.43.
[210] HM Treasury, 2003, page 6
[211] http://www.dti.gov.uk/bbf/small-business/info-business-owners/access-to-finance/page37736.html
[212] Former Department of Trade and Investment, 2003, paragraph 3.44

bandwagon as late as 2003"[213]. Today there are 35 angel networks in the UK, which is a decrease since 1999[214]. Recently there have been changes in the regulation regarding certain investments which might affect business angels within biotechnology, according to the British Business Angel Association (BBAA). The BBAA welcomes the governmental decision to support fund schemes that are approved within The Enterprise Investment Scheme. This scheme gives investors in certain qualifying companies the right to a range of tax reliefs[215]. One of the criteria is that the portfolio should include high risk companies. Investment in early stage companies should be 90% and the recent rearrangement prolongs the period of time for the investor to find suitable companies. However, the BBAA is concerned that the annual £2M limit for investments in individual companies, following an application of EU State Aid rules, will constrain the investors and individual entrepreneurs within "businesses on a fast growth trajectory and requiring high levels of early stage funding (eg those in biotech sector)"[216].

Public Funding

In the report "Bridging the finance gap: Next steps in improving access to growth capital for small businesses", the government's view of the reasons underlying the equity gap that faces business seeking to raise modest sums of risk capital, is set out. They conclude that companies that are seeking up to 2 million of growth capital and in particular those seeking between 250,000 and 1 million, are mostly constrained in their growth by the equity gap. For larger companies, a shortage of venture capital can occur when seeking investment to modernise or diversify[217]. In addition to the constraints in supply, the factors underlying the demand should also be taken into consideration. The governmental report suggests that a lack of awareness of the various funding possibilities among entrepreneurs could present a constraint in growth and business formation. They further claim evidence that fear of loosing control is a major deterrent to seeking finance for many entrepreneurs[218].

The equity gap has been addressed by a number of initiatives and programmes, like The Grant for Research and development, the Early Growth Fund, Regional Venture Capital Funds and Enterprise Venture Capital Funds. There are also initiatives like Small Firms Loan Guarantee,

[213] http://bulletin.sciencebusiness.net/ebulletins/showissue.php3?page=/548/art/4772
[214] http://bulletin.sciencebusiness.net/ebulletins/showissue.php3?page=/548/art/4772
[215] http://www.eisa.org.uk/render.aspx?siteID=1&navIDs=21,97
[216]http://www.bbaa.org.uk/portal/index.php?option=com_content&task=view&id=186&Itemid=53
[217] http://www.dti.gov.uk/files/file37477.pdf
[218] HM Treasury, 2003, page 6

Late payment and Community Investment Tax Relief. Since the number of publicly funded business support products that address the equity gap of early stage and growth companies is so extensive, the descriptions of these are outlined in appendix 2.

Strengths and weaknesses identified in the financial support system

A weakness has been identified by the government when it comes to the financial support system. There is an equity gap, which affects not only early-stage companies but also growth companies. Although the overall access to capital is very good, this is identified as an important problem. A mismatch between the size of investments required by the SMEs and the sums that venture capitalists are willing to invest also constitutes a problem[219]. However, these issues have been addressed in an extensive way. There are numerous and important programmes and initiatives aiming to bridge the equity gap address the constraints to growth. It is interesting to note that this situation is highly recognised by public actors in the UK and is a high priority issue to solve.

The well developed business angel market is a strength of the UK life science innovation system. The government provides incentives for investment in order to increase the capital access to early stage companies.

4.1.3 Policy evolvement

Infrastructure and organization

The main policy makers of the British Life Science innovation system are outlined in figure 4.6. The scheme has been checked with representatives from the British innovation system. Policy making public authorities with a mainly advising function is marked red and public authorities that are executive bodies that mainly implement policy decisions are marked with blue. Important restructuring among the actors has occurred in the last year. One brand new important actor in the British Life Science innovation system is the Department of Innovation, Universities and Skills (DIUS), formed in June 2007. The department overtakes the responsibilities for science and innovation from former DTI which has become the Department for Business, Enterprise and Regulatory Reform (BERR). DIUS also overtakes the responsibilities for further and higher education and skills from the former Department for Education and Skills (DfES), which has become the Department for Children, Schools and Families (DCSF).

[219] http://www.dti.gov.uk/files/file37477.pdf

In bringing together these responsibilities in a new department, the UK government aims to "build a dynamic knowledge based economy"[220].

Another important rearrangement is the transformation of the Technology Strategy Board (TSB) into an executive and independent Non Departmental Public Body (NDPB)[221] that is to "operate on an arm's length from the government"[222]. Formally the TSB is given the status of a Research Council UK (RCUK), even though it possesses a unique position among the public authorities. TSB will be described among the implementation bodies below, although it is also tasked with an important advising function, and the remit to deliver *the* Technology Strategy. Further more, important changes are about to take place among the NDPBs involved in health research. Notably, a new body interconnecting the MRC and the NIHR will be up and running in 2009[223]. This is the Office for Strategic Coordination of Health Research (OSCHR), which is shown in figure 1 and will be further outlined in the collaboration across government section.

Advisers

The main policy advice givers in the British innovation system are the Chief Scientific Adviser (CSA) and the Secretary of state for DIUS, the former is responsible for advising on science and technology policy and for the quality of scientific advice within the government[224] and the latter will advice on investment in research and innovation[225]. The CSA also has the remit to ensure that the government departments deliver Science and Innovation Strategies (S&Is)[226]. The S&Is should outline how science related activities impacts on the departments' objectives and PSA targets (Public Service Agreement). In addition to S&I targets, most departments have also developed Evidence and Innovation Strategies (E&Is), to increase the evidence-based policy making[227]. The top-level independent advisory body to the UK Government on science and innovation issues is The Council for Science and Technology (CST)[228]. The CST gives advice not only to the Prime Minister but also to the First Ministers of Scotland and Wales on cross-cutting strategic issues[229]. One chair is reserved for the

220 http://www.dius.gov.uk/functions.htm
221 http://www.berr.gov.uk/innovation/technologystrategyboard/
222 http://www.berr.gov.uk/files/file34882.pdf, page 3.
223http://www.mrc.ac.uk/AboutUs/OurStrategy/SingleHealthResearchFund/FutureDirections/index.htm
224 http://www.number10.gov.uk/output/Page7484.asp
225 http://www.dius.gov.uk/.
226 Department of Innovation, Universities and Skills, 2007a, page 47
227 Department of Innovation, Universities and Skills, 2007a, page 47
228 Department of Innovation, Universities and Skills, 2007a, page 46
229 http://www2.cst.gov.uk/cst/about/

CSA, thus creating a link between the advice given by CST and that of CSA. CSA as a chair in CST will provide advice to CST on probable response from the government to CST advice and give suggestions to CST on their work program. There is also an independent chair tasked with the less formal development of views of the independent CST members[230]. The CST members are appointed by the Prime Minister[231].The Royal Pharmaceutical Society of Great Britain (RPSGB), The Human Genetics Commission and The Human Fertilisation and Embryology Authority (HFEA) all have roles as Life Science policy advisers[232]. The most important public authority with a regulatory function is The Medicines and Healthcare Products Regulatory Agency (MHRA)[233].

Implementation
Ministers from different departments are brought together in the Ministerial group of Science Innovation & the Knowledge Economy (SIKE), in order to increase the collaboration and concordance in the implementation of innovation policies. Super ceding SIKE is the Cabinet Committee of Science and Innovation (CCSI), which has the responsibility to "determine and oversee the implementation of the Government's policies in relation to science, innovation and wealth creation"[234]. Implementation of the innovation policies is also performed by the work of DIUS in close collaboration with DCSF and BERR. Within the fields of life science, implementation of the policies is further outlined by the RCUKs, notably BBSRC and MRC and on a regional level by the DAs and RDAs.

230 The Council for Science and Technology, 2004, page 3-4.
231 Council for Science and Technology, 2007
232 http://www.fertileage.com/User/Ads/ARTinUK.pdf, page 3, http://www.hgc.gov.uk/UploadDocs/DocPub/Document/hgc02-p4.pdf, page 2, http://www.dti.gov.uk/sectors/biotech/biotechmedic/reports/page22183.html
233 http://www.dti.gov.uk/sectors/biotech/biotechmedic/reports/page22183.html
234 http://www.dti.gov.uk/innovation/innovation-dti/Innovation%20Report/page10853.html

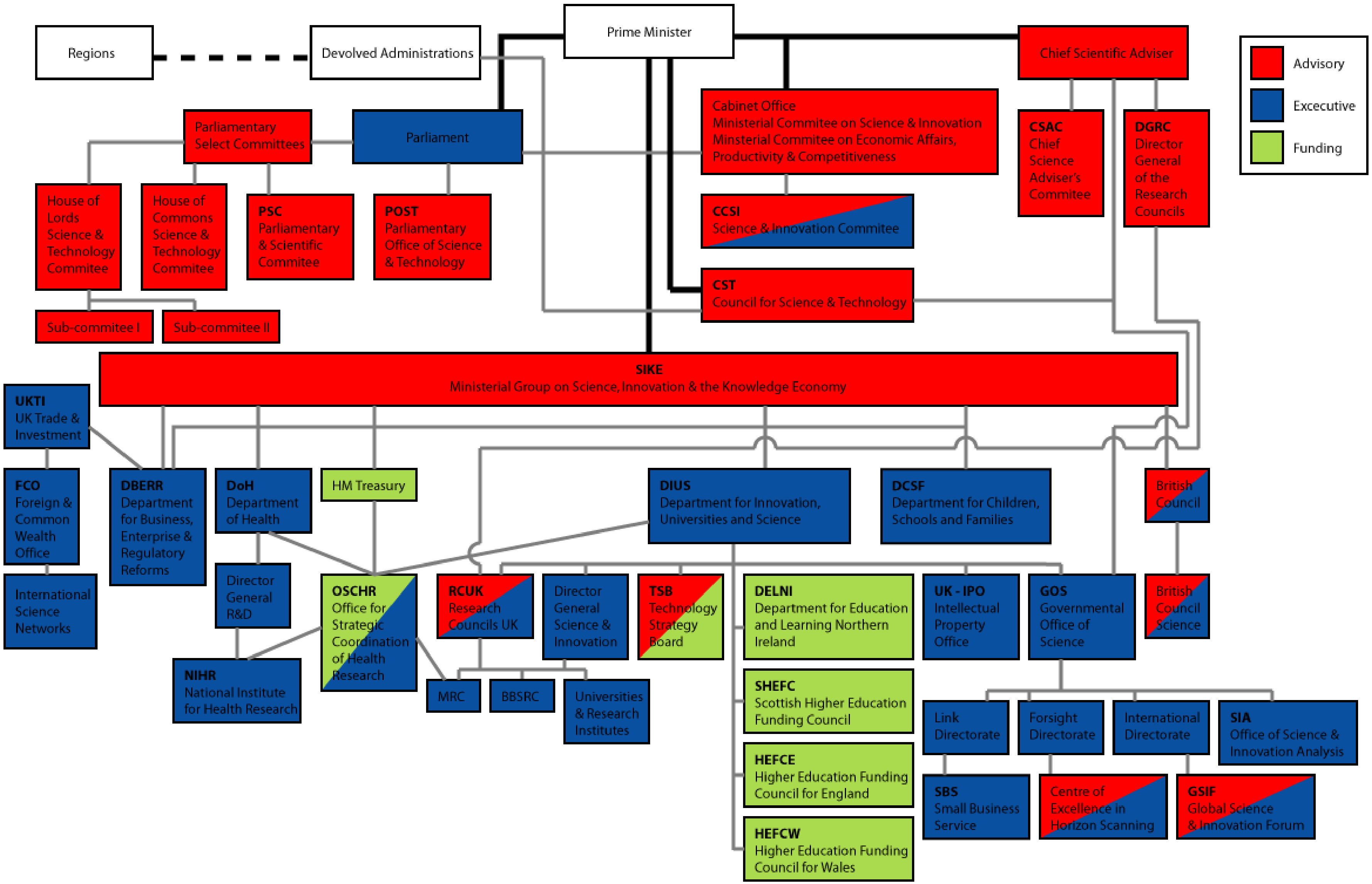


Figure 4.6.: Overview of UK Life Science Innovation System (UKLSIS) /Made by Helena Bergqvist (Vinnova)

Collaboration and partnerships

In the different policy documents launched by the government, the importance of collaboration and networks is often highlighted. The need for a more developed collaboration is particularly stressed between university sector and industry, between the national and regional level, between the governmental policy makers and industry as well as within the government. Overarching the collaboration ambitions on all levels seems to be a principle of joint funding. The approach towards this principle is outlined for some of the major actors in the national life science innovation system.

Partnerships in funding

Partnerships are among the six main objectives in the BBSRC strategic plan. Joint funding is vital and partnerships with other financers and research councils have a high priority. In line with the collaboration ambition is the recent opening to fund institutes of the Welcome Trust or other Research Councils in addition to BBSRC institutes. The partnerships aims to promote multidisciplinary research, for instance system biology[235]. To further promote the multidisciplinary research benefits, the other research councils, government departments, private and charitable sectors are involved in setting the BBSRC research agenda[236]. The collaboration between financers will also lead to a streamlining of the support activities available, which intends to facilitate for stakeholders[237]. Cross-governmental schemes are being established which includes several governmental funding bodies in funding collaborations[238]. According to BBSRC, these collaborations and joint schemes are a prerequisite to reach their strategic objectives[239]. The principle of joint funding is applied to European and international funding sources as well. Apart from the possibilities of multidisciplinary research, the aim is to provide British researchers with access to facilities and research that will strengthen the UK capability in key research areas and to promote UK bioscience on the international arena[240]. The 7th Framework Programme (FP7) introduces Joint Technology Initiatives (JTIs) which are public private investment partnerships in key technology areas that support industrially-driven research. The UK interest in these JTIs lies particularly in innovative medicines, with a budget of £2 billion[241].

---

235 BBSRC strategic plan, page 31.
236 BBSRC strategic plan, page 31.
237 BBSRC strategic plan, page 35.
238 BBSRC strategic plan, page 32
239 BBSRC strategic plan, page 37.
240 BBSRC strategic plan, page 32
241 Department of Innovation, Universities and Skills, 2007a, page 17

A greater co-operation between public funders of health research was boosted this year by the establishment of the Office for Strategic Coordination of Health Research (OSCHR). The OSCHR will include a joint health research funding board. The board will include representatives from MRC and the National Institute for Health Research. The OSCHR will be in charge of delivering a single health research strategy that should build on the current UK strengths in this field and provide better support for clinical research[242]. According to the Director General of research and development at DH R&D, the OSCHR will "offer a tangible mechanism to facilitate translation of health research into health and economic benefits for the UK"[243]. The OSCHR will also form a link between the government's health research strategy and the private sector. The organisational structure of the public authorities involved in the innovation system for health research is outlined in figure 2. This is the structure that will be valid parting from 2009. As shown in the figure, the funding flow from NIHR and MRC will be co-ordinated by the OSCHR, although the NIHR and MRC in turn are funded by separate governmental departments. A single fund for health research will be created and uplifted to a level of £1.7 billion in 2010-2011[244]. However, £1bn out of this will be ring-fenced for NIHR. In Figure 4.7, this part of the life science innovation system is marked in green.

242 Department of Innovation, Universities and Skills, 2007a, page 6
243 http://www.rdforum.nhs.uk/docs/cooksey_letter.doc
244http://www.mrc.ac.uk/AboutUs/OurStrategy/SingleHealthResearchFund/FutureDirections/index.htm

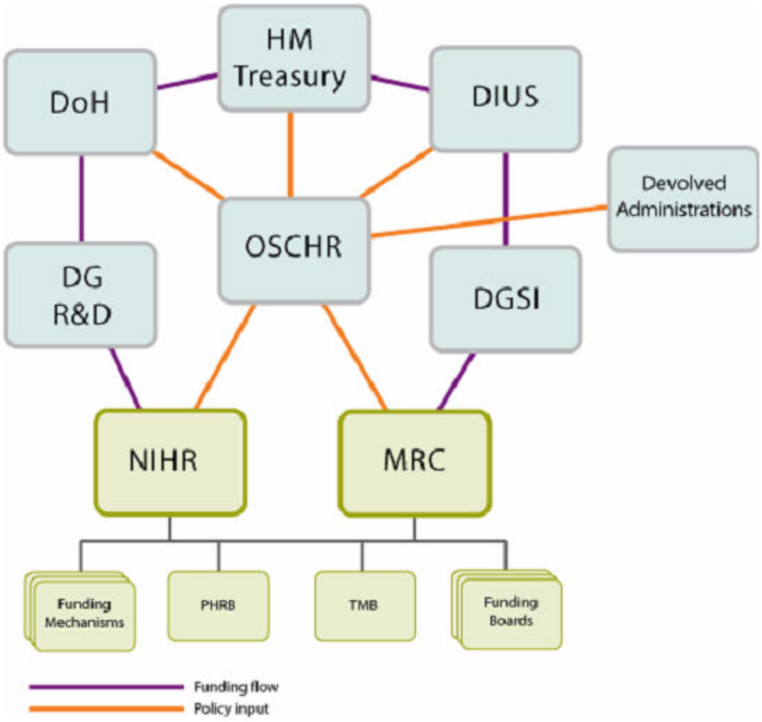


Figure 4.7. The new structure among the departments and NDPBs involved in funding health research[245].

Cross-governmental collaboration

There has been a need to improve the management and use of science and innovation across government and measures has been taken for improvement. Some of the steps are a rolling programme of science reviews and the overarching work of cross-governmental policy makers like The Chief Scientific Advisers Committee (CSAC), the Council for Science and Technology and the Horizon Scanning Centre (HSC)[246]. The CSA is head of the cross-departmental Science and technology group[247] (that nowadays is part of the DIUS Governmental Office for Science[248]) and is part of almost every important committee with an advisory function[249]. Cross-governmental collaboration has also been leveraged for instance by the establishment of the Global Science and Innovation Forum (GSIF), with DIUS, FCO, UKTI, DoH, Royal Society and the RCUKs among the

245http://www.mrc.ac.uk/AboutUs/OurStrategy/SingleHealthResearchFund/FutureDirections/index.htm
246 Department of Innovation, Universities and Skills, 2007a, page 8
247 http://www.britishcouncil.org/gost/advice.htm
248 http://www.dius.gov.uk/pressreleases/press-release-20070720.htm
249 http://www.britishcouncil.org/gost/advice.htm

members[250]. The HSC together with the National School of Government on Professional Skills for Government (PSG) are working to leverage the capability across government in science and innovation issues[251]. The progress against the ambitions defined in the ten year framework will be monitored by the governmental departments in a concordant way by using a new set of unified progress indicators[252]. A recent example of serious commitment to increased collaboration within government is the announced £120 million budget reserved for collaboration between TSB and the RCUKs to promote strengthened links between business and academy.

Collaboration between parts of the triple helix

The collaboration and interactions between the public/politics, industry and academy is referred to as the triple helix of an innovation system[253]. Increasing collaboration between industry and academy was recognised as a key objective already in the 2003 innovation report and lots of measures have been taken since to change the prevailing culture against collaboration[254]. Examples are given in section 4.1.2, in the context of commercialisation of research. The public dialogue on key scientific issues is looked after by Sciencewise, a "mass public engagement programme about science and technology"[255] that held a £1.5m budget in 2006-2007[256]. The idea is to give the public a say in the policy-making process[257]. Brain research and stem cell research are examples of such issues to be discussed nation wide. The issues to be dealt with are identified by the HSC. BBSRC has a commitment to the public to inform about biosciences and ensure that the processes of BBSRC are transparent for the public[258]. The same goes for MRC, tasked with promoting a dialogue with the public about medical research[259].

Addressing the global challenge

The UK government has developed several strategic plans in order to cope with the increasing global challenge of changing economic and research environments. The Framework for Science and Innovation sets out the aim for UK to become a "key knowledge hub in the global economy" and the partner of choice for global businesses interested in locating R&D abroad. A

250 Department of Innovation, Universities and Skills, 2007a, page 16
251 Department of Innovation, Universities and Skills, 2007a, page 48
252 Department of Innovation, Universities and Skills, 2007a, page 49
253 http://www.nutek.se/content/1/c4/27/80/TripleHelixmodellen_definition.pdf
254 Former Department of Trade and Investment, 2004, page 1
255 Former Department of Trade and Investment, 2004, section 1.2
256 Department of Innovation, Universities and Skills, 2007a, page 42
257 http://www.sciencewise.org.uk/html/secure/documents/Stemcellspressrelease.pdf.pdf
258 http://www.bbsrc.ac.uk/society/Welcome.html
259 http://www.mrc.ac.uk/AboutUs/OurMission/MRC002337

reputation of outstanding scientific and technological discovery should attract collaboration with foreign universities. The ambition is also to become a world leader in turning the key knowledge into new products and services[260]. According to The Investment Framework for Science and Innovation 2004-2014, the UK science, research and innovation system should be designed so as to;

- Maintain overall ranking as second to the USA on research excellence and current lead against the rest of the OECD: close gap with leading two nations where current UK performance is third or lower; and maintain UK lead in productivity.

- Retain and build sufficient world centres of research excellence, departments as well as broadly based leading universities, to support growth in its share of internationally mobile R&D investments and highly skilled people.[261]

In 2006, the cross-governmental GSIF published a" Strategy for International Engagement". The document aims to provide an overarching strategic framework. Strengthened international collaborations is identified as one of the keys to achieve research excellence. Attraction of international R&D investments and science as is identified as the key to excellence in innovation[262]. The strategy emphasizes the need to build on current British strengths in attracting foreign knowledge and capital[263]. Excluded by the GSIF focus are identifying and prioritising which global or European facilities that the UK should select to contribute to or host. Neither do they identify international partnerships or collaborations of strategic importance for establishments of facilities. These highly emphasised issues are from April 2007 onwards driven forward by a newly established Research Council; the Science and Technology Facilities Council (STFC), particularly tasked with these objectives[264].

Explicit programs and initiatives addressing the global challenge

The BBSRC has taken measures to address the global challenge within biotechnology and biological sciences and promotes international collaborations[265]. Their funding schemes to support international collaboration comprises an International Scientific Interchange Scheme,

---

260 Former Department of Trade and Investment, 2004, 1.45, DTI 2004
261 Former Department of Trade and Investment, 2004, Box 1.1, DTI 2004
262 Global Science and Innovation Forum, 2007
263 Global Science and Innovation Forum, 2007
264 Department of Innovation, Universities and Skills, 2007a
265 http://www.bbsrc.ac.uk/international/Welcome.html

international workshops dealing with issues of strategic importance and partnering awards with China, Japan and India, aiming at strengthening research links.

There is an increased emphasis on partnerships with China and Japan in particular. There are guidelines set up for the partnerships with certain criteria that need to be fulfilled as a condition for partnering. In focus is what benefits for BBSRC science the partnership introduces and what future benefits could follow from the collaboration. The partnership should also present a unique opportunity of access to the foreign country's expertise. Evaluation is also affected by the prospect of joint funding from other sources.[266] The International Relations Unit at BBSRC is involved in creating international links on a policy level[267]. The BBSRC exploits international funding opportunities and promotes the strength of the UK science community abroad[268]. The relations with India are further strengthened by the UK-India Education and Research initiative (UKIERI). The four year £14 million budget is intended for the creation of research links. Joint commissions have been held with China, Korea and Japan in order to establish corresponding future links in priority areas[269]. The £12m Science Bridges scheme, along with the international fellowships, will strengthen the links with researchers from the US, China and India.

In spring 2007, the Department of Trade and Industry (DTI) business support product Global Watch Service shut down as a result of the governmental streamlining of support services. The function served by the service will be undertaken by the Knowledge Transfer Networks (KTNs)[270].

Key Technologies

The TSB is currently tasked with driving forward the technology strategy which selects technology areas to be supported by public funds. Among the key goals of the TSB are to:

Stimulate those sectors and businesses with the capacity to be among the best in the world to fulfil their potential

Ensure that the emerging technologies of today become the growth sectors of tomorrow

---

266 http://www.bbsrc.ac.uk/international/bbsrc/china.html
267 http://www.bbsrc.ac.uk/international/iru.html
268 http://www.bbsrc.ac.uk/international/Welcome.html
269 Department of Innovation, Universities and Skills, 2007a, page 17
270 http://www.dti.gov.uk/innovation/globalwatch/index.html

The key technology areas are chosen based on their potential to substantially contribute to the growth of the UK economy[271]. More specifically, the areas are chosen based on the UK capacity to develop the technology, the potential impact and what share of the global market the UK could reach within the technology area of consideration[272]. Among the seven key technology areas are Bioscience and Health[273].

The BBSRC technology strategy further identifies seven key technology areas of strategically importance and where the industrial needs calls for increased investment: Bio processing, Integrated mammalian biology, exploitation systems biology, biocatalysts and biotransformation, genomics underpinning healthcare, intelligent storage retrieval and analysis of large databases, crop sciences and bio-nanotechnology[274]. The majority of BBSRC funding is allocated to priority areas through the responsive mode mechanism. The priority areas are identified by seven strategy panels that are also responsible for delivering strategic objectives[275]. There is a possibility to react to research areas in need of funding, that lies outside the identified priority areas. This research is supported through initiatives that have a defined target, budget and duration[276]. In addition to the priority areas identified, there are cross-committee priority areas that are interdisciplinary and have an equally high priority status as the priority areas[277]. Within the priority areas, the BBSRC are encouraging large grant proposals. Larger grants should boost multidisciplinary research and solve problems in strategically areas but also help provide critical mass in the priority areas. In order to become globally competitive, it is emphasised by the BBSRC that research groupings require a larger volume in numbers and in expertise[278]. The MRC has defined their current research priorities to be Clinical and public health research, Infections and vaccine research, Global health, Biomarkers, Ageing-related research and Sustaining capability in areas of strategic importance[279].

One research field that seems particularly prioritised by the Government is stem cell research. Over the period 2006-2008 a total of £100 million will be allocated to stem cell research. As a comparison, the BBSRC total

271 http://www.dti.gov.uk/innovation/technologystrategy/tsb/index.html
272 Spittle. G, 2005, Developing UK Capability and Creating Wealth
273 Technology Strategy, 2005, Page 16-17
274 http://www.bbsrc.ac.uk/business/biu.html
275 http://www.bbsrc.ac.uk/science/areas/Welcome.html
276 http://www.bbsrc.ac.uk/science/areas/Welcome.html
277 http://www.bbsrc.ac.uk/science/areas/Welcome.html
278 http://www.bbsrc.ac.uk/science/areas/Welcome.html
279 http://www.mrc.ac.uk/OurResearch/PriorityAreas/index.htm

allocation over the same period of time augments to about £800 million[280]. As a result of stem cell research being considered a key issue, the Sciencewise programme will particularly focus on stem cells.[281] A UK stem cell initiative was established in 2005 which led to a ten year research vision (shown in figure 4.9), that will be addressed by the MRC.

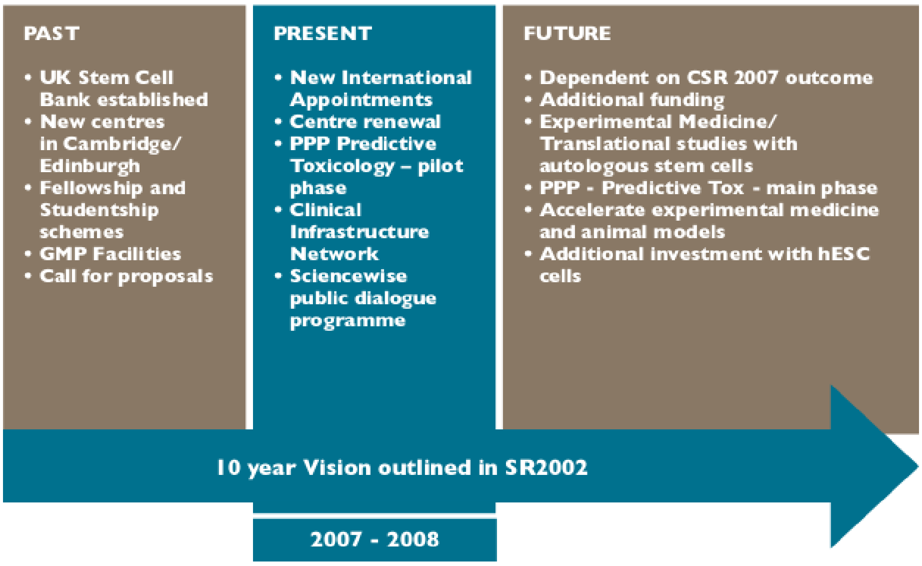


Figure 4.9: The progress and plans in stem cell and regenerative medicine

Strengths and weaknesses identified

It could be questioned whether the responsibilities to work with innovation is best located together with the responsibilities for academia or business. In the new construction, they are located together with the responsibilities for academia, or "universities and skills". However, according to BERR, the new structure enables issues of innovation, business and academia to be more closely linked. The important restructuring that has occurred in the British innovation system was motivated by the ambition to make a more coordinated approach towards innovation. The parts of former DTI and DfES that worked close to innovation issues are now enabled to work as one entity. The DTI had been criticised to have a too broad approach on innovation and the ambition with the restructuring was also to decrease the bureaucracy. Putting together competencies from a department dealing with academia and competences from a department dealing with business is claimed to be beneficial for the sake of knowledge transfer from academia.

280http://www.dh.gov.uk/en/PolicyAndGuidance/HealthAndSocialCareTopics/StemCell/StemCellGeneralInformation/DH_4124082
281 Former Department of Trade and Investment, 2004, section 1.2

The responsibility for academia is now more connected to the responsibility for innovation and DIUS will work closely to BERR[282].

Even though different actors have identified the need for improvement when it comes to collaboration in funding, within government and within the triple helix in general, the issue is dealt with in a profound way. Collaboration in funding is intended to be facilitated by the new funding structure involving MRC and NIHR. This is one example of how the funding streams are more streamlined among UK financers. It is recognised that more financers need to pool their resources in certain projects. There is also a "pooling of board members" so to speak, in order to increase the collaboration between decision makers/policy makers. There are several examples of innovative ways to increase the cross-governmental collaboration, which was identified to present a weakness. For instance the rolling programme of science reviews. The new remit of TSB also adds to the ambition to increase collaboration. According to TSB, their new role will increase collaboration between the TSB and the RCUKs, which TSB claims already has started out very well particularly concerning life science. Also, TSB will have an increased collaboration with the RDAs. The TSB perceive that the government listens to them and the technology strategy has had a large impact[283]. Therefore, it is concluded that UKLIS is well suited to develop a strong collaboration, both within government, but also with regional offices. Currently, the collaboration with industry needs to be improved according to TSB, both in terms of formal and informal mechanisms[284].

The international interaction ambitions within life science predominantly comprises the US, India, China and Japan. The China and India initiatives are quite new, but the BBSRC now has an office in Beijing and there will be one in the US and in India as well. Currently, it is only possible to receive seed funding from BBSRC to strengthen collaboration. Specific international projects can not be allocated funding. There is a discussion going on and there might be a shift in the future. The BBSRC acknowledges that the international collaborations are relatively few. This is explained by a lack of incentives to collaborate, particularly with India and China. There is reluctance in going into international partnerships[285]. The international collaborations are currently based on the net economic benefit for the UK research. In the future more attention probably will be attributed to the "economic benefit to UK economy"[286]. The willingness to participate in

[282] Interview,Griffiths David, BERR. 20071016
[283] Interview, Goldman Merlin, Technology Strategy Board, 20071016
[284] Interview, Goldman Merlin, Technology Strategy Board, 20071016
[285] Interview, Williams Mari, BBSRC, 20071016
[286] Interview, Williams Mari, BBSRC, 20071016

international partnerships is affected by the risk that money leaves the UK[287].

The identification of key technologies is addressed by BBSRC, MRC, TSB and several other public authorities. The TSB identifies key technologies rather broadly, and the research councils and RDAs then specify what areas of strength to further build upon or what emerging technologies to support. For instance, stem cell research is a priority in Scotland and MRC has a large focus on translational medicine. The TSB do not control the priorities of the RDAs but the ambition is that the priorities will be aligned and that the technology strategy is followed. It is shown in the budget allocations that the talk of identifying key technologies is more than just talk. The 100 million stem cell research allocation from BBSRC is one illuminating example. Overall, the funding streams are large and concentrated in the UK.

There are no specific mechanisms to weight the lobbying from industry in order to ensure that the lobbying of certain industries is not dominating the TSB agenda when selecting key technologies. This might inflict a problem for instance when it comes to emerging technologies which do not have the same lobbying powers. According to the TSB though, there is already lots of focus on emerging technologies and the priority areas coincide with the true areas of strength[288]. Similarly, there are no specific mechanisms to ensure that the strength of certain regions does not dominate the TSB agenda more than the strength of others in the selection of national key technology areas. Again, it is claimed that this has not constituted a problem so far, since the collaboration with the RDAs is well-functioning. The point of departure is to identify the major strengths of the UK and these are built upon[289]. The BBSRC does not have any corresponding mechanism either but likewise the TSB they do not perceive any specific problems. They collaborate with regions that already are strong[290].

[287] Interview, Williams Mari, BBSRC, 20071016
[288] Interview, Goldman Merlin, Technology Strategy Board, 20071016
[289] Interview, Goldman Merlin, Technology Strategy Board, 20071016
[290] Interview, Williams Mari, BBSRC, 20071016

5 The Scottish life science innovation system

5.1 The choice of Scotland

Scotland was chosen as a comparison to the Swedish life science innovation system for several reasons. Just like Cambridge and Uppsala, there are some similarities and differences that make the innovation systems particularly interesting to compare. The Scottish life science industry is smaller than the Swedish with 33,500 and 34,500 employees respectively[291]. The definitions of what kind of companies that counts as life science companies probably differ though and the Scottish figure would be lower with the definitions used for the Swedish companies, which should be held in mind when comparing the industries. One important difference though is that the number of employees according to several sources is increasing within the Scottish sector[292] whereas the Swedish life science sector has stagnated and in some sectors even decreased in 2006 compared to 2003, as described in the industry survey of SLIS. Scotland is also particularly interesting to compare to Sweden since their government along with a lot of key actors in the innovation system have reached a consensus to become a world leader in several life science research fields[293] These goals notably focus on achieving critical mass in a "globally focused, sustainable life sciences sector built on a fully connected national strategy"[294]. If Scotland is found to successful in achieving this, it would be an interesting example for Sweden to learn from. The issue of critical mass and what a small country can do to get around this limiting factor is approached in Scotland and is also very interesting in a comparison with Sweden.

