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Investigating the Uppsala Biotech Cluster

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**Baseline Results
from the
2004 Uppsala Biotech Cluster Survey**

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Executive Summary

Just 65 kilometers to the north of Stockholm, Sweden, the Uppsala region has been increasingly receiving worldwide recognition during the past five years as a strong and dynamic cluster in the field of biotechnology. In 2003, Vinnova and the Vinnväxt Program awarded Uppsala BIO – the Life Science Initiative a package of financial support for a period of ten years to further support the region's development and competitiveness. Uppsala BIO contracted CIND to facilitate in this process, and one of CIND's first activities was to conduct the 2004 Uppsala Biotech Cluster Survey. This survey was designed to gain an understanding of the current "state of affairs" in the Uppsala biotech cluster, and selected survey results are presented in this report.

Survey Respondents

CIND conducted the 2004 Uppsala Biotech Cluster Survey in the winter of 2003-2004. In total, a 43% response rate was achieved through this online survey with respondents comprising three main groups:

- Core companies, i.e., companies whose primary operational focus is on some aspect of biotechnology (40 respondents)
- Support companies, e.g., financial actors and specialized services companies (35 respondents)
- Government/university, e.g., academic, government, research, etc. (26 respondents)

Worldwide Competitiveness of the Uppsala Biotech Cluster

Turning to survey results, when we look at the larger regional innovation system of Uppsala, comprising companies as well as other actors, e.g., academic and research organizations, authorities, financial actors, and institutions for collaboration, etc., the survey results indicate that the preconditions for a high degree of knowledge creation and innovation in Uppsala do indeed exist. The following provide *indications of a tightly knit cluster*:

- There is a high level of labor mobility between organizations.
- There is a moderate to high level of interaction on both organizational and personal levels between the groups of actors and primarily between academia/research organizations and several of the other groups of actors.
- There is a fairly high level of cross-disciplinary research.
- There is a moderate degree of openness between individuals.
- There is a considerable degree of loyalty to the region.

Additionally, we used Professor Michael Porter's diamond model (1990) as a framework in order to evaluate the worldwide competitiveness of the Uppsala biotech cluster. Looking at the quality of the business environment and the degree to which the cluster fulfills the model's specific conditions for worldwide cluster competitiveness, we do, however, identify a number of *cluster weaknesses*:

- Local and foreign capital is difficult to obtain.
- Foreign labor with special skills is difficult to recruit.
- Local demand is neither large nor sophisticated.
- Local suppliers are not considered to be particularly competitive.
- Rivalry is low despite the low barriers to entry.
- Government organizations and policies are considered to be ineffective in furthering the cluster's competitiveness.

An additional analysis revealed that government/university respondents consistently have a more positive picture of the cluster than core companies and support companies. This may be due to the more distant relationship between government and the marketplace as revealed in our analysis of intra-regional relationships.

Evaluation of Uppsala BIO

Additional survey questions focused specifically on Uppsala BIO in terms of objectives, expectations, etc.

- Uppsala BIO has been successful in formulating and communicating its vision and objectives.
- Expectations from respondents on Uppsala BIO to improve the cluster's competitiveness are high, and not unexpectedly, respondents indicate that Uppsala BIO still has to prove its effectiveness in doing so.
- Respondents suggest that the most important activity for Uppsala BIO is "to promote the expansion of the cluster through supporting commercialization and spin-offs and attracting new firms and talent to the region".
- There is a correlation between the respondent's involvement in Uppsala BIO and expectations on Uppsala BIO, i.e., those who are more highly involved in Uppsala BIO indicate a higher level of expectations on Uppsala BIO.

Based on the results from the survey, several strategic issues were identified for Uppsala BIO:

- *Ensuring Further Development of a Dynamic Regional Innovation System.* Results indicate that government is considerably distant in terms of interaction from core companies and even more so for specialized services companies and financial actors. Thus, one potential action area for Uppsala BIO is to improve the degree of interaction between government and these companies, and in particular financial actors and specialized services companies, through involving these actors in ongoing projects to a greater degree.
- *Defining the Boundaries of the Regional Innovation System.* There is a clear discrepancy among respondents as to whether Uppsala is a distinct system in relation to the wider cluster of the Stockholm and Mälardalen region. The

government/university group views Uppsala as a distinct system while the core and support companies do not. This discrepancy calls into question the degree to which Uppsala BIO should emphasize the distinctness of the region as well as the degree to which the initiative should focus on integrating certain activities with the wider Stockholm-Mälardalen region. For example, the majority of Swedish financial actors are located in Stockholm, thus if the degree of interaction with these actors is to be improved, as suggested above, then Uppsala BIO needs to cast its net wider than the immediate Uppsala region.

- *Defining the Focus of Uppsala BIO.* While it may be difficult for Uppsala BIO to significantly impact areas such as national and international regulations, the survey did provide some areas that the initiative may more easily influence, e.g., foreign capital availability, ease of recruiting foreign skills, etc. However, in order to avoid spreading its resources too thinly, one issue to be addressed is whether Uppsala BIO should focus its activities more narrowly on research and innovation within the specific field of biotechnology or more broadly on development of the Uppsala region as a whole.
- *Defining the Technological Focus of the Cluster.* Survey results also indicate that respondents agree that the Uppsala biotech cluster has a high level of innovation in the area of methods and tools for discovery with the area of diagnostics immediately following thereafter. This supports Uppsala BIO's vision to be the center for the research and development of research methods, models, and tools within biotechnology research within the greater Uppsala-Stockholm region. Thus, one issue for Uppsala BIO is to ensure that it "restricts" itself to this focus to a sufficient degree such that its resources are effectively used.

A final strategic issue for Uppsala BIO as well as the Vinnova/Vinnväxt Program in general relates to performance measurement.

- *Assessing the Performance of Uppsala BIO.* As with any development program, it would be most beneficial if Uppsala BIO could evaluate its performance in terms of its impact on the development and worldwide competitiveness of the Uppsala biotech cluster. However, this is a very complicated task to accomplish due to the difficulty in determining cause and effect. For example, while more objective measures such as the number of patents sought per year, new start-ups, and new jobs in biotech as well as the amount of money spent on biotech-related R&D can be tracked, it is difficult to determine whether Uppsala BIO's efforts have any significant impact on the increase or decrease of these over time. A second means to assess performance is to measure people's perceptions of Uppsala BIO's impact on the cluster. As mentioned, the 2004 Uppsala Biotech Cluster Survey was designed to gain a baseline understanding of the current "state of affairs" in the cluster as well as an evaluation of Uppsala BIO's activities so that we may then compare future survey results with these baseline results. CIND plans to conduct this survey on a biannual basis with the next survey to be run in

spring 2006. While tracking these changes over time will help us better understand the impact of Uppsala BIO on the cluster, perceptions are subjective and easily influenced, e.g., by current events or the media. Additionally, this type of local assessment does not provide us with any indication of how the Uppsala biotech cluster is perceived *in other areas of the world*. Thus, in order to assess the performance of Uppsala BIO, a combination of both objective and subjective means as well as a further development of indicators allowing for cross-cluster comparisons is necessary and deserves attention.

Introduction

Just 65 kilometers to the north of Stockholm, Sweden, the Uppsala region has been increasingly receiving worldwide recognition during the past five years as a strong and dynamic cluster in the field of biotechnology. In order to further support the region's development and competitiveness, local representatives from government, industry, and academia came together to create Uppsala BIO – the Life Science Initiative. This initiative has been awarded considerable resources by the Swedish government through the Vinnväxt Program over a ten-year period beginning in 2003.

One of the conditions of the Vinnväxt Program is that Uppsala BIO should work together with academia in order to ensure that learning and knowledge created during the ten years could be captured and disseminated to other Vinnväxt participants. As a result, Uppsala BIO contracted CIND, the Centre for Research on Innovation and Industrial Development, at Uppsala University (www.cind.se) to facilitate in this process by monitoring, analyzing, reflecting upon, and giving advice regarding all aspects of Uppsala BIO's activities.

One of CIND's first tasks was to conduct a survey during the winter of 2003-2004, the 2004 Uppsala Biotech Cluster Survey. The purpose of this survey was to develop a baseline understanding of the Uppsala region in terms of its competitiveness and dynamics as a biotechnology cluster as well as to evaluate Uppsala BIO and its activities. CIND plans to conduct this survey on a biannual basis, thus the baseline data collected in this initial survey will be used in future comparisons in order to better understand the impact of Uppsala BIO on the cluster's development.