One such research field where Scotland aims to become a world leader is stem cell research. Therefore it is particularly interesting to look further into the case of Cellartis, a Swedish stem cell research company that was attracted to Scotland and has localised a production facility in Dundee. The case study performed on Cellartis focuses on what importance different activities have had on the localisation and investment decision of this individual company. The case of Cellartis is used as a tool to highlight and discover potential competitive disadvantages in the Swedish life science innovation system compared to the Scottish. In addition, the case study

---

[291] K:\Skottland\Scottish Development International Biotechnology and Life Sciences in Scotland – SDI.mht
[292] http://news.bbc.co.uk/1/hi/business/6210100.stm
[293] Scottish Enterprise, 2007a, page 3
[294] Scottish Enterprise, 2007a, page 3

provides a concrete example of how policy-makers in Scotland have reasoned when it comes to priority areas.

5.2 Activities

5.2.1 Knowledge development

The knowledge development is described in this section with a focus on the technological knowledge base. The top-ranked universities' main competence fields are outlined. In addition, their competence within stem cell research is described. This will give a background on what knowledge within this and related fields that was accessible for Cellartis at the time of their establishment in Scotland. The impact of the competence level on the localisation decision will be analysed in section 5.3.

Generation of knowledge elements

Public Research Funding

In 2004, The Gross Expenditure on Research and Development (GERD) constituted a lower share of the Scottish GDP than the corresponding UK average. However, the Scottish share of higher education research and development (HERD) out the GDP is larger than other regions and is also on an internationally high level compared to other OECD countries, placing Scotland in the first quartile of the OECD countries[295]. The Scottish universities and research institutions attract £410 million funding per year[296].

Both the Scottish executive and the former DTI are public financers of research in Scotland, the majority of funding is allocated by the Scottish Executive, as shown by figure 5.1[297]. The expenditure had the largest increase in 2002-2004, mainly due to the increased Scottish Executive allocation. The Expenditure on research from DTI to Scotland in 2005-2006 is approximately on the same level as in 2001-2002. The level of funding to research from the Scottish Executive however has increased since 2001-2002[298].

---

[295] Scottish Executive, 2007, page 3-4
[296] F:\Skottland\Life Sciences in Scotland.mht
[297] Scottish Executive, 2006a, chapter 2
[298] Scottish Executive, 2006a, chapter 2

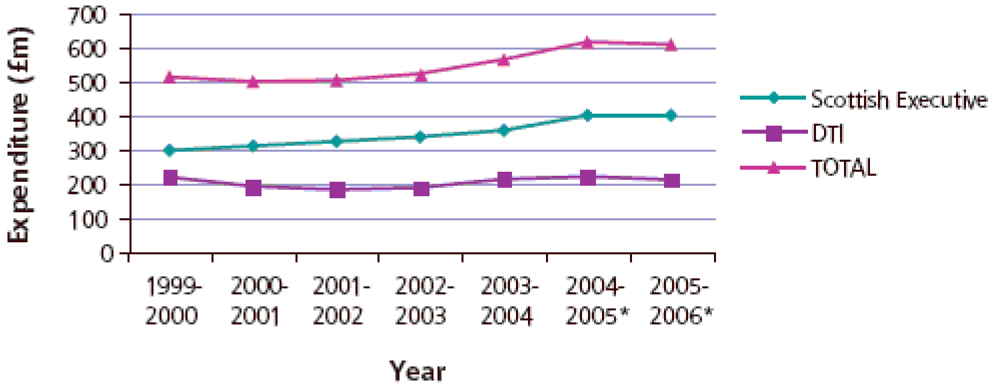


Figure 5.1. Public expenditure on science in Scotland, Scottish Executive compared to DTI. Real terms, base year = 2004-05[299].

Industrial R&D expenses

The Business Enterprise Research and Development (BERD) expenditure as a percentage out of GDP in Scotland and other regions is shown in figure 5.2. The Scottish level is many times lower than the South East level for instance, but about the same level as London. Out of the Scottish GDP, BERD contributed only 0.59% which is low considering the size of Scotland's economy. The UK average of BERD out of GDP is 1.08%, almost twice as large, and even that level is considered far too low by the UK government (see UKLIS). The Scottish level is also low when considering the size of Scotland's economy and when compared to the OECD average. However, over the 1999-2005 period there has been a significant increase in the Scottish BERD level by 29% which is way higher than the UK BERD increase rate[300]. The manufacturing pharmaceutical sector´s R&D expenditures has shown a particular strong growth. The development has occurred simultaneously as an overall decline of the number of employees in the sector and a shift from low value processes to a highly specialised and high-value sector[301]. However, the increase of BERD predominantly occurred in 1999-2003 and in later years the development has stagnated in real terms. American owned firms was responsible for half of the BERD in Scotland, with Scottish firms undertaking only 24%[302].

[299] Scottish Executive, 2006a, chapter 2
[300] Scottish Executive 2007b, page 51
[301] http://www.scotland.gov.uk/Publications/2006/06/27171110/4
[302] Scottish Executive 2007b, page 51.

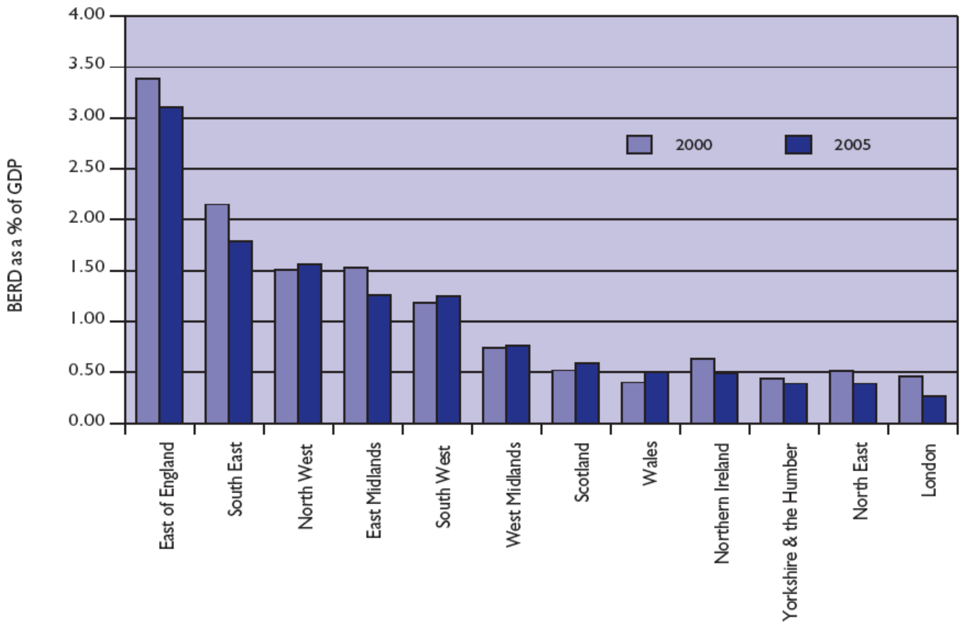


Figure 5.2. BERD as percentage of GDP for the UK regions[303].

Although the focus here is on Scotland, it is interesting to note that level of BERD as percentage of GDP in London is very low. For instance, it is much lower than the neighbour region East of England. This picture was also supported by the Office of National Statistics[304]. The situation is an issue of concern for the government. No specific reasons were found that can explain the low BERD in London. However there might be a connection to the large Higher Education Research Expenditure (HERD). Almost a quarter of the total HERD is allocated to London. If there is in fact a connection, it would be particularly interesting to study what knowledge transfer and people exchange there is between academia and industry in London[305].

Access to knowledge elements

Technological Knowledge Base

According to the Scottish Executive, Scotland has a relatively strong competence base in life science. Their statement is based on investment in research per capita (40% over the UK average), the number of scientific citations, Research Assessment Exercise outcomes and proportion of life science graduates[306] etc. The Research Assessment Exercise (RAE) of 2001 rated about 50% of the Higher Education research as internationally competitive[307].

---

[303] Scottish Executive 2007b, page 52
[304] Office for National Statistics, 2006, page 14
[305] http://www.lda.gov.uk/server/show/ConWebDoc.1340
[306] Scottish Executive 2005a, page 7
[307] Scottish Executive, 2006b, page 12

In the RAE ranking 2001, Edinburgh University came first on the list of Scottish universities[308]. It is ranked second in the medicine field in the UK according to the Guardian University Guide[309]. The university highlights biomedical research among their strengths and the stake is on stem cell research. The Institute for Stem Cell Research aims at clarifying the mechanisms underlying differentiation in stem cells with the objective to create a scientific base for cell therapy.

Dundee University describes their laboratory of translational medicine research collaboration as one of their core strengths. The partners in the collaboration are the Universities of Dundee, Aberdeen, Edinburgh and Glasgow, Scottish Enterprise, and the NHS in Scotland Grampian, Greater Glasgow, Lothian and Tayside. Wyeth, a large pharmaceutical company has also been attracted to the collaboration and co-invests £33 million[310]. According to the university, their strongest research fields are notably diabetes, cancer research proteomics, neuroscience, genomics and stem cell research[311]. Dundee recently joined ITI Life Science Stem Cell Technologies R&D programme. Dundee will contribute with screening expertise to the programme's objective to enable automated processes to produce large quantities of high quality stem cells. The university describes the development of this capacity as ground breaking and claims that it would make Scotland the world leader of stem cell research[312].

The University of Glasgow also counts as one of the UK's leading universities, according to Scottish Enterprise. The research within oncology and molecular pharmacology are achieved the highest rating in the last Research Assessment Exercise[313]. Their expert knowledge particularly lies in molecular mechanisms controlling cell signalling and development[314] according to the university.

Some other important collaborative initiatives building on the technological knowledgebase, of particular importance for the goal to become a world leader within stem cell research, are the Scottish Centre for Regenerative Medicine (SCRM), the Translational Medicine Research Collaboration and the Centre for biomedicine. The new SCRM 59£ million establishment aims to become a world leader in stem cell research and is a collaboration between Scottish Enterprise and the University of Edinburgh. The SCRM

[308] http://www.ukeas.com.tw/rankings.htm, based on RAE 2001
[309] http://en.wikipedia.org/wiki/University_of_Edinburgh
[310] http://www.talentscotland.com/view_item.aspx?item_id=47607
[311] http://www.scottishdevelopmentinternational.com/pages/Industries/Life-Sciences/Overview/index.asp
[312] http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=734&rlID=574
[313] http://www.scottish-enterprise.com/sedotcom_home/life_sciences/life-sciences-research/life-sciences-clinical-expertise-oncology/life-sciences-clinical-expertise-oncology-academic-groups.htm
[314] www.gla.ac.uk

includes a centre for scale up development and manufacturing of cells as well as clinical trials. The focus lies on the commercial opportunities arising from the research[315]. Launched in 2006, the Translational Medicine Research Collaboration is a partnership between the US pharmaceutical company Wyeth, Scottish Enterprise, NHS Scotland boards and the four universities Dundee, Aberdeen, Edinburgh, and Glasgow. The partnership aims to combine commercial, clinical and academic expertise in diseases like diabetes, cancer and stroke. The focus is on bridging the gap between laboratory drug discovery and the clinics[316]. In 2006, the first phase of the Centre for Biomedical Research was also completed. The centre is a collaboration between the Scottish Enterprise, NHS Lothian and the University of Edinburgh and is financed in a joint public and private venture. The focus on the centre is to attract international companies and expertise to the region and to commercialise research[317].

There are several other examples of centres being initiated in 2006[318]. Together, these centres firmly pinpoints some important features of the Scottish life science innovation system; a consensus in the intention to become a world leader in life science, a recognition of the importance of collaborative investments and efforts including both the private and public sector and also recognition of the importance to build up an excellent knowledge base to attract companies and experts from abroad (as well as retaining the Scottish talents).

Market related knowledge base
One of the main contributors to Scotland's world wide image as a centre of scientific result is Dolly –the sheep. Dolly was created at Roslin Institute near Edinburgh and created global interest, putting Scotland on the scientific map of life science. As a contrary, PPL Therapeutics, the company that assisted in cloning Dolly, has served as a warning example of failing in applying science into profit. Heavy losses caused by a number of high-cost, high-risk treatments which were not balanced out with sellable products, led to the company being sold[319]. Scotland though, seems to have learned its financial lesson. The severely dented biotech sector gained experience in management and an infrastructure was created to support the sector. One important initiative was the proof of concept programme. Funding is available through the programme to high quality projects with strong commercial potential. Funding is available in the £50K-200K range. The programme is said to have increased the quality and viability in the

[315] Scottish Enterprise, 2007a, page 18.
[316] Scottish Enterprise, 2007a, page 15.
[317] Scottish Enterprise, 2007a, page 19.
[318] Scottish Enterprise, 2007a, page 19.
[319] http://news.bbc.co.uk/1/hi/business/6210100.stm

commercialisation of research[320]. In the Scottish life science strategy, it was recognised as critical that industry and public sector agreed on their roles and to a larger extent worked together to fill the gaps related to certain target areas in the innovation system[321]. The ambition of the private sector that emerged as a consequence of the Dolly-lesson was to become self-sufficient as soon as possible. The awareness rose of the importance of commercial applications and spread of risk. A number of products in the portfolio are needed but at the same time risk spreading should not result in products to thinly spread that it will be difficult to launch on the market[322].

International knowledge base
The Scottish life science strategy states that "Scotland must create, attract and retain the best talent because of all the key ingredients for success, the most important is people. We need the best people in science, in technology transfer and development, and in commercial management"[323]. The Scottish Executive and other stake holders have realised the importance of an excellent technological and market related knowledge base and follows a clear three step process to attract an excellent international knowledge base. Scotland as a country is subject to competition from the international expertise, this is realised and pinpointed in the strategy and it is concluded that talented individuals must have excellent prospects for a career and development[324]. The Executive have launched a Fresh talent initiative -the working in Scotland scheme, which is formed to attract highly skilled individuals to Scotland and allows international students to stay in Scotland after they have completed their studies[325]. In addition, a clear intention behind the large public and private investments in different centres like SRCM, centre for Biomedicine etc is to attract foreign expertise and to retain the Scottish expertise within the country[326].

Knowledge transfer
Transfer of knowledge from universities and colleges to business has increased and is rather high compared to other parts of the UK, according to the Scottish Executive[327]. This is explained by the relatively high number of Higher Education Institutes (HEIs) in Scotland. The HEIs of Scotland is said to play a major part in the commercialisation of knowledge, according to an evaluation undertaken by the Higher-Education-Business and Community Interaction Survey (HE-BCI)[328]. The level of spin-outs from

---

[320] http://www.wsep.co.uk/innovativeactions/downloads/presentations/UK_Ireland%20Networking%20Event/SE%20Innovation%20Support%20Pipeline%20Presentation.ppt
[321] Scottish Executive 2005a, page 11
[322] http://news.bbc.co.uk/1/hi/business/6210100.stm
[323] Scottish Executive 2005a, page 10
[324] Scottish Executive 2005a, page 10
[325] Scottish Executive, 2006a, objective 2
[326] Scottish Enterprise, 2007a, page 6.
[327] Scottish Executive 2007b, page 53.
[328] Scottish Executive 2007b, page 66.

Scottish universities per million population is not only higher than the UK average but also the US and Canada average[329] (figure 5.3). However, there was a sharp decline in the early years of the 2000th century. In terms of patents filed per 10,000 people, Scotland lies behind the UK average[330] whereas in terms of revenue on the IP generated, Scotland comes in second of the UK regions, as shown in figure 5.4[331]. The Scottish Executive has spent over £80 million on commercialisation and knowledge transfer activities since 1999[332].

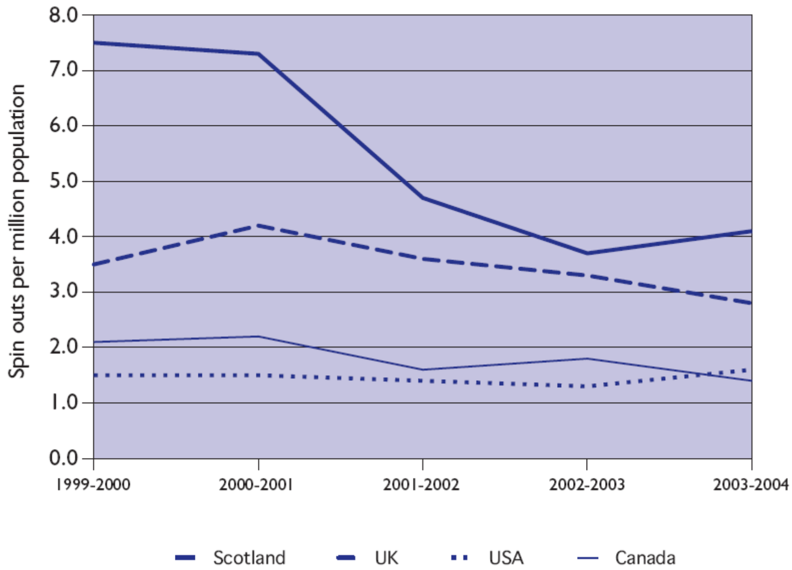


Figure 5.3. Number of university spin-out companies per million people in Scotland, UK, USA and Canada, from 1999/00 to 2003/2004[333].

[329] Scottish Executive 2007b, page 54.
[330] Scottish Executive 2007b, page 54
[331] Scottish Executive 2007b, page 55
[332] http://www.scotland.gov.uk/Topics/Business-Industry/science/16607/21286
[333] Scottish Executive 2007b, page 54

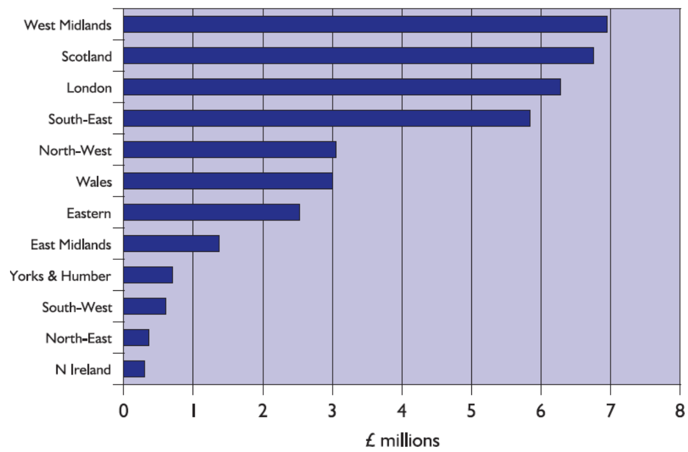


Figure 5.4. Total revenues from intellectual property by region, 2003-2004[334]

Strength and weaknesses

Scotland has a strong life science profile of their technological knowledge base. The ambitions and goals are very high and there have been large investments and efforts in the last years to reflect these ambitions in the budget allocations. This is demonstrated in the research field of regenerative medicine for instance. Within this research area, the collaboration and joint ventures between different actors has increased significantly.

The market related knowledgebase used to be a weakness within life science. It has been addressed by initiatives like the proof of concept programme. The life science industry itself has increased their awareness of the importance of spreading risks and the situation has improved. The overall economic revenue from IP is high and the turnover per spin-out has more than doubled in 2005/2006 compared to 2003/2004[335]. However, there has also been a sharp decline from 1999 in the number of spin-outs from university per million people. There might be a connection to the proof of concept programme, which was launched in 1999 and aims to improve the level and quality of commercialisation of research[336]. This might have led to fewer but more commercially viable projects funded.

Scotland is second among the UK regions in terms of revenue from IP. On the other hand, they also have the highest GERD. It is interesting though that the GERD consists of a larger share of HERD than the UK average and a lower share of BERD, meaning that public funding makes out an unusually high share compared to the rest of the UK. It is claimed that the

---

[334] Scottish Executive 2007b, page 55.
[335] http://www.scotland.gov.uk/Publications/2006/08/HEBCI, http://www.scotland.gov.uk/Topics/Statistics/Browse/Business/PubHEBCIS2003-04
[336] http://www.sie.ac.uk/startupguide_finance.aspx

Higher Education Institutes has contributed considerably to the increase of knowledge transfer and commercialisation and their budgets for knowledge transfer have increased[337]. The university teachers stand up for increased commercialisation of university research and advocates that the Scottish Executive could increase knowledge transfer by encouraging joint activities from the industry and academia. They state that "spending on research and knowledge transfer is the best way to build up the Scottish economy and therefore welcome the increased spending in this area"[338]. They also criticize the industry for not putting enough effort into research and commercialisation of research and the Scottish Executive for not putting a higher pressure on the industry in this matter[339]. It is interesting that the attitude towards commercialisation of research is so positive also from the university teachers´ perspective.

In Scotland, there seem to be weaknesses in the industrial approach towards knowledge transfer on the other hand and the BERD share out of the GDP needs to be addressed. It should be held in mind that this is a general description and specific information about attitudes within life science has not been found. Scotland shows strength when it comes to attracting *foreign* research intensive companies and also foreign skills. It is a stated high priority for Scotland to keep the foreign companies and their skilled personnel within the region. Foreign companies like Wyeth, Cellartis and Cognia[340] (American-owned) that choose to locate in Scotland, seem to do this following ambitious collaborative efforts from private and public Scottish actors. It should be held in mind though that the attraction of the companies include large public investments. The outcome for society has not been studied thoroughly enough in this report to state to what extent the efforts and investments have been beneficial to society.

Although Scotland strives to attract and keep expertise within the region, there has also been criticism about the Scottish structure of university funding. Compared to England, Scotland allocates funding to a larger number of HEIs. Larger funding streams to fewer HEIs and ring fenced funding to specific purposes is claimed by some to be required to prevent brain drain from Scotland to England.

[337] The Association of University Teachers Scotland, 2004, page 1-3
[338] The Association of University Teachers Scotland, 2004, page 1-3
[339] The Association of University Teachers Scotland, 2004, page 1-3
[340] http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=734&rlID=398

5.2.2 Financial support systems

Access to Venture Capital

General access to venture capital
Critical voices claim that Scottish companies suffer from a limited access to capital for overseas growth and capital for research and development. It is also claimed that the Scottish companies are too small to be internationally competitive. The life science sector in particular is said to be poorly connected to the investment community[341]. A worrying reality for the Scottish life science sector is that few of the companies actually make money[342]. According to the finance director of medical diagnosis firm Axis-shield located in Dundee, they are ”fairly unique in terms of life science companies in Scotland in that we are profitable”[343]. Other voices claim that the access to VC in Scotland is strong. During 2006, the life science sector in Scotland is said to have been very successful in fund raising throughout all the different steps of the development cycle[344].

Other sources of non-public venture capital
The business angel market in Scotland has increased in the last years and 2007 was a record year for Scotland. There is a strong focus on life science[345]. It is said that “Informal, business angel investment is the most significant source of external equity finance for young companies” in Scotland. About 75% of the accessible business angle market is invested in early stages[346].

Public Funding
The life science sector of Scotland has developed with governmental support. The Scottish Executive has a clear strategic focus to support the industry and academic research base in order to become a globally competitive hot spot in biosciences. One of the key goals of the Scottish Executive is to increase the level of investment in life science and the performance in achieving this goal will be measured by the annual trend of equity investment in Scotland versus the rest of the UK. Another key objective is to attract foreign direct investment to add value to Scotland and to measure the performance on an annual basis by the number and quality of the foreign direct investments achieved[347].
The ambitions are reflected by the 2006-2007 investments made by numerous actors on activities aiming to achieve critical mass in life science.

---

341 Scottish Executive, 2005a, page 13
342 http://news.bbc.co.uk/1/hi/business/6210100.stm
343 http://news.bbc.co.uk/1/hi/business/6210100.stm
344 Scottish Enterprise, 2007a, page 12
345 Smith. M, The herald 20080121, http://www.theherald.co.uk/business/news/display.var.1979830.0.Business_angels_warn_of_capital_gains_tax_threat_to_investment.php
346 http://www.finance.co.uk/business-angel/
347 Scottish Executive, 2005a, Page 14

Examples are given in table 5.1 below and are direct consequences of the Scottish Enterprise Life Sciences Plan, which in turn is a response to the Industry Life Sciences Strategy for Scotland[348].

Table 5.1. Business support in 2006-2007 that are responses to the goal of achieving critical mass[349]

Initiative	**Allocation to life sciences in 2006-2007**
Proof of concept and proof of concept plus	£2.4M
RSE Fellowships	£163K
Scottish Health Innovations	£350K
Intermediary Technology Institutes	£15M
Life Science Business Advisory Service	£230K
Co-investment, seed and business growth funds	£2.2M
R&D for SMEs and MNCs	£5M
Physical infrastructure projects	£9.3M
Other life science projects	£4.8M
Regional Selective Assistance Grants	£5.5M

It has been claimed that there was an equity gap that needed to be addressed in the market for equity investments *above* £2M and as a consequence The Scottish Venture Fund was launched in 2006, with a £20M budget for the 2006-2008 period[350]. This fund aims to help companies grow[351]. Scottish Enterprise has also launched initiatives to help companies grow and address the equity gaps facing many companies with substantial growth potentials[352]. The current access to capital from (partly) public funded venture capital funds in Scotland covers a range from £20K-£100K investments to £10M investments[353].

There are several publicly funded business support products aiming to support SMEs. For instance, the Scottish Executive has launched SMART: Scotland, intended to help small and medium sized businesses. The aim is to improve their competitiveness by developing highly innovative and commercial sustainable products which concordantly contributes to the welfare of Scottish economy[354]. Characteristic for Scottish public business support is that there should be an economic benefit to the region. Companies can receive support from Scottish Executive for Technical and Commercial

---

348 Scottish Enterprise, 2007a, page 29
349 Scottish Enterprise, 2007a, page 29
350 Scottish Executive, 2005a, page 6-8
351 UK Trade and Investment, 2007, page 3
352 Scottish Executive, 2005a, page 6-8
353 UK Trade and Investment, 2007, page 3
354 http://www.scotland.gov.uk/Topics/Business-Industry/support/16879/6782

Feasibility Studies or research development given that they are based in Scotland or soon to be located in Scotland[355].

Access to Public Funding – The stem cell industry
The stem cell industry is a relatively risky business since it is still very new and the start-up costs are extensive. Pay-back from commercial products lies in a far and uncertain future for the investors due to long lead-times. The Scottish stem cell industry therefore struggles with the hurdle to attract private investment. The Government has assessed the VC problem for the stem cell industry by encouraging risk-averse investors to consider the industry. Also, centres of excellence within this area, aiming to facilitate trans-national partnerships, has been established with governmental support. The centres aid in the commercialisation of stem cell research by creating the surrounding infrastructure. A concrete example is the £1.85 million funding the Scottish Stem Cell Network acquires from Scottish Enterprise Edinburgh and Lothian over the next ten years to enable interdisciplinary collaboration between researchers, clinicians and others in the stem cell field. Another £35 million was allocated to a new centre for stem cell research, The Centre for Regenerative Medicine, to be sited in Edinburgh University. A £5 million investment fund will additionally support translational stem cell research. A matching principle is used to encourage the share of private equity; each private investment will be matched by an equal public funding[356]. For instance, the Translational Development Fund will support the activities required to translate stem cell development into practical use in clinical applications. The intention is to fund research or commercial activities and to co-invest in Scottish projects as one of several financers[357].

Strengths and weaknesses

Characteristic for Scotland seems to be the determination and consensus of many actors to follow a plan that will put Scotland on the map as a world leader in certain life science fields. At least this is the picture that emerges from studying documents of the wide range of actors that are already on the bandwagon. There is a consensus in the long term strategic plans that aim at achieving common goals in 2020! The strategic approach towards building a strong life science industry is reflected in many ways, but one of the most obvious is the publicly funded business support. The business support products are direct consequences of strategic plans that are well rooted in a broad range of representatives from the life science innovation system.

It was recognised as a weakness by some actors in ScLIS that the equity gap for companies seeking investment above £2million was not addressed. The Scottish Venture Fund was established as a consequence. It is a strength that

[355] http://www.scotland.gov.uk/Topics/Business-Industry/support/16879/6782
[356] http://www.ukscf.org/news/news_items/item14.html
[357] Scottish Enterprise, 2007b

potential gaps in the financial support system are identified and filled by new actors, like the case of the Scottish Venture Fund, or by the existing actors of the system. The business support products currently cover the whole range from seed capital to £10 million investments. On the other hand, the opposite situation with easy accessible funding to late stage projects that might not be viable should also be avoided. Finding the right balance is crucial and it remains to be seen how strongly the Scottish life science industry will develop. As was described previously, the number of spin-outs from the universities has decreased whereas the turnover per spin-out has more than doubled. This might indicate that the Scottish proof of concept programme has indeed been successful in picking winners and should be considered a potential strength.

Since the venture capital market in Scotland is strong, the perceived equity gap above £2million might have been due to a similar mismatch between investors and companies that was claimed in Sweden[358].

The life science industry itself has increased their awareness of the importance of spreading risks and the situation has improved. The overall economic revenue from IP is high and the turnover per spin-out has more than doubled in 2005/2006 compared to 2003/2004[359]. However, there has also been a sharp decline from 1999 in the number of spin-outs from university per million people. There might be a connection to the proof of concept programme, which was launched in 1999 and aims to improve the level and quality of commercialisation of research[360]. This might have led to fewer but more commercially viable projects funded.

The Scottish Enterprise has made a strategic choice to focus on growth of companies. It is also stated in the strategy document Smart Successful Scotland that *"increasing new business starts are not enough to impact significantly on overall productivity. There remains significant scope to improve productivity levels in established businesses"*[361]. It is reasoned that critical mass in the number of larger companies is necessary in order to increase productivity levels[362]. This opinion is presented in The Life Science Strategy of Scotland which is rooted in a wide range of representatives[363]. It is viewed as more important than the increase of number of firms that the number of large and established firms is growing. These could function as a training ground and eventually create more companies[364]. The approach is

---

[358] Interview, Ylva Williams, Invest In Sweden Agency, 200705
[359] http://www.scotland.gov.uk/Publications/2006/08/HEBCI, http://www.scotland.gov.uk/Topics/Statistics/Browse/Business/PubHEBCIS2003-04
[360] http://www.sie.ac.uk/startupguide_finance.aspx
[361] Scottish Executive, 2004, page 15
[362] Scottish Executive, 2004, page 15
[363] Scottish Executive, 2005a, page 6
[364] Scottish Executive, 2005a, page 6-8

reflected, not only in the relatively high focus on growth in established companies, but also in the determination to attract foreign companies by business support. The Scottish life science innovation system differs from many other countries in this matter and their development will be interesting to follow. It is acknowledged that there is not enough evidence to state that this approach is more effective than a system that encourages start-ups in general, but the determination remains. The picture that emerges is that there certainly is a Scottish way in the life science innovation system.

The focus on economic benefit to Scotland is large in the business support products and the efforts to attract investments and direct investments to the region. It is interesting that business support from the Scottish Executive is accessible not only to companies that are already established in the region bur also to companies that are soon to be located in Scotland. The business products functions as a measure to attract companies from other parts of the UK and from abroad. The Swedish company Cellartis is one such example, as will be described in section 5.4. It could be argued that late stage business support to individual companies is too risky since there are no insurances that the company stays in the region and contribute economically to the region that provided the business support[365]. This risk is taken into consideration by the Scottish Executive and the different actors that provide such business support follow specific schemes and criteria in order to ensure economic benefit to the region. The decision criteria of ITI life science in the Cellartis case for instance is a representative example of how the Scottish governmental policies are implemented.

5.2.3 Policies

Critical mass

This section deals with key technologies, the issue of critical mass and collaboration. This approach was chosen for the Scottish Life Science Innovation System since the selection of key technologies and collaboration was so tightly connected to achieving critical mass in the Scottish policy documents. The Scotland life science strategy states that since Scotland is a small country, it needs to focus on the opportunities that hold the largest potential value to the region. This means, according to the strategy, that the public sector and research community should engage with the private sector in areas where Scotland could become a world leader and sustain the leadership. This in turn refers to sectors that have a large potential to grow if supported and also sectors that could win investment from abroad[366]. In line with the view presented in the strategy document is the identification of key technology areas as described below.

[365] Interview, Neil Madeleine and Åström Jonas Uppsala Bio 20080205, Interview, Sandström Anna, Vinnova, 20080116
[366] Scottish Executive, 2005a, page 12.

Key technologies
In Scotland, as in the rest of the UK, key technologies are identified within life sciences and other areas. The Scottish Executive was tasked by the Science Strategy to implement the policy of priority areas throughout financers in Scotland. A shared understanding of the importance of priorities aims to create co-ordination between financers in order to enlarge the size of each funding[367]. The funding policy of both public and non-public bodies, like the Scottish Funding Council, Scottish Enterprise, the health department etc, is to focus the support efforts to businesses active within research fields that have the potential to be competitive internationally. It is recognised in the life science strategy that in order to become globally competitive, Scotland must be globally focused. This means that "'Scotland's industry and researchers will address global markets and compete on a global scale whilst concentrating their efforts on specific areas where they have real competitive advantage and know Scotland can compete with the best"[368]. As a consequence, a rationalisation in the number of initiatives and support bodies has taken place. A Scottish Science Advisory Committee has been established by the Executive to identify the Scottish Strengths and what areas have key strategic importance[369]. The establishment of the three ITIs is also a step towards the development of key technologies in the long term perspective[370]. The ITI life science identifies key technologies, conducts forsighting activities and identifies future areas of interest[371].

The life science industry has been identified as one of the six national priority industries "that offers major opportunities for economic growth" and has therefore been allocated about £40million from the 2006 Scottish Enterprise budget[372]. The UK government and the Scottish Executive both hold stem cell research as one of the key technologies in the future. Selective support to build on the existing competence is being delivered and in Scotland, measures are undertaken to reach this goal is a three step process.

Critical mass by collaboration
However, in the efforts to achieve critical mass in Scotland there is several other measures taken on as well. In the strategy, it is pinpointed that efforts must be done in concert by the different public and private actors as well as beyond the regional borders in order to reach the goal[373]. A small country can not afford to not make the best possible use of the resources it has. By

[367] Scottish Executive, 2006a, page 19
[368] Scottish Executive, 2005a, page 6-8
[369] Scottish Executive, 2006a, page 19
[370] Scottish Executive, 2005b, Business - University collaborations in Scotland – The Scottish Executive's response to the Lambert review , page 1
[371] F:\Skottland\ITI life sciences Current areas of interest.mht
[372] Scottish Enterprise, 2007a, page 28.
[373] Scottish Executive, 2005a, page 12.

collaboration and joint ventures, critical mass is achieved and international markets can be accessed. It is also noted in the strategy that the fact that Scotland *is* a small country should enable actors to work efficiently in partnership[374].

Recognition of what importance collaboration between different actors in the innovation system has on achieving critical mass is demonstrated in several ways. The establishment of the Translational Medicines Research Collaboration, the centre for biomedicines and the SCRM could be viewed in this perspective. The formation of a national strategy for Scottish life science was backed up by the Scottish Executive, universities, research institutions, industry, NHS Scotland, Scottish Funding Council and Scottish Networks[375]. The industry was given an important role in the formation of the strategy and the process was overseen by the Scottish Life Science Industry Advisory Group[376]. One of the results of this was the formation of the Scottish Life Science Alliance, which includes representatives from these actors[377]. The alliance has the remit to implement and develop the strategy[378]. One company representative of the alliance has described the role of the government as a catalyst that made things happen. But to take integration to a higher level, it is the different groups and actors themselves that must recognise "that it is only through a focused and coherent approach that a small country like Scotland can fulfil its vision to become a key player in the global life science industry"[379]. The partnership between American giant Wyeth, Scottish Enterprise and four universities would not have taken place if it were not for a strong connectivity already in place in Scotland[380].

Global challenge

The Scottish Life Science Strategy sets out the goal for Scotland to have "a globally focused, sustainable life sciences sector built on a fully connected national strategy that exploits strengths in scientific excellence, financial services and innovative business models and that develops, retains and builds upon Scotland's talents" [381]. In the tough and fast-changing global competition, Scotland is firmly determined to rise to the challenge[382]. In doing so, it has been recognised the importance of learning from others and that benchmarking need to be done to the best environments in the world.

---

[374] Scottish Executive, 2005a, page 12.
[375] Scottish Enterprise, 2007a, page 3
[376] http://www.scottish-enterprise.com/sedotcom_home/life_sciences/life-sciences-in-scotland/about-life-sciences-scotland.htm
[377] Scottish Enterprise, 2007a,, page 7.
[378] http://www.scottish-enterprise.com/sedotcom_home/life_sciences/life-sciences-in-scotland/about-life-sciences-scotland.htm
[379] Scottish Enterprise, 2007a, page 7.
[380] Scottish Enterprise, 2007a,, page 7.
[381] Scottish Executive, 2005a, page 6-8
[382] Scottish Executive, 2005a, page 6-8

The process involves finding opportunities for partnerships with foreign regions that would be beneficial for the Scottish life science cluster and provide entrances to the overseas markets[383]. The US and China are recognised as the most important strategic countries[384]. The strong focus on achieving critical mass by increased collaboration and the concentration of efforts on key technologies is also tightly linked to the Scottish way of addressing the global challenge and is characteristic for the Scottish life science innovation system in particular. The Scottish life science strategy states that the competitive position of Scotland depends on weather they succeed to grow larger companies and attract larger companies[385]. Strategic investments in the technological knowledge base, like the Scottish Centre for Regenerative Medicine (SCRM), the Translational Medicine Research Collaboration and the Centre for biomed, are fundamental in the Scottish approach to address the global challenge and aims to attract both skilled researchers and research intensive companies to the region.

Explicit examples of programmes or initiatives to address the global challenge

The Scottish approach to address the global challenge aims to go beyond increased exporting and inward investment. Value should be generated also by knowledge flows and internationalisation of operations. SDI plays an important part of this work[386]. In 2005, it was criticized that the life science industry held to few transport links to the US and other international life science locations. There are several life science international partnerships in place currently[387], but the increase in the HEI´s budget for global connections only slightly increased in the last years as shown in figure 5.5 below[388]. Among the international partnerships are notably the partnership between the University of Dundee and Singapore's Agency for Life Science. The aim is to develop a research and training co-operation[389]. There is also a partnership between Scottish Enterprise and Massachusetts to facilitate matchmaking and collaborations for Scottish companies and the establishment of Massachusetts companies in Scotland[390]. Globalscot, a network of 950 senior business leaders spread all over the world functions as connection brokers and provide expertise to other Scottish companies that wish to go global. The aim is to support the growth of the Scottish economy and life science is well represented[391].

---

383 Scottish Executive, 2005a, page 12
384 Scottish Executive, 2006a, page
385 Scottish Executive, 2005a, page 6-8
386 Scottish Executive, 2006a
387 Scottish Executive, 2005a, page 6-8
388 Scottish Executive, 2006c, page 102
389 Global connections magazine – For Scottish Companies Doing Business Internationally, issue 11, page 2
390 Scottish Enterprise, 2004, page 1-3
391 http://www.sdi.co.uk/pages/Our-Services/Globalscot/index.asp

£000s	2002-03 Budget	2003-04 Budget	2004-05 Budget	2005-06 Budget	2006-07 Plans	2007-08 Plans
Growing Business	110,636	102,063	109,386	101,386	116,386	126,386
Skills and Learning	132,556	157,079	155,929	155,779	155,779	155,779
Global Connections	77,594	100,000	82,000	82,000	82,000	82,000
Management and Administration	75,000	92,000	91,528	91,879	91,879	91,879
Careers Scotland [2]	20,993	-	-	-	-	-
Voted Loans (Net)	2,277	437	437	437	437	437
Resource accounting and budgeting charge	9,622	9,622	9,622	9,622	9,622	9,622
Total	**428,678**	**461,201**	**448,902**	**441,103**	**456,103**	**466,103**

Figure 5.5. The Scottish Executives budget draft of 2006 showing budget allocations and planned budget allocations to HEIs[392].

5.2.4 Strengths and weaknesses

Although no in depth study of success indicators of the ScLIS has been preformed, the determination of ScLIS was found to be striking. The focus is on achieving critical mass, by increased collaboration and by concentrating efforts to specific areas, in order to become world leaders. It seems to be as simple as that in the Scottish system. It remains to be seen what outcome there will be from the approach. Important in this context is probably that the life science community of Scotland does not have as long tradition of organic growth as has been the case (more or less) in Cambridge and Uppsala. The relatively more selective, focused and top-down approach probably would be difficult to implement in a system with a history of organic growth, and probably less successful. The point that is made is that even though the Scottish way might prove to be successful, it could be very difficult to copy the success in “older systems”.

Growing and attracting large companies is strongly addressed since it is perceived as a current weakness of the Scottish life science industry that these are to few. They are viewed as strategically important for the competitiveness of the entire life science community of Scotland, due to economic and knowledge related spill over effects.

It has been recognised that the international links needed to be strengthened and measures have been taken to address the deficit. However, the partnerships in place currently from SDI for instance only covers a couple of strategically important countries, the US and Singapore. Partnerships with several other strategically important countries fall short. The links to international research locations and markets however are looked after in an informal way by the Globalscot initiative.

392 Scottish Executive, 2006c, page 102

5.3 Case study: Cellartis

The Swedish stem cell company Cellartis in 2006 established a production facility in Dundee, Scotland. Lots of attention was given to the location decision, from Swedish public authorities and even the government. In this report, the case study of Cellartis was found to be an illustrative example of how the Scottish life science policies are implemented and the strategic approaches to increase the competitiveness of Scotland. The ambition was not primarily to address the question why Cellartis chose Scotland for the establishment, since the strong economic incentives presented to the company quit quickly answers this question. The focus is on how Scottish authorities reasoned when providing these incentives and why corresponding incentives were not and are not a reality in Sweden.

5.3.1 History of the company

Cellartis was established in 2001 by researchers at Sahlgrenska University Hospital and The University of Gothenburg. The company has shifted it's focus from potential regenerative cell therapy treatments to the more lucrative production of stem cell lines as test lines for preclinical studies[393]. The strategic goal was to scale up the human embryonic stem cell technology and in order to speed up the development, the company was part of several partnerships with both industry and university. In 2006, a research collaboration with Nova Thera in the UK was initiated. The partnership included Centres of Academic Excellence in Imperial College London, Cambridge University, Manchester University and The Roslin Institute in Scotland as research partners whereas the two companies held the commercial rights[394]. The partnership that has been in the centre of the Swedish attention though is the one with one of the Scottish Intermediary Technology Institutes, The ITI Life science. The ITIs are publicly funded innovation funds that target commercialisation and development in both existing and new companies[395]. According to Cellartis, they were contacted by ITI Life Sciences with a favourable deal at a point of time that coincided with an investigation, undertaken by Cellartis, about the possibilities for an international expansion and the establishment of a production facility. The other alternatives were the US, Singapore, Switzerland and the Netherlands[396].

---

[393] http://www.drugresearcher.com/news/ng.asp?n=73553-cellartis-iti-life-sciences-stem-cells-scotland-ian-wilmut

[394] http://www.cellartis.se/res/PDF/20060829pressreleasenovatheracellartis.pdf, press release 20060829

[395] http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=36

[396] Interview that Sweden Bio performed with Cellartis, previously accessible on internet

5.3.2 The selection of stem cells as a Scottish key technology and the selection of Cellartis for the partnership

As an outcome of the policy to focus on key technologies, many actors have selected stem cell research as one key technology. For instance, Scottish Enterprise decided to venture in the area of stem cell research and ITI Life Science also identified stem cells as a key technology. The ITI Life science selection process starts with the identification of "major trends and drivers in the sector"[397]. The ITI Advisory group identifies options that hold the largest potential of commercial viability. The advisory group consists of influential representatives of industry and academia with strong connections to global networks. They also help in the identification process by insight to global market potential[398]. Apart from the advisory board, ITI life science also consults with industry, the research community and investors in order to "identify future market needs and technology development opportunities"[399]. Based on this foresighting process, the key technology is selected. The scope is then further refined based on specific assessment criteria, as outlined in table 5.2[400]. Areas outside the immediate focus area could also be taken into consideration based on these criteria. As shown by the set of criteria, the selection is based on economic benefit to the region to a large extent. It is also important that the benefits from the investments can be controlled, like the IP, and that sustainable values are created that build upon the already existing resources of Scotland. The stem cell area was chosen based on the belief that it has a strong potential to help develop drug development processes as well as effective cell therapy processes and regenerative medicine, in the long term[401]. According to ITI´s foresighting, the market for cell-based tools within the pharmacy industry was worth US 1.4 billion in 2001and rapid growth was expected[402]. Based on these foresights, Scotland has worked very hard to create a global platform for a successive development of this area[403]. Investments have been made in the centre for regenerative medicine to build up the competence in and Cellartis was considered a good fit that is complementary to the work planned[404].

397 http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=410
398 http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=410
399 http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=727
400 http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=727
401 http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=734&rlID=545
402 http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=734&rlID=545
403 http://www.sdi.co.uk/pages/Invest-News/News/index.asp?newsid=1163
404 http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=734&rlID=545

Table 5.2 Selection criteria[405]

Assessment criteria for potential programmes within key technologies:
Market attractiveness: scale and feasibility within a commercial time scale
The extent to which we can build, protect and defend valuable IP
The ability to create sustainable competitive advantage for the future business
The Scottish fit with available resources or existing applied research capabilities
The ability to achieve a positive return on our investment, including economic benefits for Scotland

5.3.3 The partnership

Cellartis will add to a three year programme that includes Glasgow University, Dundee University, Scottish Development International and Scottish Enterprise Tayside. The research collaboration primarily aims "to control the way in which a stem cell differentiates into another cell type, e.g. a liver cell or a heart cell; and to develop a robust process for producing large numbers of stable differentiated cells"[406]. The major part of the capital investments and the operational conduct is financed by ITI life science. A total of £9.5million is available from ITI over the three years. About one third will be allocated to the new production facility of Cellartis[407]. In return, ITI Life sciences will own all IP generated by the project. They will not commercialize the assets themselves though. This will be a privilege of the partnership companies. The right to dispose over the assets will take the form of royalty licences handed to Cellartis by ITI life Science, the latter in turn receiving a knowledge licence from Cellartis. The factory will be constructed following the instructions of Cellartis[408]. In addition, Cellartis is allocated £1.2 million from SDI as a regional selective assistance, RSA. The size of the RSA is related to the employment Cellartis will contribute to Scotland. Further more, Cellartis qualifies for R&D tax incentives[409]. The intention from the Scottish actors with this partnership is that it will add benefit to the region by providing 75 new jobs and further build on the Scottish expertise in this area. By building up expertise, the idea is that even more companies and expertise will be attracted to the region, eventually making Scotland a world leader[410].

Matching Swedish offers

---

405 http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=727
406 http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=734&rlID=574
407 http://www.sdi.co.uk/pages/Invest-News/News/index.asp?newsid=1163
408 Interview that Sweden Bio performed with Cellartis
409 Interview that Sweden Bio performed with Cellartis
410 http://www.cellartis.com/res/PDF/itistemcellprogrammejan071.pdf, press release 20070117

The Swedish public authorities were taken by surprise with the sudden closure of the deal and regret the lack of contact undertaken by Cellartis in the matter[411]. From the point of view of Cellartis, the favourable deal from Scottish ITI in combination with the risk of loosing the offer in the case of hesitation resulted in few attempts to receive an alternative offer from Swedish counterparts. There were contact with the former Djurskyddsmyndigheten and the Swedish foundation for strategic research. The latter is said to have turned down financial support, referring to the nature of the application. The application applied for financial support to research being conducted within the company, which is not approved of[412].

It could also be questioned what actual counterbids Cellartis would have got if discussions would have taken place with Vinnova for instance. As it was put by the CCO of Cellartis; “you can’t ask Vinnova for 40 million”[413]. It is claimed that the public authorities are listening more to the needs of the life science industry in Scotland. ITI life science plays a major part in this. The national policy level of Sweden is also hard to impact from a regional level[414].

5.3.4 Factors underlying the establishment

This section is entirely based on the interview at Cellartis headquarters in September 2007 and an interview performed by Sweden Bio with Cellartis.

Cellartis recognised that the development they were after needed to be done in partnerships. The research collaborations in Sweden were much appreciated but the partnership provided in Scotland provided expansion capital in addition. A matching expansion capital was not, and still is not, available in Sweden. Apart from the economic incentives, there had to be a strong accessible knowledge base within this area in Scotland as well as a liberal legislation. In addition, Cellartis stresses the importance of the access to a global market. As far as the research base and legislations are concerned, the access was perceived as good in both Sweden and Scotland. It was reasoned that the competence accessible in Sweden still remains accessible for Cellartis and the Scottish competence became accessible in addition. When it comes to the global market though, Sweden falls short in the comparison. Not only is the UK market larger than the Swedish, but more importantly the international markets are more easily accessed through Scotland. The British networks are very strong, according to Cellartis and provides lots of assistance, for instance with connections to Japan. The support from the Invest in Sweden Agency is much appreciated, but in Scotland there are many and very strong organisations. The well developed

[411] Interview, Sandström Anna, Vinnova, 20080116
[412] Interview that Sweden Bio performed with Cellartis
[413] Interview, Hyllner Johan,Cellartis 20070906
[414] Interview, Hyllner Johan,Cellartis 20070906

Scottish Stem Cell Network has also been important. A corresponding initiative is not present in Sweden. It is also a matter of communications according to Cellartis. There simply aren't as many direct flights between the US and Gothenburg as it is with Edinburgh.

5.3.5 Attraction and retention factors in the Swedish and Scottish innovation system

For the specific case of Cellartis, economic incentives, access to an international market and a strong technological knowledge base with recent large investments relevant to the company all came together to work for Scotland. This is an illustrative example of how the innovation systems of countries are subject to competition. Further more, it is an illustrative example of how the *governmental policies* are subject to competition. The study of the ScLIS shows in several ways that the system is competitive and that the competitiveness is to a large extent created due to governmental policies. The major underlying attraction factor of ScLIS in the Cellartis case is commitment from the Scottish government. Without commitment from the government, ITI Life science would not have had the mandate and resources to offer such partnerships to foreign companies. The investments made in the technological knowledge base, like the centre for regenerative medicine, also are dependent on governmental commitment. It should also be noted that the partnership is a consequence of the selection of the stem cell area as a key technology. Policies regarding the selection of key technologies seem to be well rooted in the system, and also the identification of stem cell research as one of them. In addition to the governmental commitment, one important attraction factor relevant to the Cellartis case is the strong cooperation between different actors. This partnership has been highlighted as "a positive example of the cooperation between ITI Life Sciences, Scottish Development International and Scottish Enterprise Tayside."

It is often discussed weather the retention of research intensive companies are good enough. Apparently, there are retention factors in the Cellartis case since the company did not move to Scotland, the expanded in Scotland. They are still located in Gothenburg as well due to certain retention factors. The retention predominantly lies in the two open doors available to Cellartis; by being located in Scotland, there is easier access to international markets and by being located in Sweden, there is access to AstraZeneca for instance. The dual location is valuable to the company. Cellartis perceives the technological knowledgebase and research collaborations available in Sweden as strong. From their perspective, the Scottish establishment adds to what already is accessible to the company.

One interpretation of the Cellartis case, when it comes to attraction and retention factors, could be that focus should be attributed to clarifying why certain Swedish companies chooses to expand or invest abroad. In addition, it is important to address the reasons lying behind the decisions of companies that have considered investing in Sweden but chose to invest abroad. According to Invest in Sweden Agency, there are many examples of companies that talk about investing in Sweden but eventually there is not much action[415]. The point that is made here is that in discussions of what risks there actually are that Swedish high-tech companies could move away from Sweden, it might be more important to focus on what was *not* invested in Sweden. Awareness of what we miss out on, and why, should be stronger.

[415] Invest in Sweden Agency 20080211, presentation of the report ”Utländska investeringar i den svenska life science industrin –framgångar på sluttande plan”.

6 Macro level innovation system comparison

6.1 Sweden - UK

The Swedish public funding of knowledge development is characterised of many funding sources but small amounts available from each of them. Even though co-funding is often required, the funding streams to individual projects and subject fields might be more scattered in Sweden than in the UK. In the UK, there has also been important pooling of resources from different governmental departements in the UK funding structure. The OSCHR is one such example of public actors taking on the responsibility to increase co-funding. The OSCHR functions as an intermediary structure between Department of Health and the new Department for Innovation, Universities and Skills. The UKCRC is another. In the Swedish approach to increase funding streams, it seems like requirements on the individual research groups or companies to achieve co-funding is attributed more importance than governmental initiatives to increase collaboration in their funding.

In the UK, the relative share of industrial R&D expenses has shown a decline the last decade. The public funding has increased on the other hand and the trend is positive. In Sweden, the industrial R&D expenses has also showed a decline but the public funders have not significanltly increased their funding. The funding of Swedish and British life science research currently relies on different kinds of actors. In Sweden, the private funders stand for a larger share.

The technological knowledgebase within life science in the UK is ranked higher than the Swedish and probably will remain that way considering the high political ambitions in this area, reflected in the increased public funding and the efforts to increase industrial R&D expenses.

Another interesting difference between the UK and Sweden is that there seem to be a stronger focus on licensing opportunities in the UK. It is an excplicit strategy of the government to support licensing on the expense of spin outs. The income as percentage of R&D investment on licences has showed a rapid and strong increase in the UK.

Cultural barriers between academia and industry has been very strong in the UK for historical reasons, but the situation has improved due to strong national policies and efforts. Also in Sweden, there are reports that the situation has been improved.

The access to venture capital is stronger in the UK, which is natural due to the much larger market. In particular, the UK business angel market is stronger and more mature than the Swedish. Many Swedish actors agree on a current mismatch between small companies and the investors when it comes to investment size. A corresponding mismatch has been claimed in the UK as well. An equity gap is identified in the UK for early stage companies and companies in their early growth phase. The equity gap has achieved lots of attention from the UK government in past and current strategies and there are many important schemes to adress the equity gap in place.

It has been recognised both in Sweden and in the UK that policies of nations are subject to competion, not least when it comes to attracting world class researchers and research intensive industries. However, in the UK it seems like the public funders to a larger extent submitt industries to competition. Their cooperation with national schemes and efforts aiming to adress the global challenge affect whether they remain priority industries or not.

In the policy evolvement comparison, differences were found between UK and Sweden. First of all, the rearrangement that recently occured in the UK departemental structure links innovation and universities tighter together and the knowledge transfer between industry and academia is more strongly sought after. In Sweden, the current departemental structure has been critisised to lack the cooperation necessary between the Ministry of Education and the Ministry of Enterprise, Energy and Communications. In the UK, the industry have been attributed an increased policy impact in later years by the uplifting of the industry led Technology Strategy Board (TSB) to an executive body. The TSBovertook the responsibility of the major research and business supporting programmes of former Department of Trade and Investment.

Vinnova and several other Swedish actors call for larger collaboration in between financers, private as well as public. In the UK, the public authorities have taken on the responsibility to create cross-governmental schemes which include several governmental funding bodies in funding collaborations.

The UK government and public authorities seem to have taken the selection of key technologies further than in Sweden. The dedication to prioritising on research areas of strength is shown not only in policy documents but also in the actual funding flows, which consequently are less scattered than in Sweden. Focusing on key technologies has been discussed widely also in Sweden, but there are stronger concerns about who is to make the pinpointing, how emerging technologies will be looked after and how the high quality basic research will be secured. This was not found not be an issue of concern in the UK selection process.

Addressing the global challenge in the UK is largely about what strengths do we have and what opportunities are there to make the most out of it. Creating an attractive environment for research intensive industry is a major overarching theme in the UK policies and seems to be more overall present in a wide range of issues. Awareness of the global challenge is high also in Sweden and there is a globalisation council with general strategic responsibilities.

Immediate access to the international market is very important for small life science research companies. The UK is ahead of Sweden due to their own large market and stronger links to other markets. The importance of critical mass is often pinpointed in Sweden. The critical mass issue is tightly linked to creating links for small companies to access international markets. Creating international visibility should likewise be adressed in the same context. There was a stated awareness of these issues and their interconnectedness in The Swedish life science strategy. However, many of the important recommendations were never put into action. The attitude towards international research collaborations seem to be more positive in Sweden than in the UK which is important in the assesement of critical mass.

6.2 Sweden – Scotland

The share of the GDP that is allocated to research in Scotland is smaller than in Sweden. The Scottish BERD-level is also relatively low, both compared to Sweden and to the rest of the UK. On the other hand it means that the vulnurability that the Swedish R&D funding could be facing due to private R&D funding making out such a large share of the total funding, might not be the case in Scotland. In Scotland, the level of HERD and the share hat ERD makes out of the total research funding is relatively high. In both countries it would be an interesting subject for further studies to examine the connection between the levels of private funding and public funding. The funding situation differ significantly from each other although the high ambitions within life science research are very high for both countries.

It is also interesting to note that the growth of private R&D investment in Scotland is predominantly explained by manufacturing firms and a shift towards a more specilised high value sector. It could be reasoned that once the shift has occur, Scotland would face a challenge when continuing the increase of private R&D by other means than increasing the value added in existing sectors. There has indeed been a stagnation in the BERD levels after the high value shift and the ambitious policies of both governmental and non-governmental bodies to attract R&D intensive foreign direct investment might be a consequence of this development.

It is difficult to compare the strengths of the technological knowledgebases in Sweden and in Sotland within life science, since various ranking systems might be used. It could be noted to that the profile areas of Sweden and Scotland coincide to some extent, for instance in stem cell-, genomics- and diabetes research. The regulation surrounding stem cell research are also very similar. Life science holds a strong position compared to other science fields in both Sweden and in Scotland. The life science industry achieves lots of attention in both countries and is in the fous of many debates, for instance related to clinical research and what actions that need to be done in order to become internationally competitive.

It should also be noted that there are some major investments made recently in Scotland in certain profile areas and it shall be interesting to follow the scientific development following the establishment of these collaborative research centres. In particular, it would be interesting to examine their effect on the industrial development and the attraction of foreign direct investments as well as of skilled researchers and students. There seems to be a more prominent intention in Scotland to access the international knowledge base through these investments than in Sweden.

Deficits in market related knowledge might have been subject to a stronger wake up call in Scotland than in Sweden due to the development that faced the company that came up with Dolly –the sheep. At least it seem to have functioned as a warning example in the story telling of policy makers and there are claims that an improvement has occured among life science companies.

Knowledge transfer and making business out of research also seem to achieve more political attention in governmental policies and strategies in Scotland. The government is working closely with industry in major policy areas. The distinction between the tasks of public agencies and private actors is more overlapping in Scotland and there seem to be a strong concensus among the broad range of actors. When it somes to revenue on IP, Scotland comes out very high compared to other UK regions. It is also particularly interesting to note that the university teachers in Scotland are very offensive in increasing commercialisation of university research. The roles are somewhat reversed, since it is the university teachers that demand more action from the industry, in order to make practical use of the research. From a Swedish point of view, this discussion would be interesting to follow due to current debates regarding the levels of applied and basic research. It might be that universities in Scotland has acknowledged a somewhat different view of how society and individual university entrepreneurs could benefit from research.

The business angel market is claimed to be more mature in the UK than in Sweden and this seem to be the case also for Scotland. When it comes to venture capital in general, the view depart, just like in Sweden, regarding the access. The mismatch percieved in Sweden might be less severe in scotland due to the strong business angel market that is reported to invest predominantly in early stages of company development. Both Swedish and Scottish life science firms suffer from negative results though and it is highlighted that the number of firms that actually make a profit are far to low.

Perhaps the most prominent dfference in governmental business support between Sweden and Scotland is the large focus on achieving critical mass in Scotland. This is reflected not only in governmental strategy documents but also in business support funding schemes. The attitudes towards direct funding of research intensive foregn companies as an instrument of attraction also differ. The Cellartis case is an illustrative example of Scottish policies regarding business support products, for instance regarding the procedure to ensure benefits for the local environment. It is also illuminating of the collaborative efforts that are possible in Scotland. It might be fair to say that Scottish life science industry has developed with a larger share of govermental support than the Swedish life science industry.

As a consequence of the higher focus on critical mass in Scotland, the focus on key technologies is also larger. There is an awareness though of the measures that need to be undertaken in order to ensure development of emerging technologies.

It might aslo be fair to say that Scottish life science policies and investments is to a larger extent a result of very high awareness of the global challenge and the competition it leads to when it comes to governmental policies and attractive business environments. Since the decisions made in Scotland are the consequences of such a clear strategy, that in many respects differ to the Swedish policies, it is important to follow the development in Scotland to learn from their achievements as well as mistakes.

7 Micro-level: The life science innovation systems of Cambridge and Uppsala

7.1 Sub-regional scope

7.1.1 Choice of sub-regions

Choosing the Cambridge biotech environment and the Uppsala biotech environment for the biotech sector innovation system comparison on a sub-regional level is motivated by some similarities between the areas, which make them comparable, and some differences in current and past strategies, which makes the innovation systems interesting to compare. Both cities have long academic traditions and a deeply rooted city culture influenced by the universities. Not only do both clusters have universities with strong reputations internationally, the biotech academic activities have a large relative importance within the universities and have internationally strong reputations. Biotechnology industry plays and has played an important role for the local labour market for decades in Cambridge as well as in Uppsala[416].

One factor that makes Cambridge interesting from a Swedish point of view is the well-known Cambridge Phenomenon. This is the striking success and speed of the development of the Cambridge cluster. The number of high tech companies has increased from 20 in 1978 to 360 in 1985 and 1000 in 2006[417]. On the European Commission ranking list, Cambridge always comes in as one of the top ranked areas. The economic growth of the region is on the same level as leading regions in the USA[418]. The region, by some, is said to produce high economic value that stays within the UK and significantly contribute to the UK economy[419]. The phenomenon has been explained in different ways, with some actors advocating an organic growth, others the effect of extensive top-down initiatives[420]. This created an interest in the Cambridge Life Science Innovation System, from now on called CLIS. Uppsala Life Science Innovation System will be referred to as ULIS.

---

[416] Region Uppsala, 2004, page 9
[417] St John´s Innovation Centre, 2006, page 1,
[418] St John´s Innovation Centre, 2006, page 2
[419] St John´s Innovation Centre, 2006, page 2
[420]http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78

Another vital factor that makes it interesting to look into CLIS is the current discussion in Cambridge about constraints to growth. The Cambridge phenomenon has led to many start-up companies but few of them are profitable and they remain very small companies[421]. The reasons for this and to what extent the situation needs to be addressed are debated in Cambridge. The discussion has been described as "where are the big gorillas?"[422] This question is highly relevant for the objective of this report, to analyse the competitiveness of the Swedish Life Science innovation system compared to the UK. Data on the industry structure of both Cambridge and Uppsala is accessible and makes it possible to compare the innovation systems of Cambridge and Uppsala regarding the growth of companies and constraints to growth.

7.1.2 Previous work

There are a number of reports dealing with the Cambridge life science sub-region already. Likewise, the evolution of the life science industry in Uppsala has been subject to previous investigation. A comparison of Uppsala and Cambridge was made by Uppsala University Industrial Relations Office in 2002. What value then could possibly yet another comparison adds to the current knowledgebase in the matter? It lies in the nature of an industry system to be dynamic[423]. The prospects of industries in terms of access to financial support systems and market demands vary over time. Policy standpoints also fluctuate since politicians and priorities are exchangeable. Comparisons and status reports a few years old in some matters doesn't give a valid picture of the current situation. Still, the system to be analysed needs to be delimited in terms of space and time to understand the characteristic relations, thereby delimiting the understanding[424]. The study of Uppsala and Cambridge will constitute sub-regional blocks in a wider analysis of the innovation system of the UK and Sweden and hopefully give a deepened understanding of the competitiveness of the Uppsala and Swedish life science innovation system. It has been noted that there is a need for more comparative studies of the Uppsala innovation system[425], which is the objective with this Uppsala-Cambridge comparison.

---

[421] The Cambridge Cluster, Chapter 3.2.1
[422] Owen. G, 2004
[423] Waxell. A, 2005, page 51
[424] Waxell. A, 2005, page 51
[425] Waxell. A, 2005, page 180

7.1.3 Delimitations of the innovation systems

The spatial delimitation is problematic due to the local, regional and national spatial levels being interconnected and diffuse[426]. The Uppsala Life Science Innovation System, ULIS, is defined as the local labour market of Uppsala and CLIS concordantly as the local labour market of Cambridge. Stockholm and London are not included in the delimited areas. The system structure analysis of Cambridge and Uppsala focuses on the sub-regional area. However, as described in the analytical model an approach in chapter 2, the interconnectedness between different sub-regions, regions and national actors is not neglected. The network overview and the activities take this into account. Notably, the *policies* affecting the sub-regional level are highly influenced by national strategies. This is further described in chapter 11. The priority here has been on sub-regional initiatives, actors and relationships etc.

7.1.4 Course of action

In this comparison of an innovation system on a sub-regional level in Sweden and in the UK, the current status has been in focus. Since limited statistics is yet available for 2007, data for 2006 has formed the basis for the comparison, with additional information from interviews and recently up-dated web pages to give an as updated picture of the status as possible. Representatives from different actors in both CLIS and ULIS have been interviewed at place in Uppsala and Cambridge. A full list of interviews performed and conferences attended to is given in the reference list. In order to put the current situation into perspective, bibliographical studies have been made on the activities to describe the development of the sub-region.

The comparison was performed with a different course of action than previous comparisons of other authors. The industry structure of Cambridge has been analysed before, but in order to make a fair comparison of the industry structure, naturally the characterisation of the industry structure must be performed in the same way. The industrial structure of the life science industry of Uppsala has been characterised in this report, as part of the industrial structure of the entire life science industry of Sweden. Managing an equally extensive survey of the UK Life Science industry over time was considered to extensive for the time devoted for this report. Therefore, the biotech industry of Uppsala in 2006 has been chosen to be compared to the biotech industry structure of Cambridge in 2006. The generation of the industry structures has been performed in the same way. The classification into business segments applied on the Swedish companies was also applied to the Cambridge Biotech population and not the

[426] Waxell. A, 2005, page 44.

classification of the biotech population previously used by East of England Regional Biotech Initiative (ERBI), for the sake of comparability.

8 Cambridge life science innovation system

8.1 Industry structure Cambridge

Just like the industry structure generated for the Swedish life science industry, the companies within the life science industry in Cambridge has been classified in order to generate figure 8.1. It should be noted though that the industry structure of CLIS does not include the individual business segments within med-tech. This is because the data kindly submitted from ERBI did not include medical technology companies, with a few exceptions. This might also be due to a smaller med-tech sector in Cambridge than Uppsala but cannot be verified.

There are a total of 183 biotech companies in Cambridge, comprising 6244 employees. This does not include marketing and sales companies though. The most striking feature of the industry structure of Cambridge is the large consultancy business segment, predominantly due to a large number of Contract Research Organisations (CROs). There is one very large CRO company shown in the figure. This is Huntington life sciences, which has been classified as CRO since this is their own description of the company. This is one of the world's largest CROs and was established already in the 1950s[427]. The business segments Drug discovery and biotech tools and supplies are prominent in Cambridge. Some drug delivery, drug production and agricultural biotech companies are also part of the industry structure. Apart from Huntington life science, there are few very large companies. This has been attributed lot of attention in CLIS already, with conferences and discussions on the theme, "where are the big gorillas". This refers to the absence of large companies.

Among the companies which perform broad R&D, there are many without a product on the market. The largest companies are naturally found among those that have put a product on the market. Among the companies which perform narrow R&D, most companies have reached the market. The narrow R&D companies are often very small companies, with a few exceptions. They are also often drug discovery companies. It should be noted that in the contact with ERBI, they questioned whether the number of companies defined to have a product on the market was not exaggerated. One explanation could be that in the industry structure classification, companies that had any kind of product linked to their activity were defined to have a product on the market. However, there are several examples of

[427] http://www.huntingdon.com/index.php?currentNumber=0&currentIsExpanded=0

research companies that work towards the launch of a drug or a biotech tool However, in the mean time; they sell a simpler product that does not require extensive R&D. These companies have been categorised among the ones with a product on the market, in order to be consistent with the Swedish (and Uppsala) industry structure. This phenomenon was not as frequent in the Swedish industry structure. Thus, the number of "product on the market" companies is exaggerated in that sense. Also, companies which sell a license are also put into the product on the market group, in order to be consistent with previous work. Licences occur among the companies within consultancy activity as well, but this activity is not further divided into sub-groups.

When considering the companies that have been established after 2000, it is shown that most of these were either drug discovery companies or biotech tools and supplies companies. There are also many newly established CRO companies. However, it is interesting that the large CRO business segment is not a new occurrence in CLIS, although it has increased significantly in later years. The consultancy sector does indeed have a long tradition in Cambridge. Among the newly established companies which perform broad R&D, very few have managed to put a product on the market (yet). Among the companies which perform narrow R&D on the other hand, more than half of the companies have a product on the market.