This report presents the findings from this initial survey and is organized as follows. First, a description of the background and present structure of the Uppsala biotech cluster is presented in Chapter One. This is followed by a presentation of the Vinnväxt Program and Uppsala BIO in Chapter Two. The next chapter presents the theoretical foundation of the survey, notably by discussing the cluster concept and the related notion of regional innovation systems. Chapter Four presents the design of the survey while Chapter Five provides a brief description of the analysis as well as selected results from the survey. Finally, Chapter Six concludes the report with a discussion.

We include here a short note on terminology. When we discuss the Uppsala biotech cluster in this report, we refer to the set of firms, institutions, and organizations that make up the wider system of interrelated biotech activity in Uppsala. The Uppsala Biotech Cluster Survey refers to the questionnaire, the results

of which are reported here, while Uppsala BIO refers to the specific cluster initiative that is part of the Vinnväxt Program.

This report is the result of a joint effort by a CIND research team during an intense period between December 2003 and February 2004, and the four authors have contributed in various ways. Robin Teigland coordinated and contributed to the survey design and administration as well as the writing of the report. Göran Lindqvist was in charge of administering the survey online in addition to conducting the statistical analyses, writing the report's empirical parts, and creating the report's layout. Anders Waxell provided the report's description of the Uppsala biotech cluster and the data and contact information on a subset of the survey's respondent pool in addition to contributing to the survey's design. Anders Malmberg led the project and wrote drafts of the report's first three chapters. The authors also wish to thank Daniel Hallencreutz and Per Lundequist, who provided material about the Vinnväxt Program and comments on the report, and Örjan Sölvell, who in the project's early stage contributed to the survey's design. We would also like to thank Christian Ketels and the Clusters and Competitiveness Foundation, an independent foundation resulting from the collaboration between Professor Michael E. Porter of Harvard Business School and the Catalonian government, for their comments and discussions regarding the formulation of one section of the survey.

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Chapter 1. The Uppsala Biotech Cluster – Past and Present

The Uppsala region has been increasingly receiving worldwide recognition during the past five years as a strong and dynamic cluster in the field of biotechnology. It is a well-established fact that the contemporary growth and dynamism of an industrial cluster is the result of historical processes. One of the key factors that has been identified in the historical processes particular to biotechnology clusters across the globe is a close relationship between industry and academia (see e.g., Jaffe 1989; Audretsch & Stephan 1996; Eliasson & Eliasson 1997; Zucker et al. 1997; Prevezer 1998; Zucker et al. 1998b; Nilsson & Runeberg 2000; Nilsson et al. 2000). The Uppsala biotech cluster is no exception as the development of this cluster is clearly related to the historical and current interplay between industry and academia.

A Tradition of Close University-Industry Links

The Uppsala biotech cluster can trace its origin back to a number of researchers and research findings at Uppsala University during the 1920s and 1930s as well as a significant related decision made by Pharmacia in the 1950s to relocate its core business from Stockholm to Uppsala. Of considerable importance is that the Uppsala research environment has centered on the work conducted by two Nobel Laureates in chemistry, Theodor (The) Svedberg (1926) and Arne Tiselius (1948), and several other prominent researchers such as Björn Ingelman, Jerker Porath, and Per Flodin in the 1940s and 1950s. These researchers built strong ties with industry, in particular with Pharmacia and what is known today as Amersham Biosciences (see e.g., Backlund et al. 2000; Affärsvärlden 2000; Carlsson 2003; Jonsson 2003; Rydell 2003; Waluszewski 2003; Widmalm forthcoming).

The first groundbreaking event in Uppsala's history was the development of the Ultra Centrifuge by The Svedberg in 1925. Professor Svedberg created an innovative environment around his research, which in turn was the basis for a rewarding collaboration with industry. In the early 1940s, a research contract between Uppsala University and the Swedish sugar company, Sockerbolaget AB, then resulted in an unexpected side effect. Researchers, Björn Ingelman and Anders Grönwall, discovered that the polysaccharide, dextran, could be used as a plasma volume expander for patients who had lost a significant amount of blood. This research finding became extremely important for Uppsala's industrial development within biotechnology. In collaboration with Pharmacia, which at the time was located in Stockholm, Ingelman and Grönwall further developed the product Dextran, later to be named Macrodex. Due to these developments, Pharmacia desired a closer

working relationship with Uppsala University and thus decided to relocate its operations from Stockholm to Uppsala in 1950 (Jansson 2003; Rydell 2003).¹

Additionally, collaboration between Pharmacia and a number of persons connected to Professor Tiselius and his work on serum proteins was of considerable importance. For example, on the basis of the dextran research, Jerker Porath, Per Flodin, and Bertil Gelotte developed in 1958 the gel filtration medium, Sephadex, that could be used for the separation and purification of proteins and peptides. The various products related to Dextran were commercially very successful and became the basis for Pharmacia's continued expansion. This research on proteins was also the foundation for the establishment of the Biotech Division within Pharmacia, later to become Amersham Biosciences through a series of restructurings (Carlsson 2003; UNT 2003).