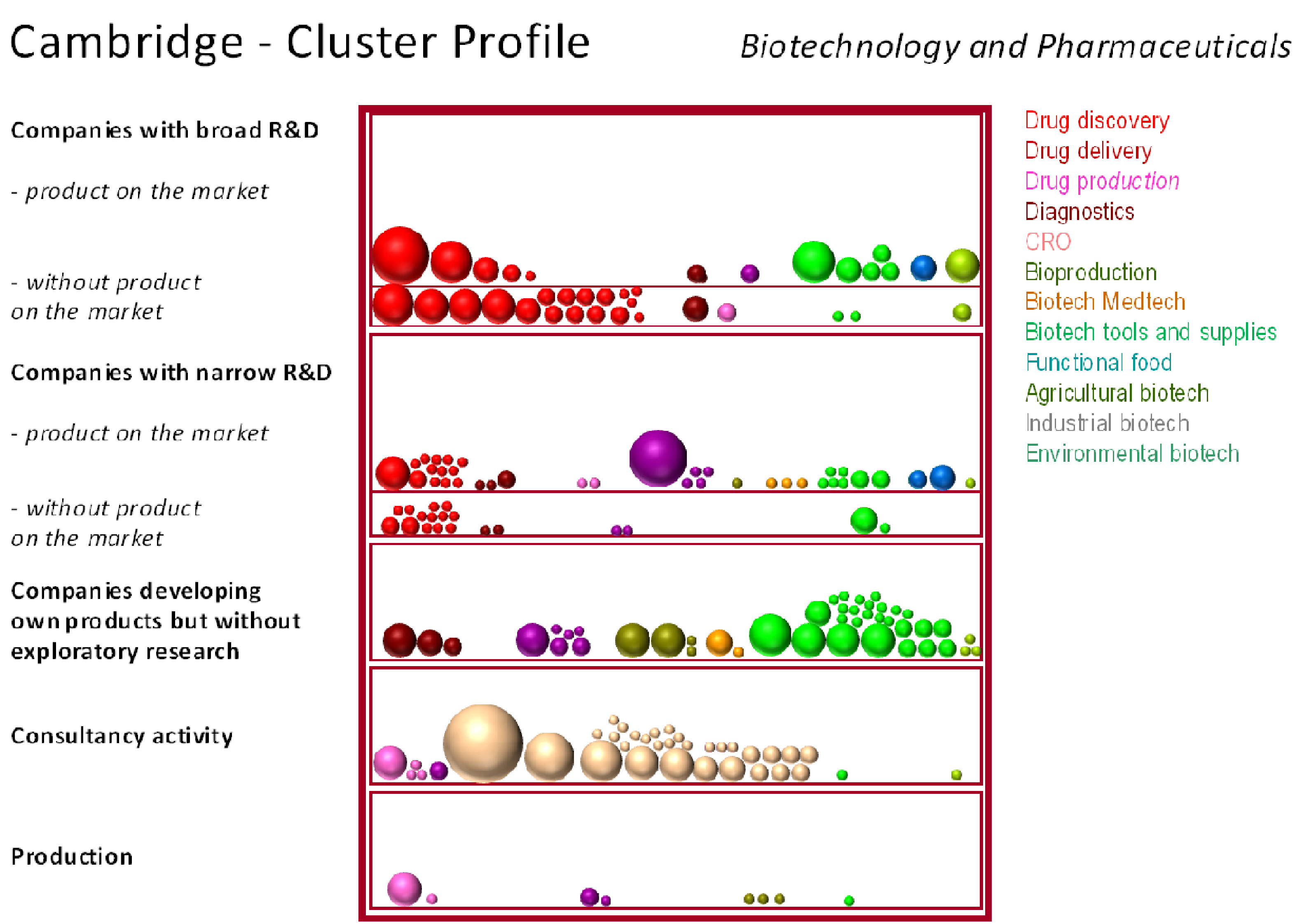


Figure 8.1 Industry structure of Cambridge /Helena Bergqvist (Author), 2007, Vinnova, layout: Tage Dolk , Addendi, 2007

8.2 System Structure Cambridge

In the system structure of the CLIS, the actors of the innovation system are presented. The actors chosen were selected because they constitute the most vital bricks of the system. These are the companies, the public authorities, the industry associations and partnerships, the innovation centres and science parks. In the system structure analysis, the most vital networks are also presented. The networks naturally are made up of relations between actors, but some of the actors classified in the groups above also could be seen as networks by themselves. Consequently, there is an overlap of the networks and the actors presented. Interesting occurrences in the innovation system of Cambridge (and in the UK as a whole) are the funding networks. This is a term used by HM Treasury referring to the bodies that are both financiers and networks[428]. The system structure analysis seeks only to describe the components of the innovation system. In the activity analysis section, the activities within the innovation system and the role the actors play in the system is described and analysed.

The populations of networks and funding-networks in East of England were generated by a search tool of the HM treasury homepage and should give the total populations on a regional-basis relevant to the Life Science industry. All of the networks and funding-networks, public as well as non-public, were studied with a point of reference on their focus on certain key issues. The result is gathered in table 2 and 3 and analysed in the activity section policy evolvement.

8.2.1 Public authorities

Starting from the top, the UK government's route to implementing the strategies and policies down to the sub-regional level of Greater Cambridge is crocket. As opposed to Scotland, there is no corresponding gathering Devolved Administration for England. England responds directly to the British Parliament and the government and there is no legislative assembly of England. Responsible for the execution of the public administration are the nine regions. The constitution within these regions differs. However, in all of the regions there are Government Offices (GOs) that sit between Whitehall departments and regional organisations. The nine regional offices are gathered in a network with a Regional Co-ordination Unit that functions as an interface towards the Whitehall departments[429]. The offices are part of the department for Communities and Local Government and in each GO, eleven Whitehall departments are represented. Each GO department manages extensive programmes on behalf of the corresponding Whitehall department and also ensures that East of England interests are represented in

[428] http://www.entrepreneurs.gov.uk/directorySearch.cfm
[429] http://www.gos.gov.uk/aboutusnat/

the national policy-making process. The GO for the East of England, Go-East, is led by the Go-East board of nine directors[430].

In the East of England Regional Assembly (EERA) elected representatives from the 54 local authorities are gathered in a partnership with representatives from social, economic and environmental interests The aim of the assembly is to promote the well-being of the region by developing a concordant policy of promoting East of England as" a world class economy renowned for its knowledge base" [431]. The administration below governmental level is carried out on a county level or even a local level within the county. In the East of England region there are over 50 councils and within Cambridgeshire there are seven councils.

8.2.2 Industry associations and partnerships

The development of the region and the crucial link to national public bodies like Technology Strategy Board (TSB), Department for Innovation and Universities (DIUS), former Department for Trade and Industry (DTI) and department for Education and skills (DfES), are also looked after by the regional development agencies (RDAs). The RDAs' focus lies in bringing investment to their region and increasing productivity[432]. The influence of RDAs and other regional bodies and partnerships has increased. They play an important role as the delivery bodies of governmental spending programmes. Business support programmes are carried out by the RDAs that also develops the Regional Economic Strategies (RES) to set the framework for the economic development in the region[433]. The RDA of East of England is EEDA, East of England Development Agency and is led by board members with a background in politics, business and the voluntary and community sector. The board is appointed by government ministers[434].

On a sub-regional level, there are organisations like The Greater Cambridge Partnership (GCP), The Learning and Skills Council (LSC) for Cambridgeshire and Business Link that implements the governmental agendas for skills and business development[435].

The interests of East of England are also looked after by the East of England European Partnership (EEPA). Their ambition is to serve as a guide for organisations and companies in their contact with the European Commission and to provide intelligence and advice about the development of funding policies. The aim is also to create strategic links with other European

---

[430] http://www.gos.gov.uk/national/
[431] http://www.eera.gov.uk/category.asp?cat=386
[432] http://www.englandsrdas.com/businessefficiencyinvestmentandcompetitiveness.aspx
[433] http://www.englandsrdas.com/economicdevelopmentandregeneration.aspx
[434] http://www.eeda.org.uk/abouteeda/staff.html
[435] Cambridge City Council, 2004, page 8-9

regions and promoting East of England to decision makers on a European level[436].

8.2.3 Innovation centres, science parks and incubators

St John's Innovation Centre
The Centre was established to support early stage, knowledge based companies. The tenants are also older technology based companies that bring maturity to the park and service companies that provide support in training, marketing, networking, public relations etc. This combination provides the base for a regional, national and European networking. One of the virtual services of the centre is Enterprise Link, which is a business club for small high tech companies[437].

Cambridge Innovation Centre (CIC)
The CIC is a science park with more than 60 companies with R&D activities. University spin-outs, multinational pharmaceutical companies, venture capitalists, patent agencies, consultants and business support are gathered under the same roof[438].

Babraham Bio incubator
In the Babraham Bio incubator, start-up and early-stage companies are offered combined laboratory and office accommodation[439]. Among the incubators purposes are to stimulate knowledge transfer awareness and to lead partnerships in the region to promote knowledge and skills[440].

ERBI
The primary objective of ERBI is to accelerate the growth of biotechnology within the sub-region. Partnering, collaboration and strategic alliances are encouraged. Among their activities are hosting an annual bio-partnering exchange with a delegates from all over the world. Among the services accessible for the biotech industry are finance and regulatory services. ERBI also provide consultancy to government departments[441].

8.2.4 Research Institutions and Universities

There are over 30 research institutes and universities in the Cambridge cluster[442], notably Cambridge University, the UK top ranked university when it comes to science and technology and the new stem cell institute

---

[436] http://www.east-of-england.eu/
[437] Smeets. A, 2006
[438] http://www.cambridgescienceparkinnovationcentre.co.uk/about.html
[439] http://www.babraham.ac.uk/facilities/Bioincubator.htm
[440] http://www.babraham.ac.uk/facilities/objectives.htm
[441] http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_11/_firsttitle.xsl/6
[442] http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78&xsl_arg=//BF%5FERBI%5FAB%5FBIO%5FFAF/&xsl_argx=3

with over 160 stem cell researchers[443]. The other universities are University of Cranfield, University of East Anglia, Essex, University of Hertfordshire and University of Luton. There are also three university hospitals, Addenbrookes which is the research hospital of Cambridge, Papworth and Norwich[444]. Life Science holds a strong position in the academic environment of Cambridge. There are 3500 students and 350 research groups within Life Science. Among the key activities in the region are drug delivery and discovery, stem cell research, diagnostic, oncology, neurology and converging technologies[445].

8.2.5 Networks and funding networks

In East of England there are a total of 55 high-technology networks, including i.e. some of the actors mentioned above[446]. Out of the 55 networks, 30 networks are predominantly or exclusively involved in biotechnology (table 3). There are 22 funding networks in the East of England out of which 21 are relevant to the biotech industry[447].The networks have been found by using the web based search tool of UK networks directory. The homepages of all of the networks and funding networks listed in table 2 and 3 were examined regarding their focus on the issues chosen. If one or several of these are formulated as key goals, key objectives, and key priority or in any other way described as an issue of major concern for the network or funding network, then it has been considered a focus. The entire table forming the basis of table 8.1 and 8.2 below is found 3 and 4.

443 http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78&xsl_arg=//BF%5FERBI%5FAB%5FBIO%5FFAF/&xsl_argx=2
444 http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78&xsl_arg=//BF%5FERBI%5FAB%5FBIO%5FFAF/&xsl_argx=2
445 http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_52/_page.xsl/79,
http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78&xsl_arg=//BF%5FERBI%5FAB%5FBIO%5FFAF/&xsl_argx=3
446 http://www.entrepreneurs.gov.uk/directorySearch.cfm
447 http://www.entrepreneurs.gov.uk/directorySearch.cfm

Table 8.2. The science and Life Science networks of East of England. The crosses indicates that the network have a focus on that particular issue[448]

Network	key technology areas	commercialisation	applicable research/economic benefit to the society	collaboration	global challenge
The Accredited Chamber of Commerce Bedforshire and Luton			X	X	X
Biology in Business (BIB)		X			
Cambridge & District Chamber of Commerce & Industry					
Cambridge Enterprise Agency		X			
Cambridge Genetics Knowledge Park (CGKP)				X	X
Cambridge Network		X			
Corporate Liaison office		X		X	
Cambridge university Entrepreneurs		X			
Cambridgeshire Chamber of commerce			X	X	
Cambridge County Council	X				
EEDA		X	X		X
East of England Innovation Relay Centre (EEIRC)			X		X
ERBI				X	X
Enterprise-link		X			
Essex Chamber of Commerce			X	X	X
Exemplas		X		X	X
gateway2Innovate		X		X	
The Great Eastern Investment Forum (GEIF)		X			
The Greater Cambridge Partnership (GCP)			X	X	X
Hertfordshire Chamber Of Commerce		X	X	X	X
i10		X		X	
East of England Innovation Relay Centre (EEIRC)			X		X
Invest East of England			X		X
Library House					
Local Industry Network		X			X
MedLink East		X			X
Norfolk Chamber of Commerce		X	X		X
Norfolk Network		X	X		
St John's Innovation Centre		X	X	X	X
East of England Stem Cell Network		X	X		
Cambridge University, Institute for Manufacturing		X			X

[448] Author/ generated by the UK directory search tool at http://www.entrepreneurs.gov.uk/directorySearch.cfm

Funding networks

Table 8.3. The science and life science funding networks of East of England. The crosses indicates that the network have a focus on that particular issue[449]

Name of funding body	Key technology areas	Commercialisation	Needs-driven research/economic benefit to the society	Collaboration	Global Challenge
3i Group plc					X
Cambridge Venture Partnership		X	X		
Research Counsils' Follow-On Fund	X	X		X	
BBSRC's Follow-On Fund	X	X			
Cambridge enterprise Seeds Fund (CESF)		X	X	X	
Cambridge Enterprise Proof of Concept Funding (PoC)		X			
Cambridge University Entrepreneurs' Business Plan Competitions		X			X
Amadeus and Angels Seed Fund (AASF)					X
Cambridge Angels		X	X	X	
Great Eastern Investment Forum (GEIF)				X	
GEIF Ventures		X		X	
Create East of England Fund			X		X
NW Brown Group, IQ VC fund				X	
Cambridge Capital Group	X	X	X		
Cambridge Gateway Fund	X				
Cambridge Research Bioventures		X			

449 Author/ generated by the UK directory search tool at http://www.entrepreneurs.gov.uk/directorySearch.cfm

Cambridge Research & Innovation Ltd					
ET Capital Fund		X			
Pall Mall Partners Ltd					
Prelude Technology and Prelude Ventures					
Iceni Seedcorn Fund LLP		X	X	X	

8.3 Activities

8.3.1 Knowledge development

In this section the generation of knowledge elements will be described. Of vital importance for understanding the generation process is the access to knowledge, both technological and market related, and the knowledge transfer between the academy and industry. The Cambridge phenomenon is interesting to discuss in the context of knowledge transfer since it has been highly debated in Cambridge to what extent knowledge transfer has occurred between the actors.

Generation of knowledge elements

Factors affecting the direction of research

The region hosts a traditional strong research base in agriculture due to the surrounding agricultural landscape. However, among the first products produced by the cluster back in the 80's were human therapeutics products. The potential in human health products increased and attracted the interest of investors. Due to requirements for fast financial return, therapeutics continued to be a favoured research field. Platform technology companies increased in the 90's when the investor interest raised in technologies and services aimed to commercialise other companies' products. More tangible products were required. After the dot com bubble, investors were more reluctant to high risk and steered the research and the commercialisation of research towards a product-based economy[450].

The impact of the University of Cambridge and the other local research institutes on the generation of a knowledge base is undoubtedly important. A pool of a highly skilled workforce available to the business community has been generated, apart from the knowledge bank hosted within the university and institutes.

[450] The Cambridge Cluster, Chapter 3.2.1

Public Research Funding
Cambridge University is allocated the highest amount of public research funding of all British universities. The distribution of total income (Private grants & contracts, HEFCE Recurrent Research Grants and other Government grants & contracts) between the UK top ten universities is outlined in figure 8.2. As shown in the figure, Cambridge also has the highest total income.

22. Available at <http://education.guardian.co.uk/higher/research/>

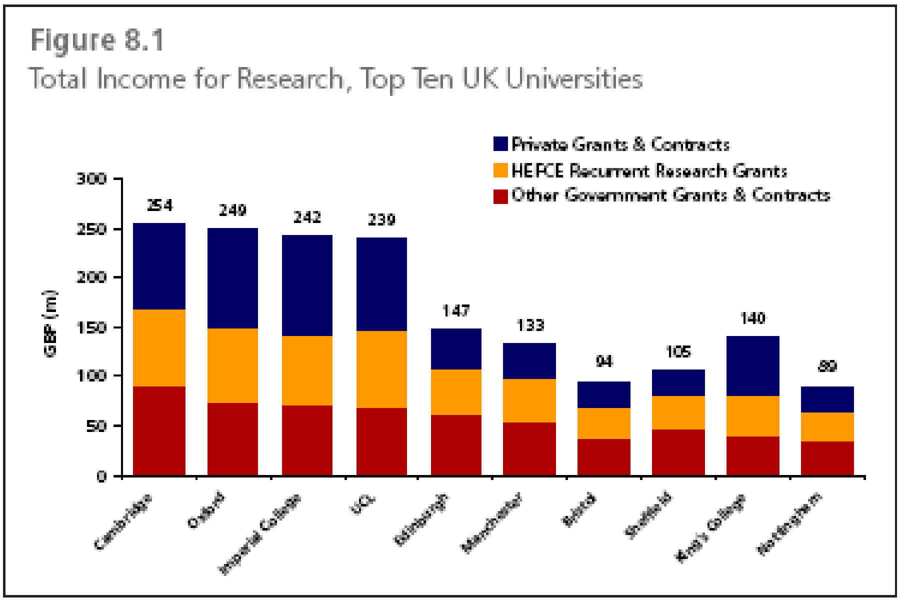


Figure 8.2. The total income for research for the top ten UK universities[451].

However, with the top four ranked universities globally as a point of reference, Cambridge is allocated the lowest amount of funding[452]. The competition exclusively comes from American universities. With adjustments made for the number of academic staff, Cambridge comes in third out of the four, as shown in figure 8.3[453].

[451] Library house, 2006a, page 47
[452] Library house, 2006a, page 48
[453] Library house, 2006a, page 48

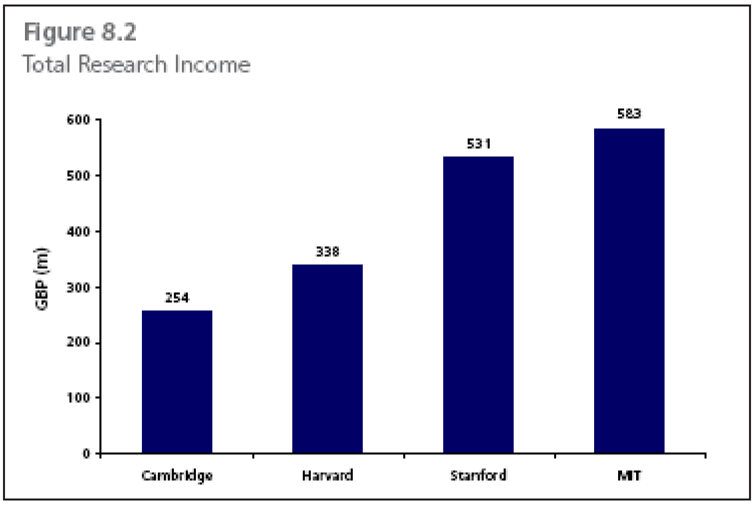


Figure 8.3.The total research income for the top four ranked universities in the world[454].

Industrial R&D expenses

The East of England has the highest level of Business Enterprise Research and Development (BERD) of all the regions in the UK. In 2005, £3.3 billion was spend on BERD. The region also has the highest R&D intensity measured in shares of total economic activity. BERD contributed 3.5% of GVA in 2005[455]. This is largely focused on a small geographic area and a small number of companies[456]. As shown in figure 8.4, the biotechnology and healthcare industries have relatively higher R&D expenses than other high-technology industries in the Greater Cambridge Area[457].

[454] Library house, 2006a, page 48
[455] East of England Development Agency, 2007, page 20
[456] East of England Development Agency, 2007, page 33
[457] http://www.gcp.uk.net/SITE/UPLOAD/DOCUMENT/CIR_HiTech_2006_Final.pdf

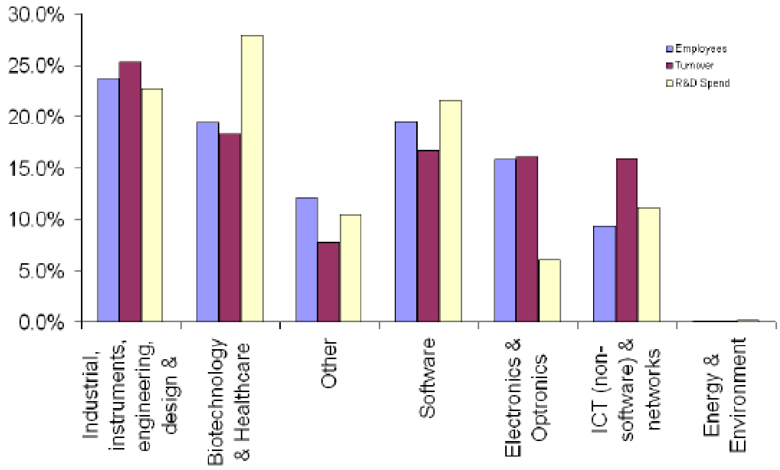


Figure 8.4. The number of employees, R&D expenses and turnover of the Greater Cambridge Partnership companies, data over 2005-2006[458].

As was commented on in section 5.2.1 when dealing with BERD as percentage of GDP in Scotland, London had a suspiciously low level compared to other regions. East of England holds a much larger BERD level than London[459]. No specific reasons where found that explain for this, but it could be speculated weather there are connections to the very high relative share of total HERD allocated to London[460]. Also, when it comes to differences between East of England and London, there might be spatial delimitations complicating the interpretation of statistics.

Access to knowledge elements

Technological knowledgebase

The Life Science knowledge base of Cambridge is highly ranked regardless of measurement chosen. Since Watson and Crick made their breakthrough discovery, 14 Nobel Prizes in medicine and chemistry has been attributed to Cambridge scientists[461]. This constitutes 20% of all Nobel prizes in medicine and chemistry.[462] The strength of the technological knowledge base as measured in number of publications per year compared to three highly ranked universities in the USA is outlined in figure 8.5. The comparison shows that as far as publications per year are concerned, Cambridge University compares well with Stanford and MIT.

[458] http://www.gcp.uk.net/SITE/UPLOAD/DOCUMENT/CIR_HiTech_2006_Final.pdf
[459] http://www.lda.gov.uk/server/show/ConWebDoc.1340
[460] http://www.lda.gov.uk/server/show/ConWebDoc.1340
[461] http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78&xsl_arg=//BF%5FERBI%5FAB%5FBIO%5FFAF/&xsl_argx=3
[462] http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78

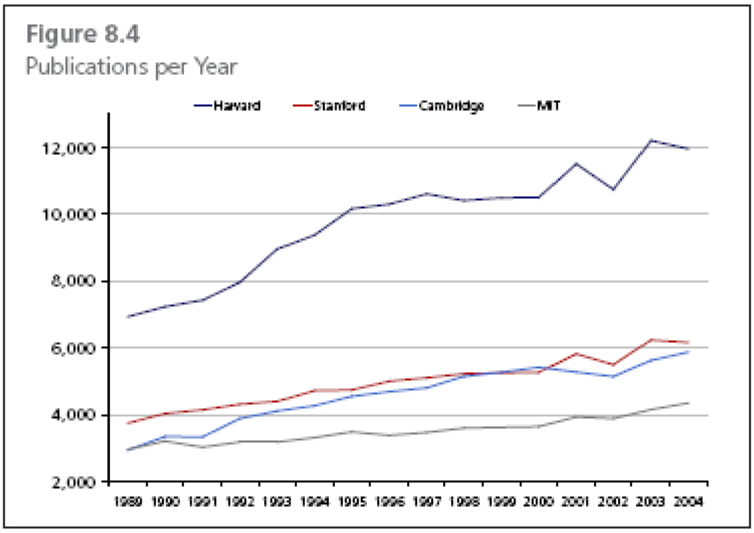


Figure 8.5. The number of publications over time for the top four ranked universities in the world, according to Library House[463].

Market related knowledge base
Market related knowledge is one of the most advocated underlying explanations for the Cambridge success story. The formation of a company called Cambridge consultants in 1960 is referred to as a key trigger for the growth of the cluster. Their focus lied on the market and applicable research. According to ERBI, already in the 1980's, the market knowledge of the bio-community included intellectual property exploitation, business skills and the importance of knowledge transfer[464].

Today, there are over 350 service providers in the region that claim to have biotech specialist competence and over 100 organisations engaged in the development of the bio-community, according to ERBI[465]. Life Science stands for a substantial share in several of the activities aiming to increase the market related knowledgebase as shown in the table 8.3.

Table 8.3. Life Science share of market related knowledgebase support services[466]

Specialist service provider offerings:	Share of actors with total or major focus on Life Science

[463] Library house, 2006a, page 49
[464] http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78&xsl_arg=//BF%5FERBI%5FAB%5FBIO%5FFAF/&xsl_argx=1
[465] http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78&xsl_arg=//BF%5FERBI%5FAB%5FBIO%5FFAF/&xsl_argx=3
[466] http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78&xsl_arg=//BF%5FERBI%5FAB%5FBIO%5FFAF/&xsl_argx=3

Financial services	9%
Legal services	5%
Consulting services, 100% dedicated to pharma/biotech industries	15%
Other business services, offering a local biotech centre of excellence	31%

However, even though the accessible services aiming to increase management and market skills are many, the lack of competence in this area was viewed as the major constraint to growth among the high-tech cluster firms in 2001, as outlined in figure 8.6. This picture is still valid according to the industry representatives interviewed in Cambridge.

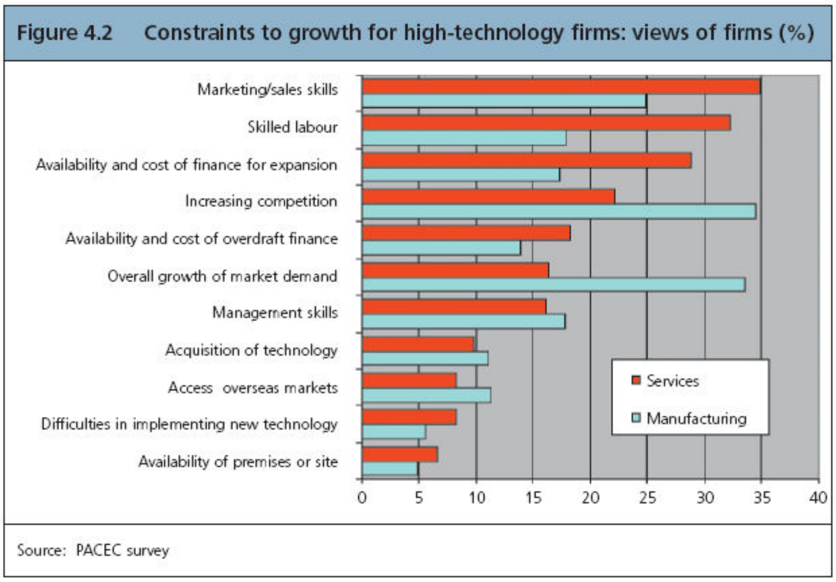


Figure 8.6. The constraints to growth for high-tech firms according to the firms themselves in 2001[467].

The 2001 result is derived from a survey of high-technology firms in the local labour market. Among the Finance sector and Business support sector, the lack of management skills is viewed as a constraint by almost 90% of the respondents and the lack of marketing skills by almost 70% of the respondents[468]. It seems to be the general view that managerial skills are in shortage in the region, although the Cambridge local labour market is better off than other parts of the region[469]. In the Regional Economic Strategy 2008-2031 (RES), an EEDA product that sets the framework for the work of Go-east and local public authorities, the problem is addressed and a number

[467] PACEC, 2003, page 58
[468] PACEC, 2003, page 58
[469] East of England Development Agency, 2007, page 51

of schemes and products are suggested to boost the up-take of managerial skills[470].

International knowledgebase

The knowledge base is further strengthened by the international knowledge base. Access to foreign research by networks and collaborations as well as the attractiveness to foreign top researchers are essential today in order to cope with the global challenge. According to GCP, the level of international interconnectedness is high in Cambridge and the sub-national region is highly active in participating and developing mechanisms that brings innovations to a global market[471]. Cambridge has been involved in several successful international collaborative research projects in the biotech field. The development of a universal database and knowledge base of protein molecules, a 15 £ million collaborative research project initiated by the US National Institutes of Health, NIH is one such example[472].

However, the international interconnectedness of Cambridge University and the other research organisations could be questioned. As shown in figure 8.7, almost all co-authorships in life science journals with an impact factor above 6 are exclusively British. Among the international co-authorships, it is the US that dominates, as shown by figure 8.8 . The US and some European countries are quit well represented, but India for instance is not visibly present on the co-authorship map. Apart from European countries and the US, there are co-authorships with Japan, Israel, China, Australia and Canada. When considering the specific organisations taking part in the co-authorships (as shown by figure 8.8) it is clear that among the international co-authorships of the University of Cambridge there are predominantly US universities with strong reputations, like Harvard and Stanford. This is consistent with the description given by Cambridge University that international collaborations with US are the ones that are highest ranked in a research career. There are not strong career incentives to take part in other international research collaborations[473]. It should be held in mind that the maps are generated exclusively based on co-authorships in journals with impact factor >6. If there are strong co-authorships with certain countries in less highly ranked journals, this would not show in the maps. In Cambridge, it was claimed in interviews with industry representatives that the international connections probably are stronger when considering industry. This might be true if considering international connections with clients and suppliers in general, but as far as research collaborations are concerned, the industry falls short. Universities and hospitals dominate the map of organisations.

---

[470] East of England Development Agency, 2007, page 55
[471] PACEC, 2003,, page 40
[472] PACEC, 2003, page 39.
[473] Interview, Reschner Richard, research services Division, Cambridge University, 20071018

Research organisations in Cambridge have participated in 60 life science projects of the 6th European Framework Programme, FP6, started in 2004 or after. Over the period 2004-2006, the number of projects started where Cambridge participates has decreased. The main partner organisations outside the region are mainly situated in France, Germany, Great Britain and Sweden. A minority of the organisations with which Cambridge have collaborated in several joint projects are industry organisations and the vast majority is in academia. Collaborations with industry in other European countries are predominantly restricted to single joint projects. Overall, the academy dominates. The academia also dominates when considering what type of organisations within the region that takes part in the FP6, 52 out of 60 projects involve a Cambridge partner from the academia and 16 from the Cambridge industry. The strongest thematic area in terms of number of joint partnerships is cancer[474].

[474] www.lifecompetence.eu, 20080205

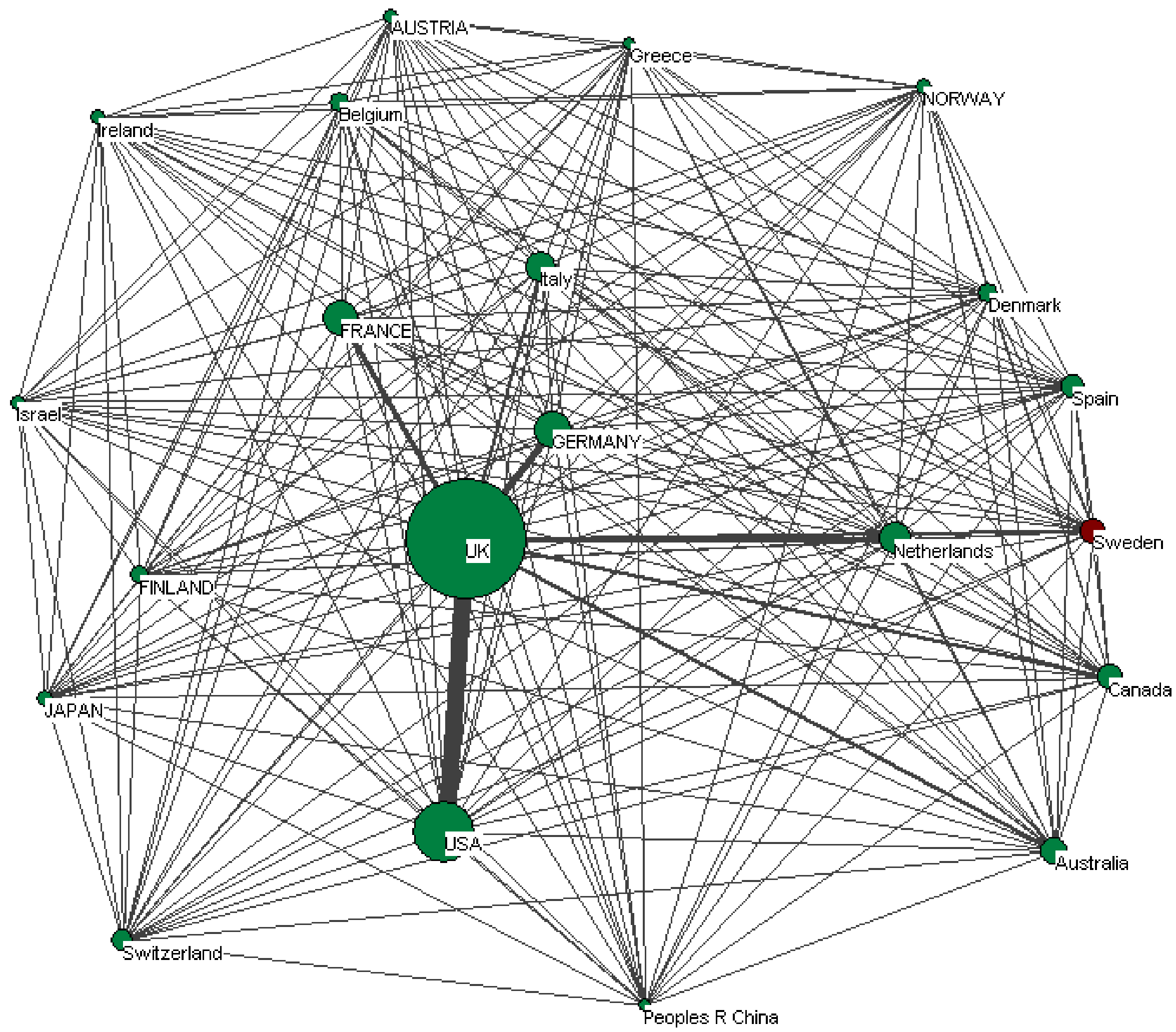


Figure 8.7. Co-authorships between organisations in Cambridge and organisations, nationality shown.

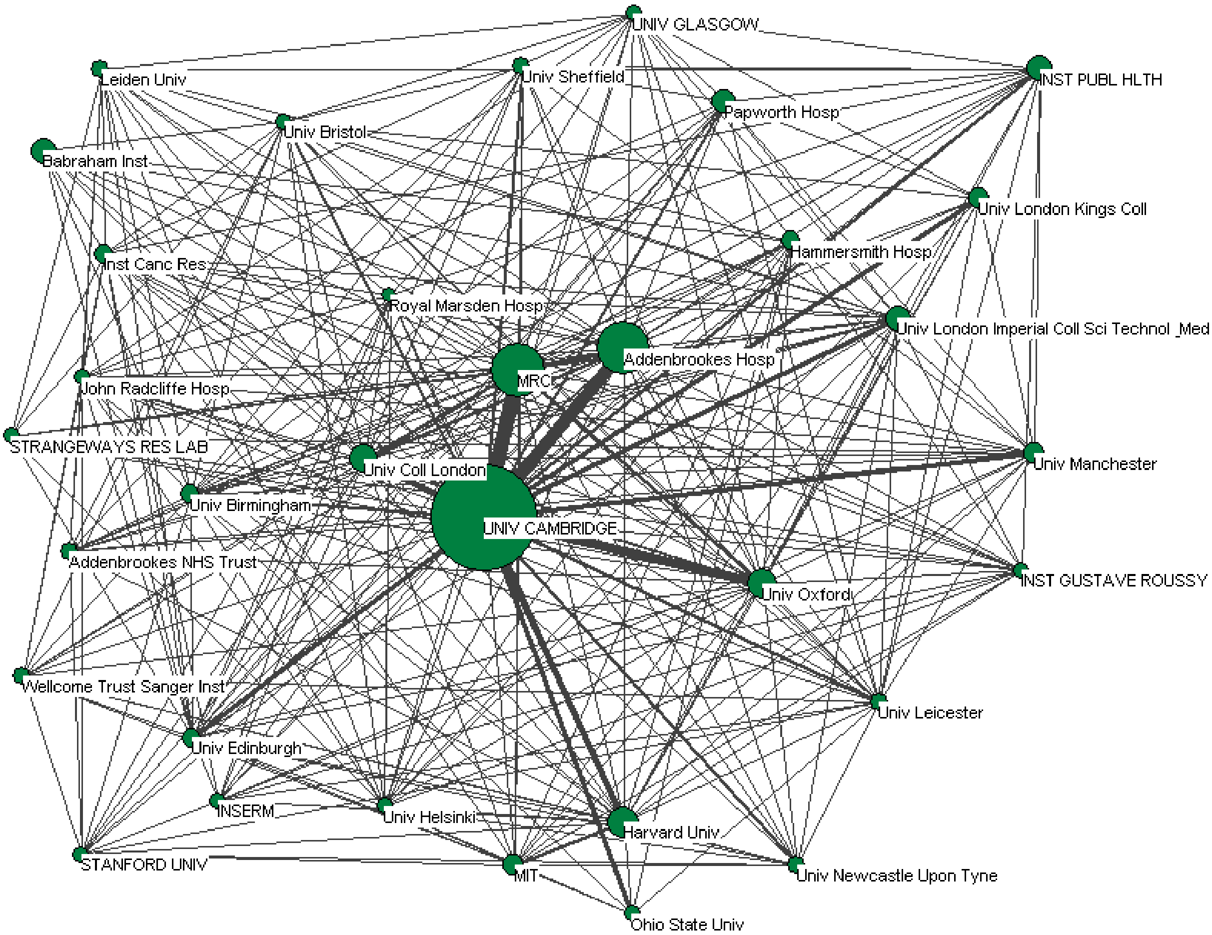


Figure 8.8. Co-authorships between organisations in Cambridge and other organisations, organisations shown

Knowledge transfer

Commercialisation activities

According to ERBI and St John's Innovation Centre, the Cambridge phenomenon can not be attributed to the University of Cambridge, referring to the low extent of commercialising efforts up till a few years ago[475]. The University staff and students have founded about 50 spin-off companies based on university IP[476].

In contrast, Library House, Cambridge City Council and several others advocate the view that the University of Cambridge indirectly has had a

[475] http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78

[476] Library house, 2006a, page 10

profound impact on the development of the Cambridge phenomenon[477]. The economic impact of the university is recognised at a much higher extent than the St John point of view. The net return on investment for educating a Cambridge graduate is estimated at over six times the original investment according to Library House[478]. By using a model designed to enable the analysis of the impact of HEIs on economies and societies, Library House investigated not only the direct economic impact of research activities but also the knowledge generated through these activities that was made available to regional, national and international business through technology licensing, faculty consulting activities, research contracts etc[479]. They conclude that the economic benefit from the Cambridge University to the East England Region and the Greater Cambridge sub region is profound, both in economic and social terms, as outlined in table 8.4

Table 8.4. The economic impact of the University of Cambridge on the region and on the nation[480]

Economic Impact of The University of Cambridge	
Number of employees directly employed by The University of Cambridge	11,700
Indirect jobs created by The University of Cambridge	77,000
Net present value added to the region	£21,1 billion
Net present value added nationally	£4,4 billion

Strengths and weaknesses identified related to the knowledge development

One of the most obvious strengths of this activity is the technological knowledge base of Cambridge. However, the volume of publications from the University of Cambridge is not increasing. This development is not highlighted by the university or the surrounding innovation system and thus presents a potential future concern in the technological research base.

The strength of the market related knowledge base in Cambridge is debated. The general view among the persons interviewed is that the management skills have been improved in recent years. There are a lot of management support products available, although some of the people interviewed claim that the companies just won't listen to all the advice they are given. Based on the survey to representatives of the high-tech firms of Cambridge in

477 Library house, 2006a, page 58 and http://www.cambridgeshire.gov.uk/business/economic/Research+and+development.htm
478 Library house, 2006a, page 1
479 Library house, 2006a, page 23
480 Library house, 2006a, page 1

2001, where a large share of firms and business support providers claimed management skills to be a constraint to growth[481], at least there has been a large potential for improvements. It has also been claimed that there simply isn't enough interest among the CEOs of expanding their business considerably. The drive is the entrepreneurship in itself and the profit gained when selling the business. The entrepreneurial researcher then hops on to the next project. If a lack of management skills still presents a weakness in the life science innovation system of Cambridge and constitutes a constraint to growth, it is probably a combined constraint, partly due to reluctance among the local business leaders to bring their company to perform in the specific way that might be considered successful from an external point of view. The individual entrepreneurs and CEOs might make a profit on their company by consultancy activity or by-outs even though the company as a hole is not profitable or growing in terms of number of employees. Then, it is a question of lack of incentives more than a lack of management skills. The strong presence of consultants, in combination with a relative high amount of business support products available, presents a strength if considered separately. The overall contribution to the innovation system for life science of Cambridge might not be as strong as it could have been with better translation mechanisms into economic benefit for the region.

Since international collaborations and partnerships has a very high profile on the national agenda (UK strategy documents, frameworks etc), it is particularly interesting to investigate what international links there are on a sub-regional level. Based on the results of the sub-regional policy examination, the co-authorships of Cambridge University and other organisations, the decrease in the participation in FP6 and finally the interviews in Cambridge, it is concluded that international links are not very strong in academia, nor in industry . In order to claim this to be a weakness, it is a prerequisite that Cambridge thereby loses out on potential benefits. It was a stand point in some interviews that there might not be that much to gain in international collaborations. Put simply, what's in it for Cambridge? Although certain successful initiatives have been established, the overall interest in international partnerships is not very high. As figure 8.7 show, the share of international co-authorships among the co-authorships of Cambridge University and other organisations is low and the US is the country that receives the largest interest from the Cambridge based researchers. An explanation for this, based on interviews in Cambridge, is that there are no real incentives for Cambridge researchers to collaborate with international researchers. The only country that is qualifying to have performed research in is the US. This is not so surprising against a background of the national view that the UK comes in second in the world when it comes to performance in life sciences. The first country clearly being the US, this has motivated some partnerships. When it comes to

[481] PACEC, 2003, page 58

receiving funding from the EU on the other hand, the East of England has been fairly successful in achieving funding and there are quite active players increasing the awareness of EU funding and helping out in accessing the available funding. The EU Frameworks and the accessible funding thereby have presented incentives to build on European links. This explains the high share of European collaborations among the total international co-authorships including Cambridge. Some of the people interviewed pointed out that links between the biotech industries of Cambridge are likely to hold more international collaborations than the university. The FP6 participation however reveals that the industry participates in quit few research collaborations compared to the academia. The international connections with clients and suppliers on the other hand are stronger, according to ??. There is a brokerage service available for companies seeking international partners, IRC. Their focus however lies within Europe and no corresponding brokerage player has been identified for international collaborations for industry in the emerging economies of East Asia.

Knowledge transfer between academy and industry is another key issue on the national agenda. This has been in the sub-regional and regional spot-light for a longer time than the importance of international links in addressing the global challenge. This might explain the much stronger policy focus on commercialisation than global challenge among the life science networks and funding networks of East of England. Several actors claim that there have been cultural barriers preventing knowledge transfer from the University of Cambridge. Leaving the discussion of relative parts played in the Cambridge phenomenon to hair splitting, it is however clear that there has been a large potential for improvements. Most of the players seem to agree that there has been an improvement of the attitudes and some speak of a cultural shift in the universities. It might be that knowledge transfer from the universities to industry has reached a quite satisfactory level, however the commercialisation of knowledge into products and profitable companies has not. As shown in the industry structure, the share of companies that have managed to put a product on the market is small and so is the share of the companies actually being profitable. Thus, knowledge transfer is not included among the weaknesses (nor among the strengths), but commercialisation into profitable products is included among the weaknesses.

8.3.2 Financial support systems for innovation

In this section, different aspects of the financial support system are dealt with. The general access to venture capital as well as private versus public capital in the system is outlined. In the discussion about strength and weaknesses following the activity description there is an additional focus on the question “Where are the big gorillas?” This is because constraints to growth are a major topic in the Cambridge financial support system. The question was also found very important since the same question is on the agenda also in SLIS and ULIS.

Access to Venture Capital

General access to venture capital

Although the South Cambridgeshire and Cambridge city accounts for less than 1% of the UK population, 7.8% of all venture capital investments are made in these districts (July 2006)[482]. According to St John's innovation centre, a decline in investments has been noted and also a decline in the number of start-ups. The downturn should be put in a wider UK and European perspective however, since there is a general decline in investments and start-up companies[483]. The general access to venture capital historically has been considered good, and the relative access to venture capital in East of England and in the Cambridge and South Cambridgeshire districts is high. As shown in table 8.5, the average share of the total amount of venture capital backed companies in the UK that was based in Cambridge and South Cambridgeshire was high in 2004 but saw a decrease in 2005. This was however the overall development in the UK that year and Cambridge and South Cambridgeshire did relatively well.

Table 8.5. Average share of UK venture capital backed companies based in Cambridge and South Cambridgeshire.

Year	Average share of UK venture capital backed companies based in Cambridge and South Cambridgeshire
Before the 20th Century	7.7[484]%
2004	25.0[485]%
2005	20.3[486]%

Today, several sources claim a funding gap, predominantly in three stages of business development. In the Biotech sector in particular, it has been argued to be deficient seed funding for start-ups[487]. There is also a debated lack of 'grow-on' funding[488]. This kind of funding required is larger than the seed funding, 2-5£ million. Finally it has been argued that companies close to putting a viable business plan into market are prevented by a funding gap of £250,000-500,000. Their unattractiveness to venture capitalists springs from the narrow market niche they operate in and in order to over bridge the gap, mezzanine funds have been proposed. These funds should be used to

[482] Herriot. WJ, Minshall. T, Smeets. A, 2006, page 6
[483] Herriot. WJ, Minshall. T, Smeets. A, 2006, page 6
[484] Library House, 2006b, page 23
[485] Library House, 2006b, page 23
[486] Library House, 2006c
[487] Herriot. WJ, Minshall. T, Smeets. A, 2006, page 17, 21
[488] Herriot. WJ, Minshall. T, Smeets, 2006, page 21

offer long term loans, with a relatively high rate of return.[489] Other sources claim that the current overall venture capital funding in the biotech cluster is strong[490]. The recovery from the global venture capital dip after the dot com bubble has meant harder times for the companies, but at the same time requirements from investors for larger shares of the companies in return has increased the benefits for investors and their willingness to invest.[491]

Originally, business angels and investment funds did not play any major parts in supporting business. However, some of the early entrepreneurs that encountered success in their business later became business angels and also created investment funds[492]. The opening of Library House, which serves as a focal point to investors, increased the interest in biotechnology of business angels. The local banks however stay out of the game because of the high-risk nature of biotech-companies[493].

Public Funding

One of the reasons for so many actors to claim that the Cambridge Phenomenon has aroused from a bottom-up, organic process is that very little public funding was available for start-up companies during the fast-growing years of the biotech-cluster[494]. However, The Regional Economic Strategy concludes that there are many publicly funded business support products in the East of England and that confusion reigns about the good access. Substantial changes in the public funding have occurred in the last years, aiming to simplify and streamline the business support. The Business Link and business Support Simplification Programme are efforts to simplify the information channels about business support systems[495].

European Funding

The European Structural Fund Programmes allocates £320 million to the East of England. The GO-East has a European unit handling the administration and is actively engaged in developing European Structural Fund Programmes for the East of England region for the period 2007 – 2013[496] with the current programming period ending in 2006. There are initiatives taken in order to increase the East of England share of future

[489] Herriot. WJ, Minshall. T, Smeets, 2006, page 24, 29
[490] The Cambridge Cluster, Chapter 3.2.1
[491] The Cambridge Cluster, Chapter 3.2.1
[492] Smeets. A, 2006, page 16
[493] The Cambridge Cluster, Chapter 3.2.3
[494] The Cambridge Cluster, Chapter 3.2.3
[495] East of England Development Agency, 2007, page 28
[496] http://www.go-east.gov.uk/goeast/european_funding/?a=42496

European Structural Fund Programmes, among others the Competitiveness and Employment European Regional Development Fund (ERDF)[497].

Strengths and weaknesses identified

The general access to venture capital is a strength of the Cambridge life science innovation system. However, matching the accessible funding with demands from the industry compiles some difficulties. There is a discrepancy in the size of funding needed by the relatively small Cambridge companies and the sums that the venture capitalists seeks to invest. Also, according to Deloitte[498], the type of funding accessible is not ideal and creates a ripple effect in the system The horizon of investments is to short and the exits are too early. When comparing Cambridge to strong regions in the US, the spread of investment falls short in Cambridge, with a larger share of venture capital and IPO but less licensing than in the US[499]. However, as was shown by figure 4.4, the licensing in the UK has increased significantly in the last years and so has the income from licensing. It is also a deliberate strategy from the government's side to support this development, since the revenues from licensing often are higher than for spin outs. It could be that the development of licensing has not been as strong in Cambridge as in the UK overall, or in the life science sector as other sectors (figure 4.4 shows the overall picture, not only life science). However, from a Swedish perspective, and in particular compared to the industry structure of Uppsala as will be discussed later on, the large consultancy business segment was striking as was the share of companies that put licences on the market instead of "tangible" products.

Another aspect to consider in diagnosing the accessibility of capital to biotech companies in Cambridge is the reasons underlying the large share of consultancy companies. The strong consultancy sector can be attributed to the history of the Cambridge cluster, with the Cambridge Consultants and a few other companies being very successful and establishing a 'consultancy tradition´. Several others followed in their foot-steps and there were spin-offs from the biotech companies into consultancy. Another major factor is the increasing outsourcing of research and other activities among the drug development companies, biotech tools and supplies companies etc. Apart from these factors, the concordant view of company representatives interviewed was that the CRO business model was an alternative for funding. Unless being among the best performers receiving early-stage funding, companies which consider them selves to have a good commercial potential are left with CRO as a source of income. Some claimed that CRO

[497] http://www.go-east.gov.uk/goeast/european_funding/444865/?a=42496
[498] Deloitte 20071017
[499] Deloitte 20071017

formed a basis for the researchers and entrepreneurs who would wish to put a product on the market, but due to the difficulties and associated risks and the large consultancy incomes, many companies remain CROs or partly CROs. Some said to have been tempted to keep the goodies of the research for themselves, in order to commercialise into a product, but eventually gave up this idea. The picture that begins to emerge of the Cambridge Biotech cluster is an innovation system were some of the strengths also constitutes holdbacks in other respects. The consultancy sector has played a major part in the success of Cambridge in terms of number of start-up companies and worldwide nomination. However, the lack of profitability among many companies and the low share of drug and development companies which has actually put a product on the market is a weakness. The cluster might have locked itself into a situation where consultancy is the safest way of financing and thereby withdrawing the incentives for small research companies to go for the "product on the market alternative". Their clients are among the outsourcing companies and the trend towards outsourcing is increasing. Based in Cambridge, the CROs and consultancy sector in general both have access to the smaller clients among the Cambridge companies and the larger ones in the London life science industry. It is important to remember that this isn't necessarily a bad thing. On the contrary, it might be a development to encourage (compare to the national level of UK and governmental initiatives to increase licences).

One important aspect in analysing the performance of an innovation system is naturally what share of the economic value created that is kept within the region. What mechanisms are there to canalise the value into the local economy? It has been identified as a key problem that the exit routes chosen by venture capitalists often lead to business being closed down or purchased by American firms[500].

"Where are the big gorillas" or constraints to growth related to venture capital access

The equity gap on earlier stages has been attributed to a mismatch in the amount required by the start-up and early stage companies and the often fixed amount the investors are willing to invest. The restrictions to growth in small companies has been referred to as "where are the big gorillas?"[501] in Cambridge[502], meaning why don't companies grow faster into large

[500] Herriot. WJ, Minshall. T, A Smeets. A, 2003, page 26.
[501] Owen. G, 2004, http://www.libraryhouse.net/about/press/article/136/
[502] For instance, the title of the Cambridge Enterprise Conference 2007 was "Growing big gorillas –turning promising start-ups to major corporations": http://www.cambridgeenterpriseconference.co.uk/documents/PR01CEC.pdf, page 1

companies[503]? There are very few Cambridge companies with more than 250 employees[504]. Apart from the problems in accessing venture capital, one of the hindrances in growing larger businesses arguably is the constraints in the physical infrastructure of the sub-region. Bad communications to Heathrow and London makes the region less accessible for UK and global markets[505] Cultural factors constitutes another constraint. There is unwillingness in the city to grow out of the "small town feeling[506]". Contentment among CEOs over the current size of their companies and an unwillingness to grow into risky business also has been noted[507]. The Deloitte diagnose previously described might also add one explanation to the question at hand. As stated before, they claim that there are not enough early exits for investors in the UK compared to the US and that the type of accessible VC also plays a part. A larger spread in the spectra of types of accessible VC, like in the US, would be welcome. The main reason for the absence of the gorillas according to Professor Walt Herriot at St Johns Innovation centre is that the market of customers and the VC market are too small in the UK and companies must internationalise in a very early stage. The successful Cambridge start-ups are characterised by a presence in the US[508].

8.3.3 Policy evolvement

In this section, the policies regarding certain issues of importance for the innovation system and development are examined. These issues are the importance of addressing the global challenge, increasing the collaboration between funding bodies and other actors in the innovation system, identifying key technologies of strategic importance and retaining economic value in the nation/region. The policy study takes a point of reference in the strategies and visions of the public authorities. However, on all spatial levels of the British innovation system, the industry plays an important role in affecting the agenda for the public authorities. As mentioned in the system structure analysis, the East of England Development Agency is responsible for the Regional Economic Strategy of East of England. This strategy sets the framework for the public authorities, like Go-East, county councils and the local city councils. Not only is there non-public bodies implementing the policies of public authorities, there are also public authorities implementing the policies of non-public bodies. Delimiting the policy study spatially to a sub-regional level also creates a problem since the regional and national actors are the predominant policy-makers. Therefore, the policy study has been performed on a regional level as well as on sub-regional level. Consequently, each of the issues mentioned initially is discussed with a

---

503 http://www.libraryhouse.net/about/press/article/136/
504 The Cambridge Cluster, Chapter 3.2.1
505 Herriot. WJ, Minshall. T, A Smeets. A, 2006, page 19
506 Interviews in Cambridge
507 Herriot. WJ, Minshall. T, A Smeets. A, 2006, page 16 and interviews in Cambridge
508 http://www.cambridgeenterpriseconference.co.uk/documents/PR01CEC.pdf

point of reference in the policies of the different actors, ranging from regional to sub-regional or even sub-sub-regional level. Generally, the most explicit policies, most tangible strategies and clearest devotion were found on the regional level, predominantly in the Regional Economic Strategy (RES) and on the sub-sub regional level constituted by Cambridge City Council.

In an attempt to quantify the focus on the issues mentioned initially, all of the networks and funding networks in East of England, public as well as non-public, were examined regarding their focus on the issues chosen. This was described in the system structure analysis and the result is given in table 3 and 4. The priorities of the networks and the funding networks are interesting from a policy point of view since they show how the national and regional strategies and visions are actually implemented through out the innovation system. The study of the funding networks in particular give a hint on to what extent the accessible capital in the system is spent on these issues. The results will be discussed under the corresponding heading in this chapter.

Collaboration

Collaboration in funding

The ambition at all levels of the UK funding system is streamlining. The Business Support Simplification Programme reduced the number of schemes and a single access point for funding was established, the Business Link. In Cambridge and local labour market, the Business Link East constitutes the regionalised access point for business support and innovation programmes to enable collaboration in funding[509].

Collaboration in the triple helix

The RES states that "close collaboration between universities and research institutes, businesses and government is a key feature of successful regional innovation systems". The importance of collaboration within the triple helix is motivated mainly by the benefits it brings to the commercialisation of research and by the diffusion it creates of new technologies to the regional economy. It is recognised that in order to increase collaboration within the triple helix, the public sector must play a major role and use funding and planning systems in such a way that collaboration is facilitated[510].

Explicit funding and initiatives to support collaboration

Since July 2007, the EEDA is responsible for a single regional economic strategy, as previously mentioned. Thereby, the EEDA takes on a stronger role in bringing key actors like local government, business and voluntary

---

[509] East of England Development Agency, 2007, page 37 and 28.

[510] East of England Development Agency, 2007, page 36

organisations together. A recently established regional minister will further add to the collaboration within the region[511].

Among the four key areas of the EEDA, creating enterprise hubs is one. In the year 2005-2006, a total of £12,959 million was spend on enterprise hubs, out of which business growth networks were supported by £1,775 million and hub centres by £2,468 million. The Bio Park Hertfordshire and Papworth biotechnology incubator are two of the projects supported[512].

The aim of the East of England International is to bring together the advisory services of former DTI with EEDA funded advisory services in a streamlined support to business wishing to go international and foreign companies interested in the region.

Key technologies

The East of England is set to continue to develop a specialised economy, referring to the need to focus on the areas with the highest potential of growth and capturing shares of the global markets. A concentration of business support products to the major economic centres is motivated by building on the essential critical mass needed for business, people and infrastructure. Clusters of national and international importance are selected for efforts to overcome their constraints to grow[513]. Co-ordination and intensive business support is available for manufacturing and start-ups within key sectors[514].

However, apart from the regional level of East of England, the selection of key technologies seems to be limited. As will be discussed further on, the networks and funding networks did not focus on identifying or prioritising key technologies.

Global challenge

In the RES, it is recognised that the global challenge will increase significantly with a shift of the global economic mass to the E7 (China, India, Brazil, Russia, Mexico, Taiwan and South Korea)[515]. The development towards knowledge-based economies and a highly skilled work-force among the E7 sharpens the competition and crucially, the East of England must rise to the challenge and find ways to benefit from the emerging markets[516]. Increasing regional benefits from international trade and investment and a strengthened position for the East of England within the network of leading global innovation regions are the major issues of

---

[511] http://www.eeda.org.uk/929_2836.asp
[512] East of England Development Agency, 2006, page 21
[513] East of England Development Agency, 2007, EEDA, page 24
[514] East of England Development Agency, 2007, page 116
[515] East of England Development Agency, 2007, page 17
[516] East of England Development Agency, 2007, page 17

concern regarding the global challenge according to the RES.[517]. In the RES, priorities and corresponding (suggested) actions are listed and in table 8.6, a summary of the priorities and corresponding actions are listed based on their relevance for addressing the global challenge.

[517] East of England Development Agency, 2007, page 115 and 120

Priorities	Impact of actions	Actions, examples
Increasing regional benefits from international trade and investment	Increased foreign direct investment in the region	Promote the region as an attractive inward investment destination in a co-ordinated and consistent manner.
		An enhanced investor development programme
	Increased share of region's firms engaging in international trade	Targeted support, such as Passport to Export, to enable businesses to access international markets
		Expand capacity of business networks in the region focused on international trade and investment
A strengthened position for the East of England within the network of leading global innovation regions	Strengthened position of Greater South East as a global centre of innovation with increased impact on economic growth	Undertake a Greater South East (GSE) international promotional programme (e.g. Shanghai expo)
		Develop a global network of international ambassadors
	The East of England as international partner of choice for international collaboration and outsourced R&D	Develop international partnerships with well-matched regions
		Promote the Cambridge brand as a leading global centre of learning and research
		Increase business and higher education involvement in international innovation networks
		Enable regional businesses to partner internationally through the Innovation Relay Centre and Selecting and Managing Overseas Partners (SMOP) programme

Table 8.6. A summary of the priorities and corresponding suggested actions concerning the global challenge in the Regional Economic Strategy of East of England[518]

The Cambridge City Council recognises that the strong brand of Cambridge can not be solely relied on with the global competition increasing. The attractiveness of Cambridge is threatened by European and global alternatives and the situation requires a more active approach to inward investment. A joint marketing of the Cambridge Area, instead of the

[518] East of England Development Agency, 2007, page 115 and 120

previous marketing of the city of Cambridge and other cities in the region separately is crucial, according to Cambridge City Council[519].

Explicit funding and initiatives addressing the global challenge
In 2005-2006, £2.704 million was allocated by EEDA to international business support, with a total of 140 businesses supported. One of the key projects of the year was the East of England International, the international business support agency of the region, which was allocated £2.6 million out of the £2.704. The entire EEDA expenditure over 2005-2006 to business support was £27 million[520].

The formation of the East of England European Partnership (EEEP) and a Brussels Office is thought of as a strategic move in assessing the global challenge, by EERA. As described above, the EEEP contributes a horizon scanning activity on the European development to the East of England innovation system and promotes the strong science base of the region to create strategic partnerships. An important ambition of the Brussels office is to be able to move quickly and meet needs when they occur[521].

Relative strengths of focus areas

In this section, the outcome of the attempt to quantify relative strengths of potential policies is described. In table 2 and 3 in the system structure section, it is shown how many networks and funding networks out of the total population defined by UK Directory[522], that focus on key technology areas, commercialisation, applicable research/economic benefit to the society, collaboration and/or the global challenge. The focus areas were chosen after bibliometric studies of the main policy documents on a national level, i.e. The Science and Technology Investment Framework 2004-2014, The Science and Technology Investment Framework 2004-2014: next steps, the Technology Strategy, The innovation report etc. The aim was to study to what extent regional actors relevant to the life science industry are focusing on these issues that was concluded to be in focus on a national level, and also how strong the focus areas turned out to be relative each other.

Apparently, commercialisation was the focus area that came out strongest in the comparison, with a score of 12 out of 22 funding networks and 19 out of 31 networks. Some of the networks and funding networks are private companies that seek to make a profit on the business they support. It is not so surprising that commercialisation is in their interest since some of them require a return. However, the focus area was defined as knowledge transfer from research environment to business and the result is probably an

[519] Cambridge City Council, 2004, page 20
[520] East of England Development Agency, 2006, page 15
[521] http://www.eera.gov.uk/Text.asp?id=SX87A5-A77F5251&cat=43
[522] http://www.entrepreneurs.gov.uk/directorySearch.cfm

adequate indicator that the knowledge transfer ambitions of national policy makers has had an impact among the actors in East of England.

There are 16 networks out of 31 that focus on the global challenge. Out of the 22 funding networks, the rate was much lower, only 4 funding networks held the global challenge as a priority area. The difference between networks and funding networks on that issue may indicate a higher extent of international networking activities of the former. Needs-driven research and benefits to the region was a focus area of 13 of the networks and 6 of the funding networks.

Collaboration, in terms of collaboration between funding networks and/or networks, has been highly stressed in several national policy documents, which is reflected in the 12 out of 31 networks focusing on collaboration. The funding networks show a lower relative share of collaboration focus, 7 out of 22. The lowest relative focus lies on key technologies. Only one of the networks, Cambridge City Council, stresses the focus on key technologies as highly important. This is somewhat surprising since supporting selected emerging technologies and key technologies is the reigning politics of TSB, former DTI, the chief scientific adviser and several other major policy-makers on a national level.

In the EEDA budget for 2005-2006, business support products were allocated a total of £27,805,000 as shown in figure 8.9. The relative distribution to different support areas is outlined below. In the EEDA allocation, business support IDB is allocated the highest amount. IDB stands for Information, Diagnostics and Brokerage and means that Business Links should help businesses in diagnosing what their support needs are[523]. The real term allocations to international business support and selective finance for investment in England gives a hint on how strongly the policies "focus on the global challenge" and "focus on economic benefits to the region" are stressed. Clearly, the public actors are thought to have an important role to play when it comes to diagnosing the hindrances facing the industry whereas providing grants to enterprises however is relatively restrictive compared to other business support products. The industry criticises that the money that RDAs receive for business support doesn't really go to business support if the RDAs task is to diagnose and act as a broker of accessible business support[524].

[523] http://www.the-guild.co.uk/article.php?recordID=8
[524] http://www.the-guild.co.uk/article.php?recordID=8

Business Support	Capital £000	Current £000	Total £000
Business Support IDB		16,061	16,061
Specialist Business Support	58	2,627	2,685
International Business Support	222	2,482	2,704
Skills development package	351	2,783	3,134
Best Business Practice (SIBBP)		607	607
Selective finance for investment in England	2,571	3	2,574
Enterprise grants	40		40
Total Business Support	3,242	24,563	27,805

Figure 8.9. The distribution of business support allocations by EEDA in 2005-2006[525].

Strengths and weaknesses identified related to policy evolvement

The global challenge is strongly addressed by a few actors on a sub-regional level. The actions that need to be undertaken and what they aim to achieve has been analysed and are clearly stated on a regional level. It is recognised by EEDA that the international links of the Cambridge University could be improved and that this is a policy matter where change might be on the way, with a time delay compared to regional and national efforts[526].

As will be described in the section "interconnectedness between sub-regional, regional and national level", some of the policies strongly addressed by actors on a national level is not in the focus in Cambridge.

The public actors take on a large responsibility to increase collaboration within the triple helix. There are several public actors that take on the role of brokers of business support, advice or partnerships. The large share of the EEDA business support budget that is allocated to information, diagnosis and brokerage further strengthens this picture. It is interesting to note that the basis for the commitment to increased collaboration is the economic benefit of the region. The ambition to increase collaboration seems to be very high, based on the organisational rearrangements that have occurred. The criticism of the industry that the public actors do not satisfactory take on the role as business supporters might indicate that there is a need in the system for such an actor. The idea with Business Link is that industry will have to solve this more independently. It is claimed however that "business will never pay for business support"[527]. This development is interesting to follow, since the there is a corresponding discussion in Sweden.

[525] East of England Development Agency, 2006, page 15
[526] Interview with East of England Development Agency
[527] http://www.the-guild.co.uk/article.php?recordID=8

9 Uppsala Life Science Innovation System

9.1 Industry structure Uppsala

The figures shown of the industry structure of Sweden, described in the SLIS section, also holds information about the Uppsala life science industry structure. In the following section, information from these figures will be commented with a point of reference in ULIS. The figures that are commented are found in section 3.1.

There are a total of 71 life science companies in Uppsala, comprising approximately 4400 employees (marketing and sales excluded). Uppsala has several of the country's biotech tools and supplies companies, largely due to Pharmacia's previous activity in that region. Among the medium sized and large companies, there are GE Healthcare Biosciences and Biacore within biotech tools and supplies, Phadia within diagnostics and Advanced Medical Optics within ophthalmic devices for instance. There are also many very small companies. The business segment drug discovery is not at all as large as it is in Stockholm, there are only a few drug discovery companies in Uppsala and these are very small. Among the companies that perform broad R&D, all but one have a product on the market. Overall, there are quit few companies among the R&D companies that have not reached the market with a product. Within biotech tools and supplies for instance, there is not a single one. Half of the drug discovery companies on the other hand do not have a product on the market. Within the activity production development, there are no biotech tools companies either. The large presence of biotech tools and supplies companies is predominantly found within the activity exploratory research.

In Uppsala, the companies with foreign ownership almost exclusively are large companies. This is concordant with the overall picture of foreign ownership in the Swedish life science industry. Among the CRO companies in Uppsala that are foreign owned, there are a couple of exceptions o this phenomenon. The largest biotech tools and supplies companies as well as the largest diagnostics companies are foreign owned. It is also interesting to note, although not to surprising, that the foreign owned R&D companies all have a product on the market. A majority of the Uppsala companies have positive results. Among the very small companies however, there are many that shown negative results.

9.2 System Structure Uppsala

The actors of the innovation system of Uppsala are presented in this section. As for the system structure of CLIS, the actors chosen were selected because they constitute the most vital bricks of the system. These are the companies, the public authorities, the industry associations and partnerships, the innovation centres and science parks. In the system structure analysis, the most vital networks and funding networks are also presented. The networks and funding-networks accessible in ULIS have been identified notably by the Företagsfrämjande organisationer i samverkan FFO Uppsala search tool. FFO is a website for all business support organisations in Uppsala[528]. The networks have also been identified from many other websites, like the city council website[529]. All of the networks and funding-networks, public as well as private, were studied with a point of reference on their focus on certain key issues. The result is gathered in table 9.1 and analysed in the activity section policy evolvement.