In addition to the above, there are several other path-breaking research discoveries that have influenced the development of the Uppsala biotech cluster. Researchers Gunnar O. Johansson, Hans Bennich and Leif Wide made important contributions in the 1960s to the discovery and development of the immunoglobulin E (IgE antibody) that is used for the diagnosis and treatment of allergies. This discovery then became the foundation for the operations of Pharmacia Diagnostics. Additionally, Torvard Laurent's recent research on the function of hyaluron acid has led to a number of products in eye surgery and related fields. These have been further developed by the Uppsala firm, Q-Med. Another area of research worth mentioning is that by Ulf Lindahl on the function of the heparin structure, important for controlling blood anticoagulation and the bio compatibility of artificial implants (see Uppsala BIO & Invest in Uppsala 2003; Uppsala University 2004).

While the above efforts have resulted in considerable expertise in several biotechnological areas, the development and production of biotechnology methods, instruments, and research tools is considered to be the traditional core of the cluster. This core focus has led to the development of a national and international reputation for Uppsala as "the city of methods". Furthermore, this specific focus on methods serves to differentiate the cluster from the other two primary biotech clusters in Sweden that are located in Stockholm and the Öresund region.

The Growth and Decline of Pharmacia in Uppsala

Research has found that there are generally a number of critical actors who are more active in driving and stimulating the dynamics of regional clusters (Carlsson 1997). These key actors embody and develop the core competence of the cluster and tend to open up action spaces for other cluster actors. Such processes can take the form of a direct market interaction or work indirectly through various forms of knowledge spillovers. For example, large R&D intensive companies may play an important role in a local cluster, partly as major employers and business partners, but

¹ This decision was based on a number of reasons; however, proximity to the university and its research was one of the determining factors.

also as sites where R&D personnel receive industrial training and where applied and product-oriented research is concentrated. Within the Uppsala biotech cluster, Pharmacia has been the big engine on the industrial side in this respect (Andersson 1996; Frankelius 1999). In fact, Pharmacia has even been described as playing the role of “the third University” in Uppsala since it was the place where large numbers of researchers, managers, and others interacted and acquired industrial, marketing and sales skills. Additionally, considerable local, national, and even international interpersonal and business networks were initiated through relationships stemming from Pharmacia’s various activities (Carlsson 2003; Uppsala BIO Initiative 2003).

Even though the history of Pharmacia is complex and marked by a series of mergers, acquisitions, and spin-offs (see e.g., Andersson 1996; Frankelius 1999), certain changes have particularly impacted the company’s subsequent developments, locally as well as nationally. For a long period of the company’s history, Pharmacia was organized as an integrated company with its different business areas (e.g., pharmaceuticals, biotechnology and diagnostics) using shared facilities and sales companies. However, starting in the mid 1990s, the company spun-off, sold, or reorganized several of its larger operations such that a number of independent business units were created. These organizational changes resulted in a number of companies that are considered to be among today’s leaders in the Uppsala biotech cluster: Pfizer (embracing what is left of Pharmacia’s pharmaceutical operations), Amersham Biosciences, Pharmacia Diagnostics, Fresenius Kabi, and Biacore. Other companies with connections to Pharmacia include Active Biotech, the Lund-based company, and Biovitrum, a Stockholm-based company with some research activities located in Uppsala (see Biovitrum 2001; DI 2001; Amersham Biosciences 2003; Biacore 2003).