9.2.1 Public authorities

The County of Uppsala is led by the municipal council. There is a business unit at the municipal council responsible for the business climate in Uppsala. They should help in finding the right networks, provide contacts with investors and counsel on company start up[530]. Specific advice for life science and IT is available[531]. Apart from the municipal council, there is also a county administrative board that is particularly responsible for planning of infrastructure and to increase economic growth within the county[532]. No sector specific activity within life science has been noted apart from the 2007 celebration of Carl von Linné. The county administrative board and the municipal council collaborated with the Universities in Uppsala and the Linné society to promote and celebrate Linné and his scientific work [533]. Uppsala is also home for the Medical Products Agency and the National Food Administration.

9.2.2 Industry associations and partnerships

Uppsala Bio

Uppsala Bio is an initiative of the local biotech industry in Uppsala and was created by representatives from the life science industry, the universities and the city of Uppsala[534]. The initiative was enabled by financial support from Vinnova in the form of the VinnVäxt programme. Some steps towards joint

[528] http://ffo.biz/
[529] http://www.uppsala.se/uppsala/templates/StandardPage____3113.aspx
[530] http://www.uppsala.se/uppsala/templates/Level2Page____3006.aspx
[531] http://www.uppsala.se/uppsala/templates/StandardPage____3161.aspx
[532] http://www.c.lst.se/templates/versamhetstart.aspx?id=565
[533] http://www.c.lst.se/templates/versamhetstart.aspx?id=566
[534] http://www.uppsalabio.com/DynPage.aspx?id=4719&mn1=1223

work with Stockholm Business region and the Strängnäs cluster has been taken. Uppsala Bio markets the bioregion internationally and provides different kinds of business support products[535].

Fyrislunds Företag

Fyrislund is home to several life science companies in Uppsala, notably Phadia. The aim of this company association is to affect the development of the area and strengthen it's attraction to companies and customers. The aim is also to develop networks between industry, the commerce and service companies[536].

9.2.3 Innovation centres, science parks and incubators

Uppsala Innovation Centre (UIC)

Uppsala Innovation Centre is a company incubator that provides advice and business support to companies within the Uppsala region. They also aim to attract new companies to the region[537]. UIC have five different programs in the incubator; business start, business lab, business accelerator, alumni and growth. The growth programme is available to existing companies. The aim of the programmes is for the companies to put a product on the market or have achieved the access to long term financing[538].

Uppsala Science Park

The Park is dominated by biotechnology, material science, medicine and IT. There are a total of 140 companies and organisations within the area, including service providers within legal matters, capital brokerage, marketing and export. There are also clinics within the area, which is located in close proximity to the University hospital and the two universities[539].

Fyrislund

This is a potential future science park in Uppsala. When Pfizer left Uppsala, a long term vision was developed by local actors in concordance with Pfizer and Vinnova to develop a science park. Entrepreneurship and life science would characterize this park. Currently, the plans to establish a centre for entrepreneurship in Fyrislund are uncertain. There are also hopes that a Swedish facility for production of vaccines could be established within the area[540].

---

535 http://www.uppsalabio.se/DynPage.aspx?id=4715
536 http://www.fyrislund.com/info.asp
537 http://www.uic.se/
538 http://www.uic.se/
539 http://www.uppsalasciencepark.se/Templates/PageWide.aspx?id=695
540 http://www.stuns.se/stuns_projekt.html

Uppsala University AB (UUAB)

Uppsala University AB is the University holding company and functions as an incubator. The prime function is as a partner in different types of companies, including service companies, joint ventures and project companies[541].

9.2.4 Research Institutions and Universities

Together, the University of Uppsala and the Swedish Agricultural University, SLU, holds 35,000 students[542]. Biotechnology is one of the profile areas of Uppsala University and according to the university, their research in biosciences is world leading and is characterised by a cross-scientific approach[543]. The faculty of medicine and the faculty of technology and science are the major faculties within life science at Uppsala University. In addition, there are several research centres more or less connected to the university; the centre for bioethics, bioinformatics, surface biotechnology, mass spectrometry, Ludwig institute for cancer research and the The Svedberg laboratory. There are also research campuses like the EBC, the Rudbeck laboratory and BMC[544]. The research conducted at SLU ranges from biological natural resources and functional genomics. Within the responsibility areas food, forest, land and city, SLU combines its strong basic research with applied research[545]. The university hospital of Uppsala conducts clinical research in close collaboration with the medical faculty of University of Uppsala. The Uppsala Clinical Research centre forms an independent unit at both Uppsala University and the University Hospital. The Pet centre, positron emission tomography, is another example of university/hospital research collaboration[546].

9.2.5 Networks and funding networks

In ULIS, 17 networks were found. Some of these would classify as a funding network but this terminology is not used in UKLIS in contrast to Cambridge. No such classification has therefore been done in Uppsala. The webpages of all of the networks and funding networks listed in table 9.1 were examined regarding their focus on certain policy issues. If one or several of these are formulated as key goals, key objectives, and key priority or in any other way described as an issue of major concern for the network or funding network, then it has been considered a focus. The entire table forming the basis of table 9.1 below is found in appendix 5.

---

541 http://www.uuab.uu.se/menu2.php?id=1
542 http://www.akademiska.se/templates/page____11023.aspx
543 http://info.uu.se/fakta.nsf/sidor/bioteknik.id0E.html
544 http://info.uu.se/fakta.nsf/sidor/fakulteter..id83.html
545 http://www.slu.se/?ID=3
546 http://www.akademiska.se/templates/page____11023.aspx

Table 9.1. The networks and funding networks of ULIS

Name of network/fundng network	Key Technology Areas	Commercialisation	Needs-driven research/economic benefit to the regional society	Collaboration	Global Challenge
UppsalaBio	X	X	X	X	X
Stuns		X	X	X	X
UIC		X	X	X	X
Innovationsbron Ua		X		X	X
UUAB		X	X		
Handelskammaren Ua			X	X	X
Nyföretagarcentrum			X	X	
Drivhuset		X			
Stockholm-Uppsala universitetsnätverk SUUN			X	X	X
Connect Uppsala		X	X	X	X
CEF (Centrum för entreprenörskap och företagsutveckling i Uppsala)		X		X	
Regionförbundet i Uppsala län			X	X	X
Uppsala Universitets Näringslivskontakt		X		X	
Forskarpatent i Uppsala	X	X		X	
Företagarna Uppland				X	X
Invest in Uppsala			X	X	X
Almi företagspartner i Uppsala		X	X	X	X
SLU holding AB		X	X		X

9.3 Activities

9.3.1 Knowledge development

In this section the generation of knowledge elements will be described in terms of what factors affect the direction of research and what funding is accessible from different sources. The access to technological, market related and international knowledge elements is then described and finally how the knowledge spread in the system, with a particular focus on the knowledge transfer between academy and industry.

Generation of knowledge elements

Factors affecting the direction of research

The generation of knowledge in the Uppsala innovation system is highly influenced by the University of Uppsala and the Agricultural University (SLU). The Nobel Prize winners The Svedberg and Arne Tiselius among others have played an important role for the development of the research environment. These researchers initiated relations with the industry, notably with Pharmacia and Amersham biosciences that has been favourable for the knowledge generation[547]. It is claimed by several sources that the structure of the current biotech industry of Uppsala has substantially been formed by this initial collaboration[548]. Apart from the Nobel Prize winners, there are certain discoveries that have influenced the development, like the contribution to the IgE antibody which played a vital role for the origin of Pharmacia. The industry has functioned as a nursery for researchers during the growth of the biotech sector. When Pharmacia moved out of the innovation system, the knowledge base developed remained within the system and spread to new industries[549].

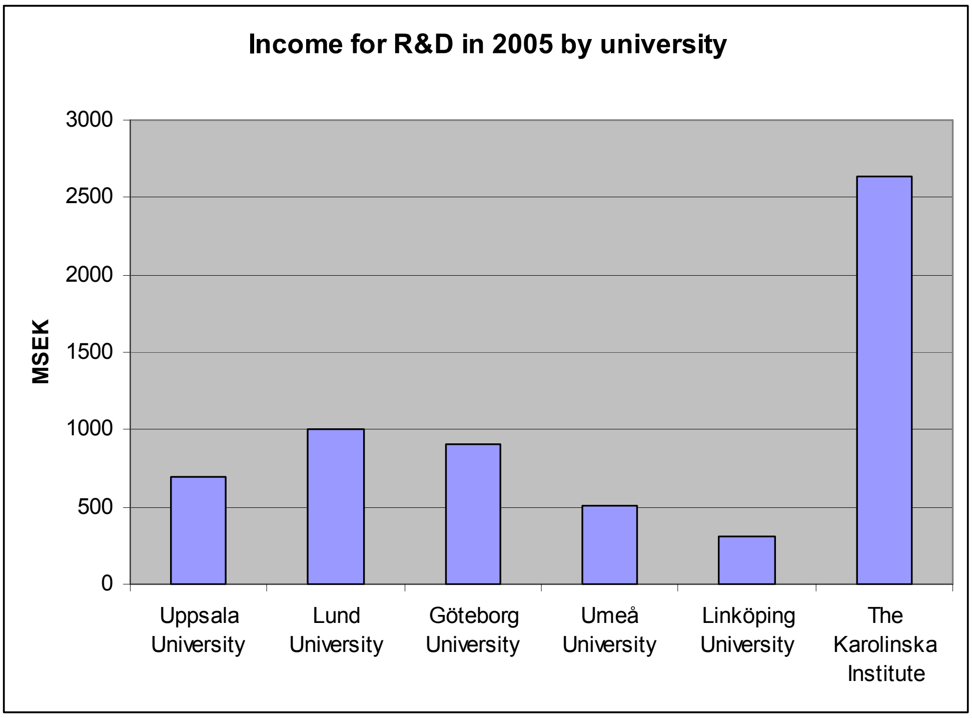
Public research funding

The total income to medical research at Uppsala University in 2005 is shown in figure 9.1. The figure shows the universities and institutes that have the largest R&D income to medical research in Sweden and Uppsala University comes in fourth[550]. It should be noted that in the year 2005, the income to pharmaceutical research at Uppsala University was additionally 88 MESK. The other universities listed in the figure did not have specific research income to this scientific area. The Swedish University of Agricultural Science had an income to veterinary research in 2005, unlike all other universities, of 150M SEK[551]. Even when taking other life science related research fields into account, like veterinary research and

[547] Waxell. A, 2005, page 54-56
[548] Waxell. A, 2005, page 66.
[549] Waxell. A, 2005, page 54-56
[550] Statistics Sweden, 2007, page 29-30

[551] Statistics Sweden, 2007, page 29-30

pharmaceutical research, the Karolinska Institute stand out by far as the largest life science research organisation in terms of research income.



Industrial R&D expenses and other sources of private funding

The sources of external funding at Uppsala University includes research councils, foundations, EC, companies etc. and most often has to be applied for by the researchers themselves. The income from interest is distributed among institutions according to the consortium[552]. The external funding makes out 52 % of the total research funding at Uppsala University. The majority of this funding is allocated through peer review. The tax reductions for private donations to research were very welcomed by the university's fundraising unit since the public financing has decreased and the need for external financing is large. A development office will be established to further increase the contact with external partners[553]. The industrial R&D expenses to medical research conducted at Uppsala University increased strongly over the 1995-2001 period, as shown in figure 9.3[554]. Over the same period, the share of medical R&D expenses from Swedish companies

[552]http://info.uu.se/uadm/dokument.nsf/sidor/E9343B7D08A843E5C1256EDF00643E8C?OpenDocument

[553] Forskning och Medicin 2007:3 http://forskningochmedicin.vr.se/knappar/tidigarenummer/innehallnr32007/enkatstortbehovavexternfinansiering.4.5d7d40fd1154283906d80003700.html

[554] Hällsten. M, Sandström. U, 2003, page 11

out of the total industrial medical R&D expenses fell drastically, as shown in figure 9.4[555].

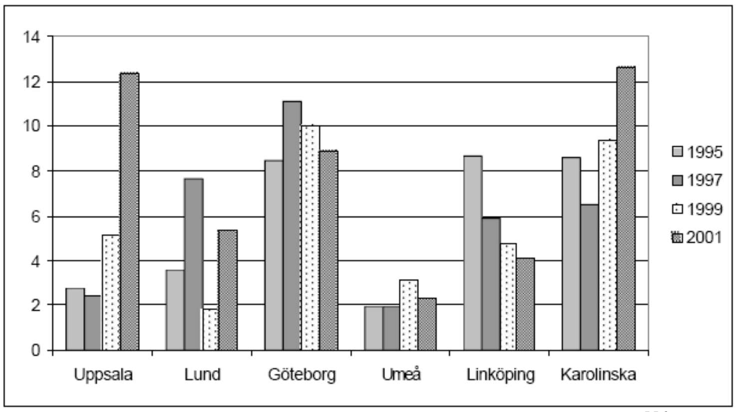


Figure 9.3. Share of industrial R&D expenses to universities[556]

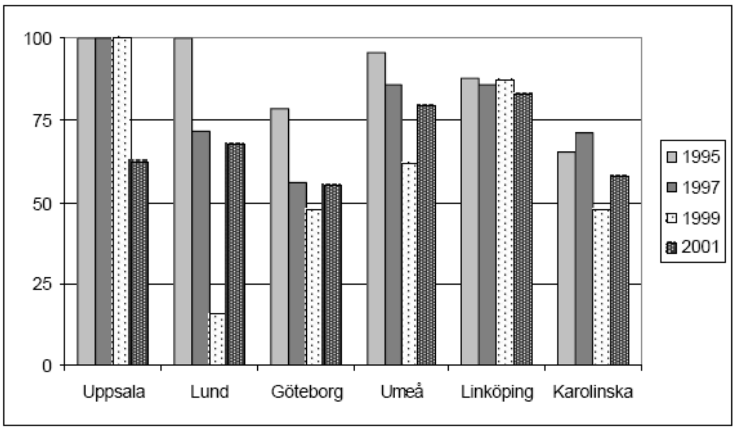


Figure 9.4. Share of Swedish industrial R&D expenses to universities out of total industrial R&D expenses to universities[557]

Access to knowledge elements

Technological knowledge base

Among the profile areas of Uppsala University according to the university are biologic diversity and evolutionary biology, biotechnology, national diseases, genomics/functional genomics, drug discovery, neuro-degeneration and neuro-regeneration, health and bioethics[558]. The only pharmaceutical faculty in Sweden is at Uppsala University[559]. Biotechnology holds a strong technological knowledge base in Uppsala, both at the universities and within the industry. In particular, the

---

[555] Hällsten. M, Sandström. U, 2003, page 11

[556] Företagens finansiering av universitetsforskning –en översikt i mars 2003, U .Sandström, M. Hällsten (SISTER), page 11.

[557] Företagens finansiering av universitetsforskning –en översikt i mars 2003, U .Sandström, M. Hällsten (SISTER), page 11

[558] http://info.uu.se/fakta.nsf/sidor/profilomraden.id8C.html

[559] Uppsala Universitet, 2003, page 12

development of methods, models and tools for biotech research are characteristic for Uppsala[560]. Diagnostics and pharmaceuticals are also among the areas of expertise[561]. One large initiative that will affect the technological knowledge base of Uppsala is a particle therapy centre for cancer treatment. The establishment means that a unique competence in radiation treatment for Sweden as well as in Europe will be developed in Uppsala[562]. The patient capacity of the establishment is set to 2500 patients. Financers of the 800 million establishment are seven county councils[563].

The biotechnology cluster's own perception of the Stockholm/Uppsala Bioregion's international ranking is shown in figure 9.5. In 2004, 7% of the respondents put the Stockholm/Uppsala Biotech cluster among the five most competitive biotech clusters in the world. In 2006, this perception was represented by 4% of the respondents. In this particular ranking, Cambridge UK is ahead of Stockholm/Uppsala and strengthened its position since 2004[564]. The industry generally was less convinced that the region is among the top five bioregions in the world[565].

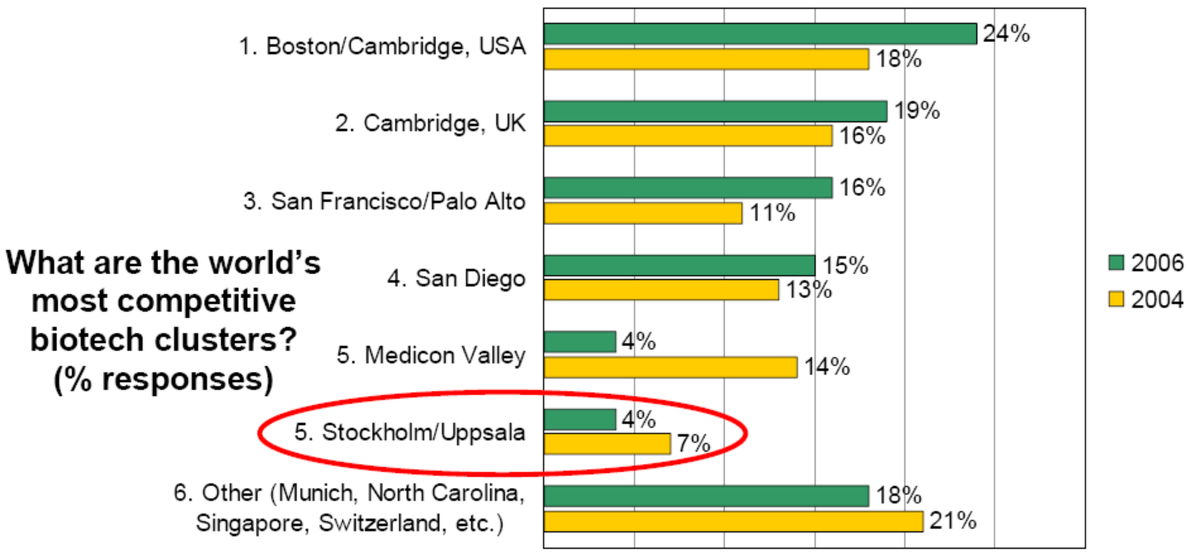


Figure 9.5. Ranking of the world's most competitive biotech clusters by respondents from the Uppsala Biotech cluster, including respondents from industry, government, academy [566]

[560] Uppsala universitet, 2003, page 19
[561] http://www.uppsalabio.se/DynPage.aspx?id=4706&mn1=1224
[562] http://www.stuns.se/
[563] http://www.cancerfonden.se/templates/Article____1778.aspx?full=1&skip=3
[564] http://www.uppsalabio.com/graphics/8494.pdf, page 11
[565] http://www.uppsalabio.com/graphics/8494.pdf, page 12
[566] http://www.uppsalabio.com/graphics/8494.pdf, page 11

International knowledge base
According to the respondents of the 2006 Uppsala Biotech Cluster Survey, the access to foreign skills is perceived to be bad and constitutes a cluster weakness[567]. Moreover, the respondents are more eager to disagree than to agree with the statement that "in the last two years, there has been an increase in the skilled labour to Uppsala"[568]. In that perspective, it is interesting that Uppsala University stated in their strategy for the 2005-2008 period that international research collaborations are crucial. The perception of the University was that their international research collaborations are extensive and well developed, particularly with Europe and USA[569].

As shown by figure 9.6, the main countries with which organisations located in Uppsala conduct research collaborations (in terms of co-authorships in life science related journals with an impact factor above 6) are mainly European countries. Apart from Europe, the US is quit well-represented. China, Japan, Israel, New Zealand and Australia are also on the map, although not strongly represented. As shown by figure 9.7, the vast majority of the Uppsala organisations in the co-authorships as well as he other organisations taking part in the co-authorships are either universities or hospitals. Pharmacia Diagnostics constitutes one exception though.

The Uppsala participation in FP6 includes 45 projects started in 2004 or after. The vast majority of the organisations with which Uppsala organisations has collaborated in more than one project are academic organisations. The collaborations with industry are predominantly single joint projects. Among the organisations of Uppsala taking part in the FP6, 41 are academic organisations whereas only seven companies participated. The counterpart countries mainly were France, Sweden, Great Britain and Germany and the main thematic area was cancer[570].

---

[567] http://www.uppsalabio.com/graphics/8494.pdf page 14
[568] http://www.uppsalabio.com/graphics/8494.pdf page 14
[569] Uppsala Universitet, 2003, page 24-25
[570] www.lifecompetence.eu, Data generated from the Cordis database

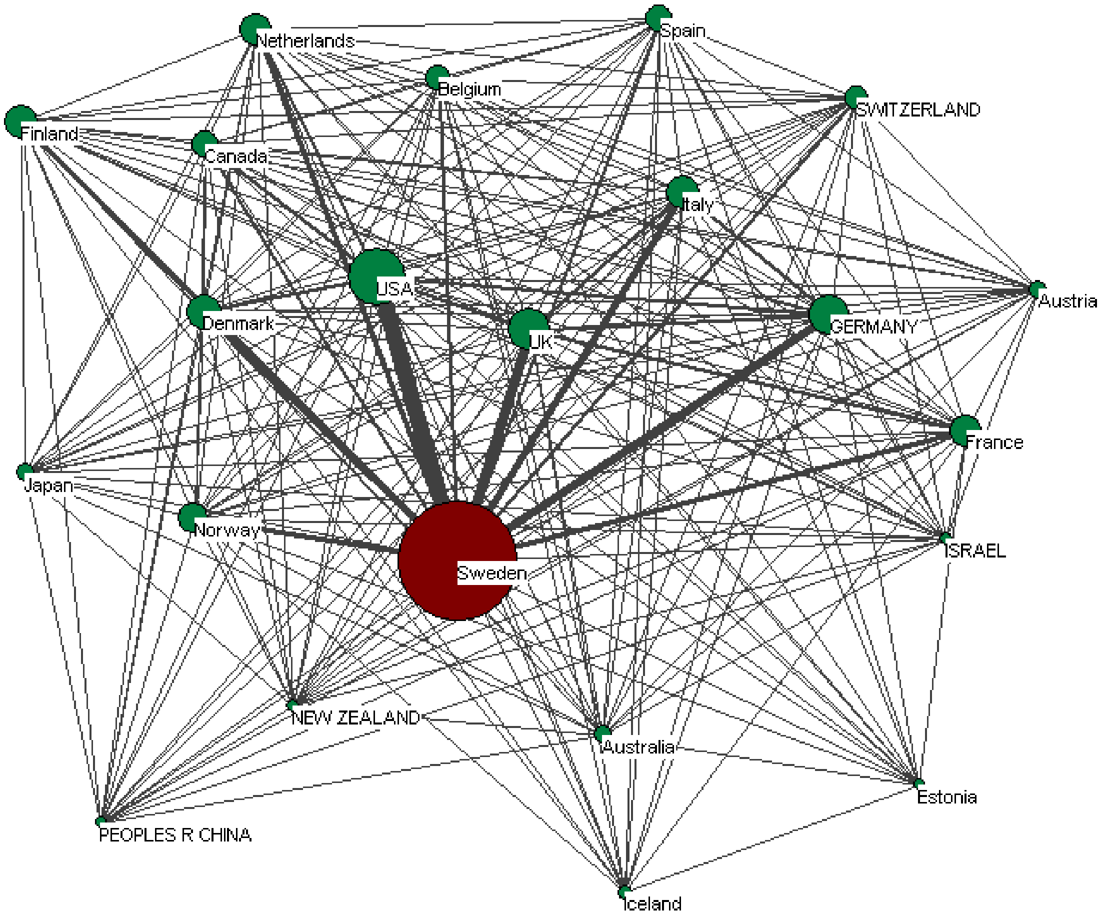


Figure 9.6. Co-authorships between organisations in Uppsala and other organisations, nationality shown.

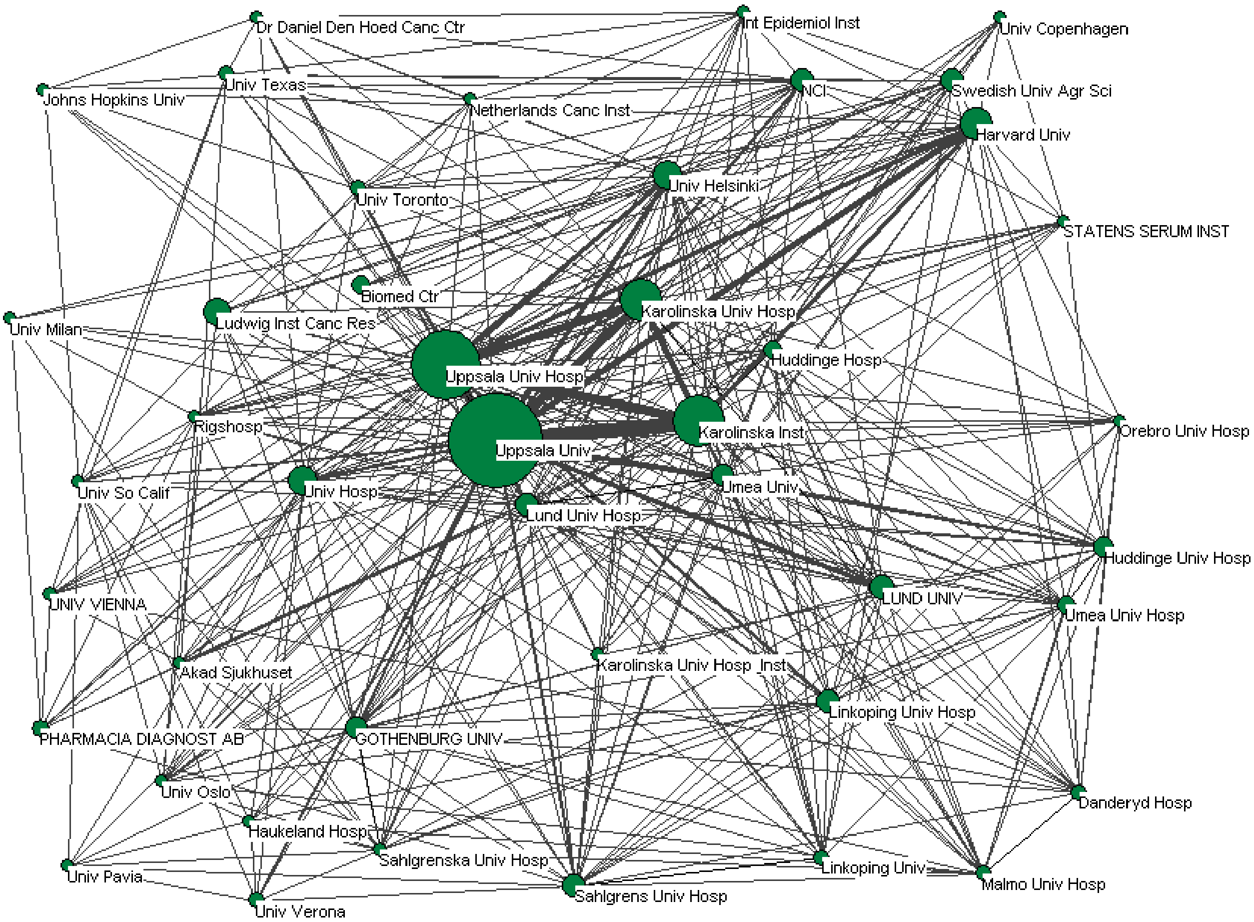


Figure 9.7. Co-authorships between organisations in Uppsala and other organisations, organisations shown

Market related knowledge base

There are a number of organisations in Uppsala that provide support to researchers and companies in order to increase their market related knowledge base. The innovation programme of Uppsala Bio focuses on business coaching, commercialisation, advice on patent strategies, mentorship and access to external networks of advisers and financers for instance[571]. The perception generally is that there has been an increase in commercialisation of research[572]. In 2003, the main challenges identified by Uppsala Bio included "to secure a steady, long-term flow of people with competencies in science and in management skills"[573]. This challenge still

[571] http://www.uppsalabio.com/DynPage.aspx?id=4645&mn1=1223&mn2=1232
[572] http://www.uppsalabio.com/graphics/8494.pdf, page 16
[573] Uppsala Bio, 2006a, page 5

remained in 2006[574]. It is claimed that the management skills are fairly good but there is a large potential for improvement, particularly when it comes to SMEs and international markets[575].

It should be noted though that it is not only a matter of market related skills that constitute a constraint to entrepreneurship. Some also claim that that a constraint is the IP ownership rules for university teachers, the so called teacher's exception. A researcher needs large resources and juridical support in order to seek patents and particularly defend the patent towards powerful companies. Some advocate that it would make it harder for large companies to over rule researchers if the university owned the patent[576].

Knowledge transfer

According to the University of Uppsala, the local relations between academy and industry are strong and have historically been very important. The knowledge transfer builds on both formal and informal relations and many biotechnology companies conduct collaborations with public research environments[577]. This picture is also attested by other sources. The development of the life science industry in Uppsala was greatly affected by interactions between certain research groups and companies, like The Svedberg, Arne Tiselius and Pharmacia[578]. On the other hand, others claim that the impact of the basic research of the universities on the biotech industry is overestimated[579]. There seem to be a debate similar to the one in Cambridge about the reasons for the Cambridge Phenomena.

Current situation and initiatives

Uppsala Bio identified a gap in the borderland between industry and academia and has quite successfully worked to over bridge this gap[580]. Research commercialisation is one of Uppsala Bio's primary objectives and according to the respondents of the 2006 Uppsala Biotech Cluster Survey, Uppsala Bio has contributed to an increase of research commercialisation over the 2004-2006 period[581]. Their 2007-2010 strategy states that there is still a gap between basic research and product development[582].

574 Uppsala Bio, 2006a, page 5
575 Stuns, 2006, page 6
576 http://info.uu.se/fakta.nsf/sidor/studenter.och.id1C.html,
577 http://info.uu.se/fakta.nsf/sidor/samarbete.forskning.id87.html
578 Waxell, A, 2005, page 55-56
579 Waxell, A, 2005, page 84
580 Uppsala Bio, 2006
581 Uppsala Bio, 2006a, page 22
582 Uppsala Bio, 2006b, page 5

Uppsala Bio-X is a programme that supports cross disciplinary research by providing complementary financing. The research should be collaborative and include both academia and industry[583]. Within technology, science, medicine and pharmacy, Upside is another initiative aiming to translate research conducted at Uppsala University into commercial products. Uppsala Bio is supported by Vinnova with 25/4 million SEK each year for eight years[584], and complements a UUAB programme called Bridge. The focus of Bridge is on the commercialisation of research within nanomedicin, and particularly regenerative medicine. The programme has been selected to lead one out of four EC commissions to increase knowledge about the triple helix, at an EC level. The project will build on experiences from European partnerships. The selection of Uppsala University for this task is thought to have strategic importance for localisation decisions of future large EC initiatives[585].

The university unit UU innovation was launched in order to strengthen the collaborations between Uppsala University and industry. This unit is intended to lead the strategic work of the university when it comes to relations to industry and it also executes strategies to some extent. The commercialisation responsibility primarily falls on the holding company UUAB[586].

Strengths and weaknesses identified related to knowledge development

As shown in the generation of knowledge elements section, the relative access to funding for pharmaceutical research at Uppsala University is high compared to other universities. In that perspective, it is interesting that the industry structure shows relatively few pharmaceutical companies compared to the Stockholm. An area for future research could be the knowledge transfer between the university pharmaceutical research and the local industry as well as what spin-out/licensing activity there is from the pharmaceutical research. It could be that the pharmaceutical university research is part of knowledge transfer with the biotech industry. In 2001, a large share of total research income stems from private sources and the share of university income from foreign companies increased drastically over a few years. There are both positive and negative sides to this, as will be discussed in "factors affecting the direction of research" in SLIS.

---

[583] http://www.uppsalabio.se/DynPage.aspx?id=4715
[584] http://www.uuab.uu.se/news.php?id=80
[585] http://www.newsdesk.se/pressroom/uu/pressrelease/view/uppsala-universitet-i-europeisk-storsatsning-paa-tillvaext-186658
[586] http://info.uu.se/fakta.nsf/sidor/uu.innovation.id6B.html

The industry structure gives information about the profile of the research competence among the life science companies in Uppsala. Biotech-tools and supplies is the largest individual business segment, in terms of number of employees as well as number of companies, and might imply that the research competence also is relatively strong within science fields related to biotech-tools and supplies. It should be noted that this business-field has a rather wide definition. Still, it is clear that the life science industry of Uppsala is less oriented towards pharmaceutical business segments than the Stockholm life science industry.

The technological knowledge base does not appear as strong in an international comparison as it was expected to be in the goals set out in strategies a few years ago. There is a discrepancy between the perception of the international ranking of Stockholm-Uppsala's biotech cluster among actors within the cluster and previous ambitions. Moreover, the perception of the international ranking of the Uppsala-Stockholm Biotech cluster has decreased since 2004. There is also discrepancy in the perception of the international knowledgebase and the goals set out in 2005. Considering the goals set out and the dominance of *intra*national collaborations (in terms of co-authorships) as shown by figure 9.6, the international knowledgebase of Uppsala could be stronger. Particularly co-authorships with Asian countries fall short. (It could be argued that life sciences in these countries are not developed enough to motivate extensive collaborations. On the other hand these countries present markets that could be vital for the life science companies in Sweden and knowledge about these markets is important.) In addition, the FP6 participation data shows that industry is not frequently involved in joint projects. Some initiatives focusing on Asia on the behalf of the life science industry of ULIS have recently been launched though by Stuns (see section 9.3.3, global challenge).

The market related skills were not found to be debated nor addressed in many explicit initiatives in ULIS, as opposed to the situation in Cambridge where this is a major issue. This is somewhat surprising since there have been extensive efforts to improve market related skills in Cambridge. Although management skills are still perceived as a challenge by some[587], it might be that the particular history of the industry structure in Uppsala has affected the management skills in a significantly positive way. The human resources that were channelled to companies that were established in the in the wake of Pharmacia has probably played an important part in building on a market related knowledge base. As shown in figure 9.8, there have also been several expansive spin-offs from Pharmacia[588].

[587] UppsalaBio, 2006, page 5
[588] Sandström. A, Bergqvist. H, Dolk.T, 2007

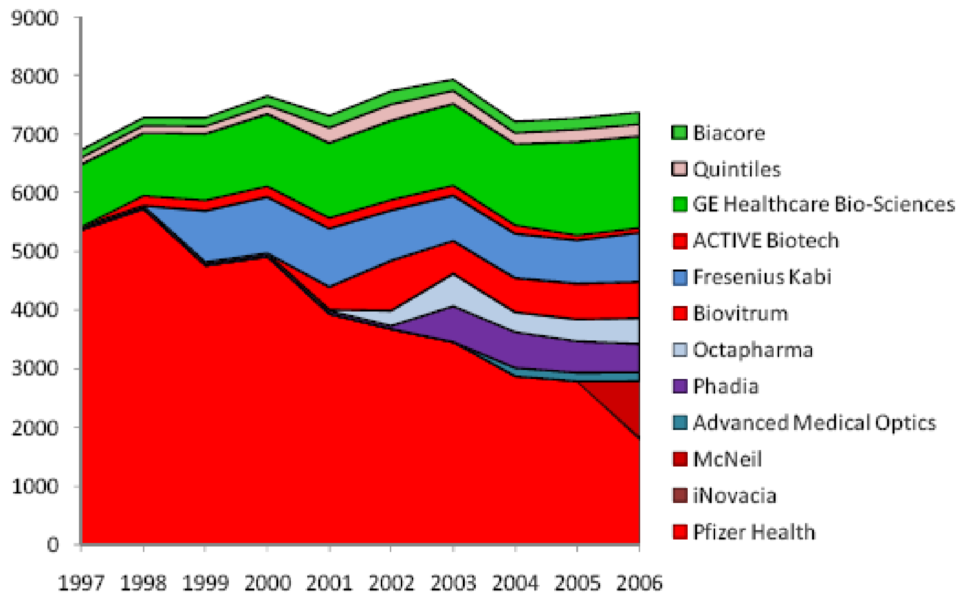


Figure 9.8. The spin-offs from Pharmacia[589]

The gap between academy and industry was identified several years ago as an important weakness to address, which explains the concordant view among actors in ULIS. This will be further discussed in the policy section. The weakness might still exist in the system but has improved, according to Uppsala Bio[590].

Just like the case of CLIS, the industry structure reveals a large share of small and non-profitable companies. There are also many companies that have not managed to put a product on the market. Therefore, the verdict is like the case of CLIS that the development of commercialisation activities presents a strength whereas a weakness is identified when it comes to actually making a profit on the commercialisation for the individual company. This weakness could be discussed in the context of how to provide efficient business support products as well as in what stage these efforts are most vital.

9.3.2 Financial support systems

Access to venture capital

General access to venture capital

The access to capital is generally good in Sweden. However, it is perceived by some as a cluster weakness, at least as far as the biotechnology sector is

[589] Bergqvist. H, Dolk. T, Sandström. A, 2007
[590] Interview, Rhiannon Sanders, 200705

concerned, that there is “relative poor availability of local and foreign capital”[591]. The biggest barrier to starting new companies is claimed to be a lack of financial support[592] and the biggest threat to the Uppsala Biotech Cluster is claimed to be insufficient financing, as shown in figure 9.9[593]. It is requested that some actor takes on the responsibility to attract inflow of venture capital to the region, the most important task according to several respondents[594]. It is not perceived that Uppsala Bio has increased the inflow of investments over the 2004-2006 period but it should be remembered that this is not their primary objective to fulfill[595]. Financing is also said to be a problem for the more mature companies that have already shown a promising development. Difficulties to raise new growth capital/ venture capital could be overcome by more collaboration with investment companies listed on the stock market. That way, the inflow of capital does not necessarily have to come from the same sector or geographic region[596].

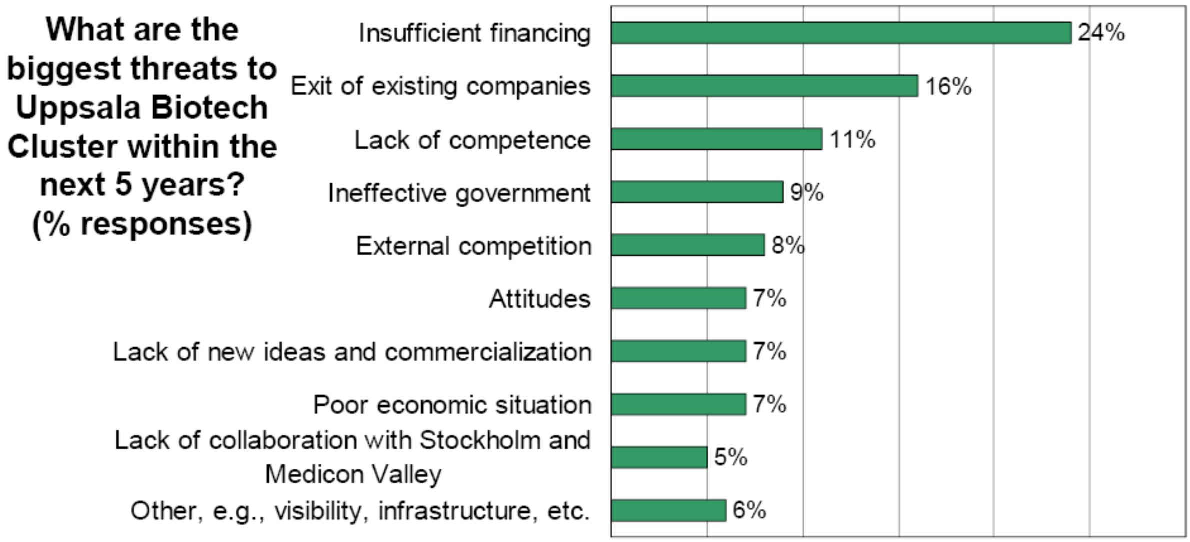


Figure 9.9. Answers of respondents of the Uppsala biotech cluster regarding the major threats to the cluster[597]

Public funding

The public investments in the UIC incubator have had high returns. In 2006 the public return on investment, ROI, was 7,9 and the UIC incubator invested 93 million[598]. Among the public financers, co-funding is often required. Almi Uppsala is a public financer that offers loans to existing companies as well as start-up companies. To receive a loan, it is provided

591 http://www.uppsalabio.com/graphics/8494.pdf page 14
592 http://www.uppsalabio.com/graphics/8494.pdf page 33
593 http://www.uppsalabio.com/graphics/8494.pdf page 32
594 http://www.uppsalabio.com/graphics/8494.pdf page 34.
595 http://www.uppsalabio.com/graphics/8494.pdf page 22
596 Stuns, 2006, page 6
597 http://www.uppsalabio.com/graphics/8494.pdf page 32
598 UIC, 2007a

that full financing has been denied from other sources. Almi then functions as a complementary financer[599]. Public funding often also requires collaborative research between academia and industry, like Uppsala Bio's research support product Bio-X for instance. Uppsala Bio is allocated 10 million per year over ten years from Vinnova and an additional 4million from regional partners and 6 million per year from regional partners in the form of work. The largest share is allocated to the research support product Bio-X[600]. According to Uppsala University, such requirements of collaboration between industry, universities and the public sector often has to be fulfilled in order to receive funding to specific projects at the university. Uppsala University has been successful in receiving such earmarked funding from the Swedish Foundation for Strategic Research[601]. Another source of public funding is Innovationsbron, which provides financial support and advice in the very early stages of commercialisation of research[602].

A recent initiative is the Uppsala Seed Capital, which will provide funding to very early-stage growth companies in order to enable them to develop prototypes, file a patent etc. The fund is estimated to hold a capital of 15-30 million and a 50/50 distribution between public and private funding[603].

Strengths and weaknesses related to the financial support system

Although the access to venture capital is generally good in Sweden today[604], it was shown in this activity that the perception within the Uppsala biotech cluster is that lack of financing is the largest barrier to starting new companies and the largest threat to the cluster. It is also claimed that the most important task of business support organisations should be to attract capital to the cluster. It is interesting then to reason about why the good access to VC is not available to some companies. A mismatch between the needs of the companies and the amount that investors are willing to invest has been pointed out on a national level[605] and might apply to ULIS as well. Another interpretation could be that there is not a lack of capital but many companies that are not growing organically due to other deficits. It has also been claimed that there are starting companies based on ideas that are not commercially viable[606] and consequently have a hard time accessing VC. The industry structure of ULIS shows a large amount of small companies that are not profitable. The restrictions to growth for these companies could

599 http://uppsala.almi.se/finansiering.html
600 Mail conversation with Stuns, 200801
601 Uppsala Universitet, 2003, page 23
602 http://www.innovationsbron.se/Bazment/926.aspx
603 UIC, 2007b
604 Interview, Williams Ylva, Invest in Sweden Agency, 200705
605 Interview, Williams Ylva, Invest in Sweden Agency, 200705
606 Interview, Rhiannon Sanders, Uppsala Bio, 200705

be that many should not have passed through the proof of concept[607]. The return on investment of public funding in UIC however has been high. It could also be reasoned that there are hindrances to growth even for commercially viable companies that should be addressed and that there are problems in a later stage than the publicly funded business support products permit. According to Uppsala Bio, potential hindrances are best approached trough a stimulating approach more than a business funding approach[608].

It has been identified in this activity that there might be a gap in the innovation system concerning business support directed to the growth of existing but very small companies. It is not necessarily an equity gap, instead there could be structures on a national level that should be improved and have positive effects for the small companies with constraints to growth. According to Uppsala Bio, innovation in procurement could be very important for these small companies for instance.

The current public actors in ULIS were found to predominantly focus on early stage business support and their problems to access funding. The issue of whose responsibility it would be to fill this potential gap has been discussed in the UK. If there is in fact a mismatch between the presumably good access to funding from investors and the size of investment that usually is requested from Swedish life science companies, there seem to be a catch 22 like situation; The small companies do not grow in terms of employees, profitability and product/patent portfolio because they have difficulties in accessing venture capital, whereas the investors are unwilling to invest in companies that are small in (terms of patent and product portfolio etc[609]) and at the same time the issue lies outside the range of what the publicly funded business support actors reason that they could or should address. Apart from the obvious need to critically evaluate how public capital should be used to selectively support industry, this standpoint has been further motivated by the concern that public initiatives might restrict initiatives emerging from the industry itself by competing with these initiatives and the consultancy sector specialised in business support[610]. Uppsala Bio highlights the importance of stimulating organic growth in the industry[611]. These questions and dilemmas have also been identified on a national level in SLIS.

Another dimension could be added to this discussion. In Cambridge, many companies that already have developed a technological platform still chose

---

[607] Interview, Sandström Anna; VINNOVA, 20080116 and Interview, Williams Ylva, ISA, 200705

[608] Intervew with Uppsala Bio 20080205

[609] Interview, Williams Ylva, ISA, 200705

[610] Interview, Sandström Anna; VINNOVA, 20080116

[611] Interview, Neil Madeleine and Åström Jonas, Uppsala Bio 20080205

to secure their financing by performing contract research instead of putting a product on the market. There are several reasons for this, as described in the Cambridge chapter, but the most cited in the interviews was a lack of financing. Consulting offers a more profitable and secure financing opportunity than to develop a product. Based on a combination of this Cambridge result and a potential funding lock up in ULIS, it is plausible that the industry structure of Uppsala will look much more like that of Cambridge with a very large consulting sector including many CRO companies. According to the Department for commerce and industry at Uppsala City Council, the consulting sector is currently expanding within life science and for the individual company this could have the benefit of accessing knowledge without employing[612]. This potential development therefore could be interesting to analyse in connection to the employment development within the sector.

9.3.3 Policy evolvement

Collaboration

Collaboration within the triple helix
Uppsala Bio describes the relations to local politicians as strong and their knowledge about life science as fairly good. Uppsala Bio recognises the importance of maintaining such relations and also pinpoints a need to strengthen relations to politicians on a national level and on a regional level[613]. The ambition is to have a close operative collaboration with other bioregions as well as with national organisations which have strong lobbying activity[614]. It is perceived that the organisational collaboration within the Uppsala biotech cluster has improved over the 2004-2006 period[615]. However, many people claim that an increased collaboration between Uppsala and Stockholm is necessary[616]. Also the community council wishes to see an increased collaboration between the regions, particularly within top research areas[617].

Explicit initiatives or programmes to strengthen collaboration within the triple helix
The association of Stockholm-Uppsala Bioregion is an example of an initiative to strengthen collaboration. This collaboration is intended to increase the visibility on the global arena and is further described in the global challenge section[618]. From a national level, there are several programmes that aim to strengthen the links between academy and industry,

[612] Mail Interview with Department for commerce and industry at Uppsala City Council, 200801
[613] UppsalaBio, 2006b, page 5
[614] UppsalaBio, 2006b, page 6-7
[615] http://www.uppsalabio.com/graphics/8494.pdf, page 16
[616] UppsalaBio, 2006b, page 37
[617] Uppsala City Council, 2007, page 7
[618] Stockholm Business Region, 2007

like Sambio and Sampost[619]. The community council supports an increased collaboration between Uppsala and Stockholm and supports Stockholm business alliance and Stockholm – Uppsala Bioregion[620].

The centre for surface biotechnology constitutes a small but enlightening example of collaboration between students, academy and industry that aims to make the most out of small resources. The industry accesses the institutions competence, international networks and a recruitment base constituted by the students participating. The institution and students accesses the expensive equipment of the industry and financing from many companies[621].

International collaboration
The collaboration on a European level is growing more and more important, according to Uppsala Bio. They recognise the importance to maximise European research resources to the region and to affect the content of the new European research programmes so that they better match the strengths of the region[622]. The community council wishes to expand the collaboration within the Baltic Sea area[623] and within life science there are collaborations in place with Minneapolis and Heidelberg[624]. Uppsala Bio was active in establishing the Council of European Biotech Regions and aims to build upon the council to strengthen collaboration with other European regions. It also aids in the contacts with the EC administration and Europe Bio[625].

Collaboration in funding
As stated in the public funding section, some financers require co-funding from other sources in order to accept funding applications, like Almi for instance[626]. According to Uppsala University, the accessible funding from research foundations and the European programmes has increased since the 90s and consequently the requirements for co-funding with industry[627].

A regional collaborative project between eight incubators in Mälardalen and Östergötland has been initiated with a 60 million SEK budget. Stuns and Uppsala are responsible for establishing an expansion capital company that aims to increase industrial growth. This is a co-funded project, where Uppsala contributes 7 million over three years. EC stand for a third of the

---

[619] http://www.vinnova.se/Finansiering/Utlysningar---forteckning/Pagaende-utlysningar/SAMBIO-2007/, http://www.vinnova.se/Finansiering/Utlysningar---forteckning/Pagaende-utlysningar/SAMPOST-2007-2/
[620] Mail interview Uppsala City Council, 200801
[621] http://info.uu.se/fakta.nsf/sidor/studenter.och.id1C.html
[622] UppsalaBio, 2006b, page 6-7
[623] Uppsala Kommuns Näringslivsprogram, page 7
[624] Mail interview Uppsala City Council, 200801
[625] UppsalaBio, 2006b, page 6-7
[626] http://uppsala.almi.se/finansiering.html
[627] Uppsala universitet, 2004, page 5 and 19.

budget and another third is allocated by Stuns and UIC[628]. Another example of collaboration in funding is the establishment of Atlas Antibodies. KTH and Uppsala University will access the profits of the company through a foundation, which in turn has an ownership in the company. According to the principals of the royal institute of technology and Uppsala University, this kind of ownership solution may increase accessible resources to Swedish research and also facilitates commercialisation of research[629].

Key technologies

The selection of key technologies does not seem to be as present in the local debate as it is on a national level. Nor is it highlighted in policy documents of local actors. Several actors claim that life science already has the status of a prioritised industry[630] and that these industry priorities were made in Uppsala innovation system even before the debate started on a national level[631]. According to the city council, there is a consensus among the political parties within the council that the life science industry is a priority industry due to its local strengths and that it has to be further built on in a long term perspective[632]. The more specific selection of prioritised key technologies however is regarded with more scepticism[633]. The University of Uppsala has chosen biotechnology as a priority area though[634] and STUNS states that drug delivery, proton therapy and veterinary research are local strengths that are particularly well suited to build further upon, by establishing cross-regional collaborations. These areas present a depth and a breadth that is unique in Scandinavia[635].

Organisations within the Uppsala life science innovation system do pin point the necessity to prioritise among activities and focus on certain key activity areas, like communication of cluster strengths to the outside world. STUNS states that they aim to stick to strategic initiatives in prioritised areas[636], Uppsala Bio regrets that certain activities, like attracting investments to the region, are not quit fulfilled since it exceeds the focus activities of the organisation. This kind of prioritising is linked to collaboration and identifying gaps in the distribution of roles in the local innovation system.

[628] http://www.uic.se/
[629] http://info.uu.se/notiser.nsf/pm/unik.agarlosning.id96.html
[630] http://www.stuns.se/ and Mail interview Uppsala City Council
[631] Mail interview Uppsala City Council
[632] Mail interview Uppsala City Council
[633] Mail interview Uppsala City Council
[634] http://info.uu.se/fakta.nsf/sidor/bioteknik.id0E.html
[635] Stuns verksamhetsberättelse 2006, page 7
[636] Stuns verksamhetsberättelse 2006 page 2

Global Challenge

The biotech industry of Uppsala is described as a local system, but there are important connections to the regional system of Mälardalen and to the global market. The international dimension is particularly strong when it comes to customers and suppliers[637]. One of the four function areas of Uppsala Bio is to "Communicate the strengths of the life science sector in Uppsala to the rest of the world"[638]. The vision stated in the Uppsala Bio strategy is that "Uppsala – Stockholm shall within five years time be recognized as one of the leading biotech regions in the world with a growing competitive industry, with world class research and education and a climate where industry, academy and people thrive. Within this region, Uppsala's emphasis is on methods, models and tools for biotech research"[639]. The strategy is backed up by academia, industry and the public sector of Uppsala[640]. The city council aims to provide an internationally competitive business climate and addresses the global challenge primarily by marketing the strengths of Uppsala and the knowledge base at hand[641]. The annual allocation from Uppsala city council to strengthen the trademark of Uppsala is 1.2 million SEK[642]. Uppsala Bio requests a political consensus to further build on the strengths within life science in the long term perspective and to attract strategic investments to Uppsala. Investment decisions needs to be more strongly supported[643].

Explicit initiatives or programmes to address the global challenge

In order to be able compete on the global arena, the association Stockholm-Uppsala Bioregion was launched in May 2007 by the foundation biotechvalley.nu in Strängnäs, Stockholm Business Region and Uppsala BIO/STUNS. This is a step towards putting more strength into marketing the region internationally and become more visible. Hopefully, the new platform will attract more foreign skills and capital and also add possibilities of cross sectional collaboration within Stockholm-Uppsala life science community[644]. The collaboration between incubators in different regions, mentioned previously, is also an initiative aiming to address the global challenge. The need of growth companies to reach the international market in an early stage of their company development has been recognised within the project[645]. The Uppsala life science industry accesses the network of business advisers of the Minnesota life science industry. This is the result of a memorandum of understanding between Uppsala Bio/STUNS and The Bio Business Alliance of Minnesota. The aim is to facilitate company

[637] http://info.uu.se/fakta.nsf/sidor/ett.kluster.idB7.html
[638] http://www.uppsalabio.com/DynPage.aspx?id=4719&mn1=1223
[639] Uppsala Bio, 2006a, page 9
[640] Uppsala Bio, 2006a page 3
[641] Uppsala Kommuns Näringslivsprogram, Page 3 and 7.
[642] Mail-interview with Uppsala City Council
[643] Mail-interview with Uppsala City Council
[644] Stockholm Business Region, 2007
[645] http://www.uic.se/

establishments in Europe and in the USA[646]. Initiatives that focus on the Chinese market have been found at STUNS and Invest in Uppsala. Invest in Uppsala aims to increase inward investment from China[647].

Relative strength of policy areas

Only one network identified a key technology to be in the focus of their activity. On the other hand, networks like Uppsala Bio have been established since biotechnology in Uppsala is identified as an area of strength to build further upon. In that sense, their existence could be viewed as an identified key technology.

Among the other policy issues looked into in table 9.1, all were highly anticipated in the sub-regional innovation system. Commercialisation of research, addressing the global challenge and needs-driven research/economic benefit to the society was in the focus for 12 out of 17 networks/funding networks. Increasing the collaboration between actors was in the focus for 17 networks/funding networks.

Weaknesses and strengths related to policy evolvement

Currently, the ambition to increase collaboration between actors is strong, particularly between Uppsala and Stockholm. The incentive clearly is the critical mass aimed to achieve in order to gain visibility on the global arena. There are initiatives under way that strengthen the picture that the ambition is taken seriously, which is a strength. However, it seems like the collaboration between Uppsala and Stockholm will be mainly restricted to joint marketing activities. Some actors request even more ambitious steps towards collaboration. Uppsala Bio has stated their willingness to take on a responsibility in order to achieve this. It is difficult to evaluate if and where weaknesses in the process towards increased collaboration could be situated. To conclude, it seems like there is a potential to take the collaboration even further and the current situation provides an opportunity for increased strength.

There are international collaborations and initiatives to address the global challenge, but due to limited resources they are mainly restricted to the marketing of Uppsala biotech cluster or the marketing of the city of Uppsala. There are few specific life science initiatives, but there is a consensus among many actors of the importance of the life science industry which is reflected in general initiatives. For instance, Stuns and Invest in Uppsala have taken steps to attract capital to the region and facilitate market entry on Chinese markets and the life science industry is naturally represented in these initiatives.

---

[646] UIC, 2007c
[647] http://www.stuns.se/projekt/index.html

The actors of ULIS were found to prioritise strongly among their activities due to limited resources. This is something that some actors regret since there are activities that are also important but left outside the primary focus. This affects the issue of addressing the global challenge. It is also interesting that prioritising among technologies has been found to occur to a small extent in Uppsala.

Since there are limited resources and important activities falling outside the primary focus of many actors, it is even more important to have a well functioning collaboration. It is also important that national actors take into account the knowledge of local actors in how national programmes and initiatives are best implemented to have a positive effect on the local industry. According to Uppsala Bio, an increased collaboration and communication about the needs in the local system in order to optimise the effect of the programmes would be beneficial for ULIS[648].

[648] Interview, Neil Madeleine and Åström Jonas, Uppsala Bio 20080205

10 Micro-level Innovation System Comparison

Industry structure comparison
Both in Uppsala and Cambridge, there are many biotech tools and supplies companies in the life science industry structure. In Uppsala, there are some larger companies among these whereas they tend to be rather small, but overall more numerous, in Cambridge. Another difference is that Uppsala life science industry structure holds few drug discovery companies whereas in Cambridge drug discovery and development make out 25% of the industry structure in terms of employees. Both industries have many small companies that have not yet a product on the market. Overall, the share of companies that lack a product on the market is larger in Cambridge. One of the most striking results of a comparison is the large share of consultancy companies in Cambridge, predominantly CROs. These are not only more numerous in Cambridge, they are also larger. This result was given extra attention. An examination of the biotech tools and supply companies in Uppsala showed that they often have a technology platform similar to that of the CRO-classified companies in Cambridge. The difference lies in the activity built upon the research and technological platform. The Uppsala companies strive to put a product on the market based on their technology platform and the result is often a physically tangible product. In Cambridge on the other hand, the same kind of technological platform is often transformed into consultancy services or licenses. The know-how in the specific research area where the company is a specialist forms the basis of the CRO company.

System structure comparison
The system structure of CLIS comprises more actors than ULIS. There are more networks, more funding networks, more science parks and more research institutes etc. This should be taken into consideration since it affects the comparability of the innovation systems. It could also be seen as a result in itself. The specific terminology of funding networks does not appear in ULIS, but there are some actors that fill the function in ULIS. There are no regional development agencies in Sweden, and no corresponding EEDA for Uppsala. Nor has any correspondence to East of England European Partnership been found. Overall, there seem to be less overarching regional bodies. On the other hand, there are departments at the Uppsala City Council for instance that partly fill the functions of regional development agencies together with actors like Invest in Uppsala, Stuns etc. The smaller size of Sweden might explain for part of this difference.

Comparison of strengths and weaknesses identified in the activities

There are differences in the generation of knowledge elements in ULIS and CLIS. In ULIS, the factors affecting the direction of research have been the industry and the connection between certain research groups and industry. Pharmacia naturally has put its stamp on the research community and contributed to areas of strength by functioning as a nursery for researchers. The importance that the academy has played on the industry development and the technological knowledge base is debated in both systems, but more embraced in Uppsala than in Cambridge. The share of private funding to university research is higher at Cambridge University than Uppsala University

The technological knowledge base is stronger in CLIS than in ULIS and the research areas differ somewhat, which is also reflected in the industry structure and business areas. Both Uppsala and Cambridge holds strong technological knowledge bases compared to other innovation systems within the nation. Internationally however, Cambridge is ranked higher, also by the Uppsala Biotech Cluster. Actually, Cambridge holds the place that Uppsala was aiming for a few years ago in local strategy documents, fourth in the world. When it comes to the international knowledgebase, the trademark of Cambridge is very strong internationally and attracts top researchers. However, the international links of Cambridge University in terms of co-authorships are weak. That is, the attractiveness of Cambridge to foreign researchers is high whereas the interest of academia in international research collaborations is limited, with the exception of the US. In Uppsala, the situation is somewhat reversed. The access to foreign researchers is perceived as limited in the Uppsala Biotech Cluster whereas the international co-authorships are stronger according to the bibliometric data. The market related knowledgebase in both CLIS and ULIS has been identified as challenges for the systems, but has improved in Uppsala where it does not seem to constitute as large hindrance, at least not in the discussion climate, than it has in Cambridge. The historical and current alleged strong connections and knowledge transfer between academy and industry might have played a part in the relatively strong market related knowledge base in ULIS.

The overall result of the innovation system study performed on the life science innovation system of Uppsala is that this is a well functioning innovation system, also compared to that of Cambridge. Overall, the actors cover the different activities needed. The access to financing is also generally good in both systems. There might be a gap when it comes to the financial support system in terms of business support and funding to companies that are in the growth phase. The growth of existing companies and attracting capital to the local industry is the focus of just a few of the actors within the Uppsala financial support system. It is not evident whose role this is to take. Some claim that this responsibility should not be taken by publicly funded actors. This would leave the industry and the privately funded actors within the financial support system with an important task.

Analysing the potential gap and how to best overcome it however should be in the interest of both publicly funded and private actors though, since deficit financial support systems for growth companies could be linked to the alarming employment development. In the UK there is a debate ongoing in this matter. The previous small business support has been replaced by Business Link which provides industry with a brokerage service of how to access business support. It is in the interest of Sweden to follow how this arrangement works out and if business will fill the part of business supporter, as has been questioned by some[649].

Both in Cambridge and in Uppsala, an equity gap is claimed by some and rejected by some. A mismatch between the size of investment required by companies and the size provided by investors is recognised in both systems. In Cambridge, the discussion about constraints to growth focuses on the equity gap, the too early exits of investors, the infrastructure and the need to go international in an early stage due to the small customers market and small VC market. The constraints to growth for life science companies has been in the spotlight in several conferences and is known as the issue of "where are the big gorillas?"[650]. The importance of access to the international market at for small biotech companies is stated also for ULIS[651] and has been addressed with a focus on China by some business support providers. However it is unsure if these efforts have yet affected any life science companies[652].

The topics are very much the same in the policy discussions within the two innovation systems and seem to be equally mature when it comes to the policies selected for further investigation[653].

In both ULIS and CLIS, selecting key technologies is not a strong policy issue among the actors. A comparison of table 8.1 and table 9.1 show that this focus area is more frequent in Cambridge than in Uppsala.

Commercialisation of research and knowledge transfer between academy and industry has been a number one topic for several years in both CLIS and ULIS and has been addressed in many ways and by almost all major actors. In Uppsala, the perception is that the development has improved in recent years and that attitudes have changed all he way. It might be that attitudes and initiatives towards commercialisation of research have had an effect on

---

649 http://www.the-guild.co.uk/article.php?recordID=8
650 http://www.cambridgeenterpriseconference.co.uk/documents/PR01CEC.pdf
651 Waxell. A, 2005, page 73
652 Mail Interview with Stuns
653 In the comparison, it should be noted that the networks and funding networks discussed in CLIS were identified on a regional basis, whereas the networks in ULIS were identified on a sub-regional basis to a larger extent.

the larger share of “product on the market” companies in Uppsala than in Cambridge

A larger share of the networks in Uppsala focuses on the global challenge. In Uppsala, the global challenge is addressed predominantly by an increased effort to market Uppsala to the rest of the world and to increase international collaborations. Increased collaboration between actors in the local system has also been linked to the task to address the global challenge, in the sense that this is needed in order to achieve critical mass and become more “visible”. Compared to Cambridge, the differences lie mostly in the various offices established in order to address the global challenge in Cambridge, like East of England International, East of England European Partnership and a Brussels office. The allocation from Uppsala City Council for international marketing of Uppsala and the allocation from EEDA to international business support are not actually comparable since EEDA covers a larger region and the two bodies have different functions. Nevertheless, the allocations are 1.2 million SEK and £2.704 million respectively.

Collaboration seems to be more emphasised in Uppsala than in Cambridge. It is recognised in both systems that more joint marketing with other sub-regions is necessary in the global competition. Needs-driven research and economic benefits to society was a more frequent focus area of the ULIS networks.

11 Interconnectedness of sub-regional, regional and national level

As described in the theoretical framework, although the main purpose of this report is to make an innovation system comparison and evaluate the competitiveness of the SLIS, there is a spatial dimension within this work as well. Innovation systems on different levels have been studied in Sweden and in the UK in order to make an extensive and fair comparison of the innovation systems, Sweden being so much smaller than the UK. The interconnectedness of these innovation systems on different spatial levels will in the following section be used as a dimension/activity in itself to compare.

The point of departure in the interconnectedness evaluation is the policies and how they are implemented. The geographic spread of knowledge and the links between regional and national capital access for instance have not been dealt with in this report. It was considered important for the evaluation and comparison of the innovation systems to see what goes on in the national policy discussions and how this is received or implemented de facto on a regional and sub-regional level. As an instrument to examine this interconnectedness, the focus on policies has been extensive in the different innovation system descriptions. On a national level, descriptions have been presented of the policies regarding certain policy areas. Explicit examples of how these policies and strategies de facto have been implemented are also provided in order to give a perspective on the extent to which policies are transformed into budgets and actions. This has also been described on the sub-regional and regional levels represented by CLIS, ULIS and ScLSIS. In addition, a systematic policy examination regarding largely the same policy issues has been performed on these levels. By using search tools, an exhaustive population of networks and funding networks has been generated and thoroughly examined. The results from these examinations, in combination with the overall policy description in each regional/sub-regional innovation system, will be used to draw conclusions about the interconnectedness.

11.1.1 Interconnectedness between UKLIS and CLIS

In Cambridge, a discrepancy was identified between the policies, or focus areas, on a national and sub-regional level. This was based on the outcome of the focus area quantification, budget allocations and local initiatives compared to the national policy documents, homepages, strategies and initiatives. There is also a discrepancy in what the regional actor EEDA stresses and what the sub-regional actors stresses. The interviews indicated that there seem to be a delayed consensus in the policy evolvement. The importance of commercialisation of research and knowledge transfer between academy and industry has been discussed and stressed for many years among policy makers on a national level and has now been highly emphasized by regional as well as sub-regional actors[654]. The need to address the global challenge and the selection of key technologies is stressed among national policy makers and is emphasized on a regional level, but is not strongly stressed on a sub-regional level. This has been noted only as an interesting phenomenon and will not be discussed in terms of strengths and weaknesses. Naturally, there might be risks connected to a fast development of consensus among actors in the innovation system. It could also be that the selection of key technologies is difficult to translate from policy to concrete action and thereby explains the discrepancy between national consensus and sub-regional actors.

11.1.2 Interconnectedness between ULIS and SLIS

In ULIS, prioritising is thought of as absolutely necessary due to limited resources when it comes to choosing among the activities aiming to support the innovation system, the tools in the tool box so to speak. It is also embraced at an industry level. Life science is considered an obvious industry of strength among a wide range of actors and it is viewed as a natural consequence that is in the focus of many efforts. Focusing efforts on specific key technologies was not found to be a strong policy issue among the actors in ULIS. As shown in table 9.1, almost none of the networks and funding networks highlights the key technology issue. On a national level on the other hand, discussions about the importance to prioritise focus more on key technology areas. Both levels emphasises the need to prioritise in order to achieve critical mass but in different ways. The sub-regional level perceives that due to limited resources they need to focus on certain activities. On the national level, there are no evident priorities made among the support activities –the tools in the toolbox so to speak. At the same time it has been identified on the national level that the business support is thinly spread compared to other countries and several claim that larger projects are needed. The need to prioritise (in general) in order to achieve critical mass is said to have been highlighted in Uppsala before it occurred on a national level.

It does not lie within the remit of this report to analyse what characterises the best approach in this matter. An explanation for the difference between

[654] Interviews in Cambridge and in London

the local and national level probably lies in the highly organic approach towards industry growth and development in ULIS and the more long term strategies and top down priorities of the national level. The approaches could probably co-exist more efficiently with a more initial communication in the launch and creation of programmes/initiatives from both parts.

In ULIS, just like SLIS, there is large focus on collaboration, commercialisation of research, addressing the global challenge and needs-driven research/economic benefit to the society. These focus areas are also currently addressed in various ways as shown by the explicit examples. It has been identified though that an even higher collaboration is required by some actors. Also, it is uncertain what effect some of the initiatives to address the global challenge have on life science in particular since their focus spans across several industries. This makes the efforts difficult to evaluate and compare to the national level. The commercialisation of research seems to have had a breakthrough in Uppsala whereas it is still perceived as a problem on the national level.

12 Overall competitiveness of the Swedish life science innovation system in relation to the British

Initially, four questions were asked. The first one was ”What is the overall structure and development of the Swedish Life Science Industry?”. This has been answered in the industry survey and to summarize, the employment development has stagnated overall in later years, whereas the productivity has improved. Between 1997 and 2003 the industry grew impressively, and this was due predominantly to research intensive companies. The second one was ”What does the British and Swedish life Science innovation systems look like and function regarding certain activities?”. The activities focused on policies and funding and the result is given in the five different innovation systems described – UK, Sweden, Scotland, Uppsala and Cambridge. To answer the third question, that is ”What is the performance of the Swedish and British Life Science innovation systems?”, the innovation systems was compared in a macro level and micro level benchmarking, based on the strength and weaknesses of the innovation systems. The comparison showed interesting differences in the governmental policies, the industry involvement and the funding systems. On the micro level, the differences in industry structure between Cambridge and Uppsala was given special attention, in particular the large share of consulting companies in Cambridge. The future development of the Uppsala life science cluster will be interesting to follow.

This section aims to answer the fourth and final question regarding the competitiveness of the Swedish Life Science innovation system; ”What can we learn from the British innovation system?”.

It is important that international benchmarking not result in copying the mistakes of others. It is difficult to draw conclusions about what impact different polices and strategies has had on the overall performance. It also might be to soon to evaluate the impacts. The fourth question therefore will be answered in a modest way.

There are high ambitions among Swedish policy and decision makers regarding the competitiveness of the life science research and life science industry. However, the ambitions are not very strongly reflected in actions and budgets. One might be concerned with the levels of public funding in Sweden, in particular when considering the vulrnability inflicted by the large share of funding that steams from a few private sources. In Scotland and in the UK overall, a larger share of industry funding is sought after.

When evaluating the pros and cons of a large industrial funding of R&D, it is important to consider the industry structure. In Sweden, Astrazeneca is a giant which stand for a large share of the industrial research funding. Even though a large industrial funding of research should be welcomed to help achieve the 3% target, it would be a less risky situation if the industrial contribution steamed from many sources instead of one single dominating contributor. There are no garanties that the main industrial contributors will remain bound to Sweden. There are lessons to learn from the UK and Scotland regarding industry involvement, but the policies cannot be ”copy pasted” in to the Swedish innovation system, due to the differences in industry structure.

In addition, there might be lessons to learn from the way public funding is allocated in the UK. For instance, the initiatives undertaken in the UK to increase governmental collaboration regarding research and innovation should be further evaluated from a Swedish point of view. It might turn out that the new departemental structure, with the launch of DIUS, is in fact a clever way to deal with business, innovation and university issues. Coordination might still be a problem in the UK innovation system but there seems to be more action going on to address the identified needs in the UK than in Sweden, not only on the governmental level.

In the UK, the industry has been attributed increased responsibility and impact on governmental policies through the establishment of the technology strategy board in the UK. This change in the British innovation system might need to be taken into larger consideration in the Swedish debate. There is no corresponding actor in Sweden to the technology strategy board and sadely, this has not been recognised in the current debate regarding the organisational structure of funding bodies.

A larger co-ordinating role could also be taken on by public funders when it comes to getting the act together with relevant actors within a certain project or research field. Increased project management from national public authorities is on the wish list from both companies and regional actors. The key to increase funding streams in Sweden might not be to increase the administrative burden on the individual companies and research groups to find co-funding. Instead, pooling funding might be something that the funders should work harder to achieve.

Sweden should keep an eye on Scotland in particular and how the selection of key technologies turns out. The Scottish ambitions to focus on key areas in order to achieve critical mass maybe could be an important source of inspiration for Swedish policies. The Scottish approach has already resulted in larger inflows of foreign direct investment. It is not evident that the Scottish approach will increase the economic benefits to society in the long term perspective. On the other hand, the actions undertaken show a comittement to stick to the high ambitions, and that might be a lesson for Sweden to learn.

It has been easier to find ”lessons to learn” for Sweden on the macro level than on the micro level. Access to international markets and means to address the equity gap might be areas where the actors in the Uppsala life science innovation system could learn from Cambridge. If a corresponding ”where are the big gorillas” discussion would occurr in Uppsala it would be most welcome and it is important that it includes macro as well as micro level actors. When it comes to the interconnectedness between the different levels in Sweden, it seems like there are differences in how actors reason about achieving critical mass. On both levels it is emphasized that priorisations are needed in order to achieve critical mass. However, the choice of priorities differs. Both on the micro and macro level though, the increased collaboration between Stockholm and Uppsala is welcomed.

13 Appendices

Appendix 1. Important policy documents

Important policy documents				
actor	name of document	aim of establishing the document	publishing dates	follow-up documents
DTI	Innovation report 'Competing in the global economy: the innovation challenge'	This report sets out the next steps we are taking inturning the Uk into a key knowledge hub in the global economy	2003	
DTI, H&M Treasury, DfES. Now overtaken by DIUS	Science and Innovation Investment Framework: 2004-2014	This framework sets out how Britain will grasp the opportunities of the global challenge and how to turn strengths in the UK science base into greater economic advantage by building on the culture change in our universities, by promoting engagement and collaboration between businesses and the science base, and by promoting innovation in companies directly.	2004	Science and Innovation Investment Framework: 2004-2014 next Steps (DTI) + annual reports on both documents (DIUS nowadays).
DTI, H&M Treasury, DfES. Now overtaken by DIUS	Science and Innovation Investment Framework: 2004-2014 next Steps	Against the background of increasing global competition for knowledge intensive business activity, this paper presents next steps on five key policy areas: maximising the impact of public investment in science on the economy through increasing innovation; increasing Research Councils' effectiveness; supporting excellence in university research; supporting world-class health research; and increasing the supply of STEM skills	2006	annual reports on both documents (DIUS nowadays)
TSB	Technology Strategy	Adress the Global Competition by focusing on those areas where the UK has the greatest capacity to develop and exploit technology.	Annual reports since 2005	Annual reports since 2005
GSIF	Strategy for International Engagement	The overarching objective of the GSIF strategy is for the UK to be the partner of choice for global business looking to locate Research and Development (R&D) activities overseas, and for foreign universities seeking overseas collaboration.	2006	

Some of the policy documents forming the basis of sections in this report dealing with UK policies

Appendix 2. Initiatives and programmes aiming to address the equity gap

The Early Growth Fund

This fund aims to increase availability of smaller amounts of risk capital by encouraging risk funding for start ups and growth firms. The size of the grant is on average £50,000 and no more than £100,000. Start ups, university spin-outs, innovative and knowledge intensive companies, smaller manufacturers with new opportunities and early growth companies are the main targets for the funding. The funds are operated by a fund manager[655].

Regional Venture Capital Funds

The explicit aim of this programme is to address "the equity gap at the lower end of the market"[656] . In the long run, the aim is to realise growth potential of SMEs by increasing access to venture capital and to promote investment by demonstrating the positive returns that are possible. It is also stated that this intervention of the government is intended to "be the minimum necessary to stimulate private sector investors to provide small-scale risk finance"[657] The programme is available for SMEs in England (one commercial fund in each of the nine English regions) and provides risk capital up to £500,000 to companies that show good growth potential[658].

Enterprise Venture Capital Funds

The equity gap for SMEs is further addressed by the Enterprise Capital Funds that are intended to provide government funding alongside private sector funds. The investments available to companies with high potential of commercial return are up to £2 million[659].

Small Firms Loan Guarantee

It has been recognised that among SMEs there is an unmet need for loans in order to realise business plans. Coventional loans might be hard to access due to lack of resources that could be used as security. This is where the

---

[655] http://www.berr.gov.uk/bbf/enterprise-smes/info-business-owners/access-to-finance/early-growth-funds/page37491.html
[656] http://www.berr.gov.uk/bbf/enterprise-smes/info-business-owners/access-to-finance/regional-venture-capital-funds/page37596.html
[657] http://www.berr.gov.uk/bbf/enterprise-smes/info-business-owners/access-to-finance/regional-venture-capital-funds/page37596.html
[658] http://www.berr.gov.uk/bbf/enterprise-smes/info-business-owners/access-to-finance/regional-venture-capital-funds/page37596.html
[659] http://www.berr.gov.uk/bbf/enterprise-smes/info-business-owners/access-to-finance/enterprise-capital-funds/page37667.html

Small Firms Loan Guarantee comes in; BERR in a joint venture with participating lenders offers a guarantee to the lender that covers 75 per cent of the loan to, the cost of two percent per year. The size of the loan is maximum £250,000 and is available to firms with a maximum annual turnover of £5.6 million per year[660].

Community Investment Tax Relief

Individuals and corporate bodies that wish to invest in accredited Community Development Finance Institutions (CDFI), that is …, can access a tax relief of five per cent per year of the amount invested in CDFI. The funding provided to CDFIs is used to support qualifying profit-distributing enterprises and social enterprises[661].

---

[660] http://www.berr.gov.uk/bbf/enterprise-smes/info-business-owners/access-to-finance/sflg/page37607.html
[661] http://www.berr.gov.uk/bbf/enterprise-smes/info-business-owners/access-to-finance/CITR/page37528.html

14 References

Ministry of Enterprise, Energy and Communications, 2006, Regeringsuppdrag N2006/11519/ITFoU

Perez. E, Oltander. G, 2005, A survey of the Swedish security industry and an innovation system analysis of the Swedish security industry, Chalmers University of Technology, VINNOVA

Arvidsson.G, Bergström. H, Edquist. E, Högberg. D, Jönsson. B, 2007, Page 30 Medicin för Sverige, Nytt liv i en framtidsbransch, Centre for Business and Policy Studies, SNS förlag

Bergqvist. H, Dolk. T, Sandström. A, 2007, National and Regional Cluster Profiles, VINNOVA VA 2007:16

Gergils. H, 2006, Dynamiska innovationssystem i Norden? Danmark, Norge, Finland, Island, Sverige. SNS förlag

Ullenius. C, 2002, Nerikes Allehanda 2002-09-26

Hällsten. M, Sandström. U, 2003, Företagens finansiering av universitetsforskning –en översikt i mars 2003, SISTER

Laredo 1999, Darby och Zucker 1995, 1998, jfr. Sandström 2003, (från företags finansiering av u forskning)

Wallberg-Henriksson, 2002, Dagens Medicin 2002-08-27

Drammeh. B, 2005, Hur finansierar Umeå universitet sin forskning - nu och i framtiden? Rapport om forskningsresurser 2005

Invest in Sweden Agency, 2003, Människor, Kapital och innovationer – Hur Kanada attraherar utlandsinvesteringar inom bioteknik, BBD Financial (?)

Main science and Technology Indicators 2005-1/ Congress of Swedish Association of Scientists 2006

Anvret. M, 2008, FoU strategi 2008, Svenskt Näringsliv, http://www.svensktnaringsliv.se/multimedia/archive/00011/Erbjudande_att_utarb_11286a.doc

VINNOVA, 2005a, Strategi för tillväxt -bioteknik. En livsviktig industri för Sverige, Vinnova policy VP 2005:02

Invest in Sweden Agency, 2004 Biotechnology –excellence in all steps of drug discovery and development. ISA02010604-11

Sweden BIO, ej publicerad? 200? Framtiden för Life Science-industrin i Sverige –hur säkrar vi företagens kompetensbehov?

Awapatent, 2007, Awapatents innovationsbarometer 2007, http://www.awapatent.com/?id=13740

Tryggvason. K, 2002, Dagens Nyheter 20020603, http://www.dn.se/DNet/jsp/polopoly.jsp?a=24049,

Rydell. I, Wiqvist. E, Zingmark. A, 2007, Expertkompetens – livsmedel och bioteknik (meNY). Utvärdering fas 1 2000-2006, KK stiftelsen ISSN 1652-5213

Ministry of Enterprise, Energy and Communicatios, 2005, Läkemedel, Bioteknik och medicinteknik – en del av innovativa Sverige, (national life science stategy),

Vinnova, 2007,Research and innovation strategy proposal 2009-20012

Vetenskapsrådet, 2003, International Evaluation of Biotechnology, VR 2003:5

Vinnova ,2005b, VINNOVA VA 2005:2.

Dagens industri 2007-03-20
Waxell. A, 2005, Uppsalas biotekniska spatiala system. En ekonomisk-geografisk studie av interaktion, kunskapsspridning och arbetsmarknadsrörlighet, Uppsala University

Jonsson. L, 2003, Uppsala Nya Tidning, 2003

Waluszewski. A, 2003, ur Pharmacias aska reste sig ingen fågel Fenix

Swedish Private Equity & Venture Capital Association (SVCA), 2005, Press release 20051202

NyTeknik 20050823

Nutek, 2007, Riskkapitalbolagens aktiviteter och finansieringar i tidiga skeden 2007

Braunerhjem. P, Wiklund. J, 2006, Entreprenörskap och tillväxt – kunskap, kommersialisering och ekonomisk tillväxt.
http://www.esbri.se/oh_estrad_061016.pdf

Claes de Neergard, 2004, Bättre finansiering för kommersialisering av innovationer, Government offices of Sweden,

NyTeknik 20050823,
http://www.nyteknik.se/nyheter/it_telekom/allmant/article36684.ece

Swedish Foundation for Small Business Research, 2006, refererat från seminarium, http://www.fsf.se/nyheter/0606dokumentation-almedalen.htm

Vinnova, 2006, Forskning och innovation för hållbar tillväxt, Vinnova information VI 2006:20

Ministry of Finance, 2007, The Budget proposals 2007, area of expenses number 16

Royal Swedish Society of Engineering Sciences, 2007, Projekt Framtidens näringsliv: Prognoser, visioner och förhoppningar. Vad händer om experterna spår rätt?

Former Department of Trade and Investment, 2004, Science and Innovation Investment Framework 2004-2014, 4.4

Former Department of Trade and Investment, 2005, Science Budget Allocation 2004-2008

Becker. B, Pain, 2003, What determines Industrial R&D Expenditure in the UK?, National Institute of Economic and Social Research

Global Science and Innovation Forum, 2007, Strategy for International Engagement in Research and Development

Technology Strategy Board, 2006, Developing UK Capability

Department of Innovation, Universities and Skills, 2007a, Science and Innovation Investment Framework 2004-2014 - Annual report 2007

Higher Education Funding Council England, 2006, Higher Education Business and Community Business Interaction Survey 2003-2004, HEFCE 2006:25

Department of Innovation, Universities and Skills, 2007b, Pre-budget report

Hampden-Turner, Trompenaars, 1993

British Venture Capital Association, 2007, BVCA – British Private Equity and Venture Capital Association Report on Investment Activity 2006 Summary of Results

Porter, 1990, the Competitive Advantage of Nations

Former Department of Trade and Investment, 2003, The innovation report; competing in the global economy, paragraph 3.43.

HM Treasury, 2003, Bridging the finance gap: Next steps in improving access to growth capital for small businesses

The Council for Science and Technology, 2004, Ways of Working, page 3-4.

Council for Science and Technology, 2007, Annual Report 2005/2006

Spittle. G, 2005, Developing UK Capability and Creating Wealth

Technology Strategy, 2005, Annual Report 2005, Page 16-17

Scottish Enterprise, 2007a, Life Sciences -Annual Review 2006/07

Scottish Enterprise, 2007, power point presentation by Ken Snowden

Scottish Enterprise, 2004, Memorandum of Understanding - Scottish Enterprise and the Massachusetts Office of International Trade & Investment

Scottish Executive, 2007a, Statistics Publication Notice

Scottish Executive, 2006a, A Science Strategy for Scotland, Progress report 2005

Scottish Executive, 2006b, Higher Education Review, Phase three. The Competitiveness of Scottish higher education, Summary.

Office for National Statistics, 2006, UK Business Enterprise Research and Development 2005 –first release

Scottish Executive, 2006c, Draft Budget 2006-2007

Scottish Executive 2007b, Scottish Economic Statistics 2007, http://www.scotland.gov.uk/Resource/Doc/182172/0051721.pdf, Scottish Executive, 2005a, Scottish Life Science Strategy, achieving critical mass, http://www.scotland.gov.uk/Resource/Doc/37428/0009610.pdf

Scottish Executive, 2005b, Business - University collaborations in Scotland – The Scottish Executive's response to the Lambert review

Scottish Executive, 2004, A Smart Successful Scotland: Strategic Direction to the Enterprise Networks and an Enterprise Strategy for Scotland

Global connections magazine – For Scottish Companies Doing Business Internationally, Business Gateway, issue 11

The Association of University Teachers Scotland, 2004, Response to Finance Committee Call for Evidence on Economic Development in Scotland

Smith. M, 2008, The herald 20080121, http://www.theherald.co.uk/business/news/display.var.1979830.0.Business_angels_warn_of_capital_gains_tax_threat_to_investment.php

UK Trade and Investment, 2007, Information Sheet: Obtaining finance in the UK

Region Uppsala, 2004, Regionalt Tillväxt Program för Uppsala Län 2004-2007, http://www.regionuppsala.se/documents/RTP%2004-07.pdf

St John´s Innovation Centre, 2006 Cambridge Technopole Report –An overview of the UK´s leading high-technology business cluster

Owen. G, 2004, Where are the big gorillas: high technology entrepreneurship in the UK and the role of public policy, Diebold Institute for Public Policy Studies

Waxell. A, 2005, Uppsalas biotekniska spatiala system. En ekonomisk-geografisk studie av interaktion, kunskapsspridning och arbetsmarknadsrörlighet, The University of Uppsala

Cambridge City Council, 2004, Economic Development Strategy 2004-2007 -Supporting Success Tackling Disadvantage, http://www.cambridge.gov.uk/ccm/cms-service/stream/asset/;jsessionid=43D75999D0C9568D02D6160285839198?asset_id=948054&

Smeets. A, 2006, The Cambridge Phenomenon and the St John´s Innovation Centre, powerpoint presentation accessible at http://www.oxford2cambridge.net/library/economy-the arc/Cambridge.St%20Js%20innovation.park%2C2006.pdf

Library House, 2006a, The impact of Cambridge University on the UK Economy and Society, published by EEDA

East of England Development Agency, 2007, Regional Economic Strategy for the East of England –Draft for consultation September 2007

PACEC (Public and Corporate Economic Consultants), 2003, The Cambridge Phenomenon fulfilling the potential, Greater Cambridge Partnership main report 2003

Herriot. WJ, Minshall. T, A Smeets. A, 2006, St John´s Innovation Centre, The Cambridge Cluster -The way ahead

Library House, 2006b, Beyond The Chasm -The Venture Backed Report UK 2006,

Library House, 2006c, The Super Cluster Question -The Cambridge Cluster Report

East of England Development Agency, 2006, Changing Peoples Lifes, EEDA Annual report 2005/2006

Forskning och Medicin 2007:3, http://forskningochmedicin.vr.se/knappar/tidigarenummer/innehallnr32007/enkatstortbehovavexternfinansiering.4.5d7d40fd1154283906d80003700.html

Uppsala Universitet, 2003, Forskningstrategier för Uppsala Universitet 2005-2008

Uppsala Bio, 2006a, Report on activities, strategies and results 2003-2006

Stuns, 2006, Verksamhetsberättelse 2006

Uppsala Bio, 2006b, The life science initiative, strategi och aktivitetsplan 2007-2010

http://www.uppsalabio.com/graphics/8494.pdf,

UIC, 2007a. http://www.uic.se/, nyhetsbrev 2007:2

UIC, 2007b. http://www.uic.se/, nyhetsbrev 2007:5

UIC, 2007c. http://www.uic.se/, nyhetsbrev 2007:4

Uppsala University, 2004, Nationell kvalitetsbedömning av samverkan med det omgivande samhället vid Uppsala Universitet

Uppsala City Council, 2007, Uppsala Kommuns Näringslivsprogram

Stockholm Business Region, 2007, Press release 20070509, http://www.stockholmbusinessregion.se/templates/page____21086.aspx

Actors

Almi

http://uppsala.almi.se/finansiering.html

AstraZeneca

http://www.astrazeneca.com/node/pressreleaselist.aspx,, press releases 1998-2008

Babraham Bioincubator

http://www.babraham.ac.uk/facilities/Bioincubator.htm

http://www.babraham.ac.uk/facilities/objectives.htm

Former Department of Trade and Investment, current Department for Business, Enterprise and Regulatory Reform, BERR

http://www.dti.gov.uk/bbf/small-business/info-business-owners/access-to-finance/page37736.html may 2007

http://www.dti.gov.uk/files/file37477.pdf

http://www.berr.gov.uk/innovation/technologystrategyboard/

http://www.berr.gov.uk/files/file34882.pdf, page 3

http://www.dti.gov.uk/sectors/biotech/biotechmedic/reports/page22183.html

http://www.dti.gov.uk/innovation/innovation-dti/Innovation%20Report/page10853.html

http://www.dti.gov.uk/innovation/globalwatch/index.html

http://www.dti.gov.uk/innovation/technologystrategy/tsb/index.html http://www.dti.gov.uk/sectors/biotech/biotechmedic/reports/page22183.html

http://www.berr.gov.uk/bbf/enterprise-smes/info-business-owners/access-to-finance/early-growth-funds/page37491.html

http://www.berr.gov.uk/bbf/enterprise-smes/info-business-owners/access-to-finance/sflg/page37607.html

http://www.berr.gov.uk/bbf/enterprise-smes/info-business-owners/access-to-finance/regional-venture-capital-funds/page37596.html

http://www.berr.gov.uk/bbf/enterprise-smes/info-business-owners/access-to-finance/enterprise-capital-funds/page37473.html

http://www.berr.gov.uk/bbf/BSS/page29002.html

BBSRC

http://www.bbsrc.ac.uk/about/Welcome.html

http://www.bbsrc.ac.uk/business/biu.html

http://www.bbsrc.ac.uk/biobusiness_guide/Welcome.html,

http://www.bbsrc.ac.uk/business/ip/Welcome.html

http://www.bbsrc.ac.uk/business/knowledge/Welcome.html

http://www.bbsrc.ac.uk/society/Welcome.html

http://www.bbsrc.ac.uk/international/Welcome.html

http://www.bbsrc.ac.uk/international/bbsrc/china.html

http://www.bbsrc.ac.uk/international/iru.html

http://www.bbsrc.ac.uk/international/Welcome.html

http://www.bbsrc.ac.uk/business/biu.html

http://www.bbsrc.ac.uk/science/areas/Welcome.html

Biotech Umeå

http://www.biotechumea.se/default.asp?id=4122&ptid=

British Council

http://www.britishcouncil.org/gost/advice.htm

British Business Angel Association

http://www.bbaa.org.uk/portal/index.php?option=com_content&task=view&id=186&Itemid=53

British Venture Capital Association

http://www.bvca.co.uk/

Cambridgeshire County Council

http://www.cambridgeshire.gov.uk/business/economic/Research+and+development.htm

Cambridge Science Park Innovation Centre

http://www.cambridgescienceparkinnovationcentre.co.uk/about.html

Cancerfonden

http://www.cancerfonden.se/templates/Article____1778.aspx?full=1&skip=3

Cellartis

http://www.cellartis.se/res/PDF/20060829pressreleasenovatheracellartis.pdf, press release 20060829

http://www.cellartis.com/res/PDF/itistemcellprogrammejan071.pdf, press release 20070117

Department of Innovation, Universities and Skills

http://www.dius.gov.uk/functions.htm

http://www.dius.gov.uk/.

http://www.dius.gov.uk/pressreleases/press-release-20070720.htm

Department of Health

http://www.dh.gov.uk/en/PolicyAndGuidance/HealthAndSocialCareTopics/StemCell/StemCellGeneralInformation/DH_4124082

Dundee University

http://www.dundee.ac.uk/general/achieve.htm

East of England Regional Assembly

http://www.eera.gov.uk/category.asp?cat=386

http://www.eera.gov.uk/Text.asp?id=SX87A5-A77F5251&cat=43

East of England Development Agency, EEDA

http://www.eeda.org.uk/abouteeda/staff.html

http://www.east-of-england.eu/

http://www.eeda.org.uk/929_2836.asp

ERBI

http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78

http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_11/_firsttitle.xsl/6

http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78&xsl_arg=//BF%5FERBI%5FAB%5FBIO%5FFAF/&xsl_argx=3

http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78&xsl_arg=//BF%5FERBI%5FAB%5FBIO%5FFAF/&xsl_argx=2

http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78&xsl_arg=//BF%5FERBI%5FAB%5FBIO%5FFAF/&xsl_argx=1

http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_52/_page.xsl/79 http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78&xsl_arg=//BF%5FERBI%5FAB%5FBIO%5FFAF/&xsl_argx=3

http://www.erbi.co.uk/bfora/systems/xmlviewer/default.asp?arg=DS_ERBI_ABOUTART_51/_page.xsl/78

England's Regional Development Agencies

http://www.englandsrdas.com/businessefficiencyinvestmentandcompetitiveness.aspx

http://www.englandsrdas.com/economicdevelopmentandregeneration.aspx

Enterprise Investment Scheme Association

http://www.eisa.org.uk/render.aspx?siteID=1&navIDs=21,97

Fyrislund

http://www.fyrislund.com/info.asp

Företagsfrämjande organisationer i Uppsala län

http://ffo.biz/

Government Offices for the English Regions

http://www.gos.gov.uk/national/

http://www.go-east.gov.uk/goeast/european_funding/?a=42496

Greater Cambridge Partnership

http://www.gcp.uk.net/SITE/UPLOAD/DOCUMENT/CIR_HiTech_2006_Final.pdf

ITI Life Science

http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=734&rlID=574

http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=36

http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=410 http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=727

http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=734&rlID=545

http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=734&rlID=574

http://www.itilifesciences.com/defaultpage131cd0.aspx?pageID=734&rlID=398

London Development Agency

http://www.lda.gov.uk/server/show/ConWebDoc.1340

Länsstyrelsen Uppsala Län

http://www.c.lst.se/templates/versamhetstart.aspx?id=566

Medical Research Council, MRC

http://www.mrc.ac.uk/OurResearch/Industrylinks/index.htm

http://www.mrc.ac.uk/AboutUs/OurStrategy/SingleHealthResearchFund/FutureDirections/index.htm

http://www.mrc.ac.uk/AboutUs/OurStrategy/SingleHealthResearchFund/FutureDirections/index.htm

http://www.mrc.ac.uk/AboutUs/OurStrategy/SingleHealthResearchFund/FutureDirections/index.htm

http://www.mrc.ac.uk/AboutUs/OurMission/MRC002337

http://www.mrc.ac.uk/OurResearch/PriorityAreas/index.htm

Nutek

http://www.nutek.se/content/1/c4/27/80/TripleHelixmodellen_definition.pdf

SCB

http://www.scb.se/templates/PlanerPublicerat/ViewInfo.aspx?publobjid=1519&lang=SV

Scottish Development International

K:\Skottland\Scottish Development International Biotechnology and Life Sciences in Scotland – SDI.mht

http://www.scottishdevelopmentinternational.com/pages/Industries/Life-Sciences/Overview/index.asp

http://www.sdi.co.uk/pages/Our-Services/Globalscot/index.asp

http://www.sdi.co.uk/pages/Invest-News/News/index.asp?newsid=1163

Scottish Enterprise

http://www.talentscotland.com/view_item.aspx?item_id=47607

http://www.scottish-enterprise.com/sedotcom_home/life_sciences/life-sciences-research/life-sciences-clinical-expertise-oncology/life-sciences-clinical-expertise-oncology-academic-groups.htm

http://www.wsep.co.uk/innovativeactions/downloads/presentations/UK_Ireland%20Networking%20Event/SE%20Innovation%20Support%20Pipeline%20Presentation.ppt

http://www.scottish-enterprise.com/sedotcom_home/life_sciences/life-sciences-in-scotland/about-life-sciences-scotland.htm

Scottish Executive
http://www.scotland.gov.uk/Topics/Business-Industry/science/16607/21286

http://www.scotland.gov.uk/Topics/Statistics/Browse/Business/PubHEBCIS2003-04

http://www.scotland.gov.uk/Topics/Business-Industry/support/16879/6782

http://www.scotland.gov.uk/Publications/2006/06/27171110/4

Scottish Institute for Enterprise

http://www.sie.ac.uk/startupguide_finance.aspx

Sjätte AP fonden

http://www.apfond6.se/Page.aspx?id=10

Stuns

http://www.stuns.se/stuns_projekt.html

http://www.stuns.se/

SwedenBIO

http://www.swedenbio.se/templates/Links.aspx?id=1973

Swedish Government

http://www.regeringen.se/sb/d/2954/a/45823

http://www.sweden.gov.se/content/1/c6/08/49/73/29f74bfa.pdf

Swedish University of Agricultural Sciences (SLU)

http://www.slu.se/?ID=3

Swedish Venture Capital Association

Press release: ”Ny kvartalsrapport med ökning av ventureinvesteringarna”
http://www.svca.se/home/news.asp?sid=337&mid=3&NewsId=9357&Page=9

Vetenskapsrådet

http://www.vr.se/ansvarsomraden/forskningsfinansiering.4.1c4900da108bf5d57a58000390.html

Vinnova

http://www.vinnova.se/Press/Pressmeddelanden/2007/2007-03-29-Sju-universitet-finansieras-med-200-milliononer-kronor-for-battre-samverkan-med-naringslivet/

http://www.vinnova.se/Finansiering/Utlysningar---forteckning/Pagaende-utlysningar/SAMBIO-2007/,

http://www.vinnova.se/Finansiering/Utlysningar---forteckning/Pagaende-utlysningar/SAMPOST-2007-2/

http://www.vinnova.se/Verksamhet/Starka-forsknings--och-innovationsmillionoer/Berzelii-Centra/

http://www.vinnova.se/misc/menyer-och-funktioner/Nyheter/Nyheter-2007/2007-12-20-FoI-strategi/

http://www.vinnova.se/misc/menyer-och-funktioner/Nyheter/Nyheter-2007/071220-Forskarskolor/

http://www.vinnova.se/In-English/About-VINNOVA/

UK Trade and Investment

http://www.entrepreneurs.gov.uk/directorySearch.cfm

http://www.entrepreneurs.gov.uk/directorySearch.cfm

University of Glasgow

www.gla.ac.uk

Uppsala Bio

http://www.uppsalabio.se/DynPage.aspx?id=4715

http://www.uppsalabio.se/DynPage.aspx?id=4706&mn1=1224

http://www.uppsalabio.com/DynPage.aspx?id=4645&mn1=1223&mn2=1232

http://www.uppsalabio.com/DynPage.aspx?id=4719&mn1=1223

Uppsala City Council

http://www.uppsala.se/uppsala/templates/StandardPage____3113.aspx

http://www.uppsala.se/uppsala/templates/Level2Page____3006.aspx

http://www.uppsala.se/uppsala/templates/StandardPage____3161.aspx

Uppsala Innovation Centre

http://www.uic.se/

Uppsala Science Park

http://www.uppsalasciencepark.se/Templates/PageWide.aspx?id=695

Uppsala University

http://info.uu.se/fakta.nsf/sidor/bioteknik.id0E.html

http://info.uu.se/fakta.nsf/sidor/fakulteter..id83.html http://info.uu.se/uadm/dokument.nsf/sidor/E9343B7D08A843E5C1256EDF00643E8C?OpenDocument

http://info.uu.se/fakta.nsf/sidor/profilomraden.id8C.html

http://info.uu.se/fakta.nsf/sidor/studenter.och.id1C.html

http://info.uu.se/fakta.nsf/sidor/samarbete.forskning.id87.html

http://info.uu.se/fakta.nsf/sidor/uu.innovation.id6B.html

http://info.uu.se/notiser.nsf/pm/unik.agarlosning.id96.

Uppsala Universitets AB

http://www.uuab.uu.se/menu2.php?id=1

http://www.uuab.uu.se/news.php?id=80

Uppsala University Hospital

http://www.akademiska.se/templates/page____11023.aspx

Other Internet Sites

http://sv.wikipedia.org/wiki/Skottland

http://sv.wikipedia.org/wiki/Storbritannien

http://www.astrazeneca.com/node/pressreleaselist.aspx,, press releases 1998-2006

http://ekonominyheterna.se/va/magasin/2007/13/sverige-forlorare-i-hjarn/index.xml

http://www.astrazeneca.com/node/pressreleaselist.aspx, press releases 1998-2007, particularly 2005

http://www.e24.se/branscher/lakemedelbiotech/artikel_30637.e24.

http://www.e24.se/branscher/lakemedelbiotech/artikel_38819.e24

http://www.esbri.se/referat_visa_b.asp?id=62

http://www.teknikbrostiftelsenilund.se/pages_sv/aktuellt/news/050221.html http://www.scandinavianow.com/biotech/ledare.html

http://www.swedishtrade.se/dagensexportnyheter/?pageid=8026

http://bulletin.sciencebusiness.net/ebulletins/showissue.php3?page=/548/art/4772

http://www.number10.gov.uk/output/Page7484.asp

http://www2.cst.gov.uk/cst/about/

http://www.fertileage.com/User/Ads/ARTinUK.pdf, page 3

http://www.hgc.gov.uk/UploadDocs/DocPub/Document/hgc02-p4.pdf, page 2

http://www.rdforum.nhs.uk/docs/cooksey_letter.doc

http://www.sciencewise.org.uk/html/secure/documents/Stemcellspressrelease.pdf.pdf

http://news.bbc.co.uk/1/hi/business/6210100.stm

http://www.ukeas.com.tw/rankings.htm

http://en.wikipedia.org/wiki/University_of_Edinburgh

http://news.bbc.co.uk/1/hi/business/6210100.stm

http://www.ukscf.org/news/news_items/item14.html

http://www.drugresearcher.com/news/ng.asp?n=73553-cellartis-iti-life-sciences-stem-cells-scotland-ian-wilmut

http://www.cambridgeenterpriseconference.co.uk/documents/PR01CEC.pdf

http://www.the-guild.co.uk/article.php?recordID=8

http://www.newsdesk.se/pressroom/uu/pressrelease/view/uppsala-universitet-i-europeisk-storsatsning-paa-tillvaext-186658

http://www.cambridgeenterpriseconference.co.uk/documents/PR01CEC.pdf

Interviews in person

Interview, Sandström, Anna; VINNOVA; 200801

Interview, Williams Ylva, Invest in Sweden Agency, 200705

Interview, Griffiths David, BERR. 20071016

Interview, Goldman Merlin, Technology Strategy Board, 20071016

Interview, Norrman Bo, The Karolinska Institute, 200705

Interview, Hyllner Johan, Cellartis 20070906

Interview, Reschen Richard, Research services Division, University of Cambridge 20071018

Interviews and conversations with company representatives at the Bench to boardroom conference 20071017 in Cambridge:

Beckman Coultier Ltd
Bioanalytical systems Ltd
Cresset Biomolecular Discovery
GE Healhcare, Unique Solutions for Pharma Ltd
NIBSC
Onyx Scientific Ltd
Avicor
Cambridge Antibody Technology
Cambridge Biorisk Ltd
Omnicare Ltd
Pronovix

East of England Development Agency
BioPark Hertfordshire

Meetings, debates, hearings and conferences

Bench to boardroom, 20071017 in Cambridge

Invest in Sweden Agency 20080211, presentation of the report ”Utländska investeringar i den svenska life science industrin –framgångar på sluttande plan”

Deloitte presentation at the B2B-confrence 20071017 in Cambridge

The Teknik och Tillväxt conference, Royal Institute of Technology, 20071115

Meeting at Vinnova with representatives from the Bioregions of Sweden

Television debate: Svt 24 debatt 20070912

Telephone interviews

Interview, Neil Madeleine and Åström Jonas, Uppsala Bio 20080205

Interview, Björn Odlander, Heath Cap, 20080205

Mail interviews:

Mail Interview with Uppsala City Council 200801

Mail Interview with Stuns 200801

Databases

www.lifecompetence.eu, 20080205

Market Manager Partner Database