In 1995 the merger between Pharmacia and Upjohn resulted in a restructuring and relocation of the company’s major research operations away from Uppsala. Many perceived this as a major blow to the city and the region since approximately 200 research and managerial positions were relocated from Uppsala to other company locations (Fridh 2003). However, as time has progressed, an alternative view has developed, especially in the national press. The exodus of Pharmacia from the area has been described as resulting in a local entrepreneurial boom in biotech with the establishment of numerous new companies. The argument is that Pharmacia’s withdrawal released resources and competences and that previously unexploited projects and ideas could now take root. This in turn attracted new capital and stimulated the further development of the cluster (see e.g., Dagens Medicin 2000; UNT 2000; SvD 2000; Metro 2000; Veckans Affärer 2000; CMA 2001; DI 2001; DN 2002; Expressen 2002).

While Uppsala’s public image and in particular the strong focus on the role of Pharmacia’s pharmaceutical operations have been questioned by some observers (see Waluszewski 2003), what seems unquestionable is that the heritage of the collaboration between The Svedberg, Arne Tiselius, and their disciples at Uppsala University and Pharmacia has been a major force behind the formation of what is today’s biotech cluster in Uppsala.

The Present Size and Structure of the Uppsala Biotech Cluster

Assessing the number of companies in the Uppsala biotech cluster is no easy task, especially since there is no one generally accepted definition of a biotechnology firm. As a result, several estimations have been offered. The City of Uppsala has estimated that there are some 140 life science related firms while a researcher at Uppsala University, Alexandra Waluszewski (2003), states that the number of “real companies” in Uppsala (i.e., companies with at least one product on the market or a prototype close to market introduction) is limited to 25. Additionally, Uppsala BIO (Uppsala BIO Initiative 2003) describes Uppsala as one of the world’s most “biotech-dense” regions, employing 4000 individuals in approximately 50 active companies of which 34 have been founded since 1995. Moreover, approximately 8% of the total Uppsala workforce is directly involved in biotech related activities through working in industry, academia, or government organizations.

Regardless of the definition, the biotech industry is a knowledge and R&D intensive industry, which is dominated by small and medium sized research companies. New products and innovations often develop at the interface between related fields such as electronics, information technology, biomedicine, and drug discovery (see Waluszewski 2002). Additionally, innovation often occurs as a result of interaction between firms, public and private research organizations, financial institutions, governmental organizations, institutions for collaboration, and specialized services companies. Uppsala is no exception with important biotech competencies and skills distributed across a wide spectrum of actors.

As mentioned, a strong research environment exists in Uppsala. There is a long tradition of research in medicine, biology, biotechnology, and materials science not only at Uppsala University but also at the Swedish University of Agricultural Sciences (SLU). These universities encompass approximately 900 researchers and graduate 900 students each year in biotechnology-related areas. The academic milieu also includes the Uppsala Academic Hospital (Akademiska sjukhuset) and a number of research centers, including the Ludwig Institute for Cancer Research, the Uppsala Clinical Research Centre (UCR), and the Center for Surface Biotechnology. These different actors serve as customers, suppliers, and knowledge resources for Uppsala’s biotech companies. Additionally, the universities have created business centers and holding companies that work specifically with the commercialization of research results.

The biotech research base in Uppsala is further strengthened by the presence of a number of national government authorities. The National Veterinary Institute (Statens Veterinärmedicinska Anstalt), the Medical Products Agency (Läkemedelsverket), and the National Food Administration (Livsmedelsverket) are all located in Uppsala, employing together around 1200 individuals. Furthermore, there are a number of local organizations that have as an explicit objective to stimulate the development of the biotech cluster, e.g., STUNS, Uppsvenska Handelskammaren, Invest in Uppsala, C-framåt, etc. These organizations act as meeting points for representatives from industry, academia, and local and regional authorities.

In addition to a heavy concentration of research organizations, biotech firms, and supporting organizations, Uppsala has also seen the growth of an extensive sector of specialized services firms. These firms provide the cluster with consulting and support, such as patenting, legal advice, business development, recruiting, auditing and marketing, and the number of such firms in Uppsala has been estimated at 35 (Waxell, forthcoming).

Having provided a short overview of the Uppsala biotech cluster, we now turn to a brief presentation of the Vinnväxt Program and Uppsala BIO – the Life Science Initiative in the next chapter.

Chapter 2. Into the Future with Vinnväxt and Uppsala BIO

While the Uppsala region has been increasingly receiving worldwide recognition during the past five years, several regional activities are being undertaken in order to improve the region's competitiveness in the future. One of these is Uppsala BIO – the Life Science Initiative, a regional development initiative within Vinnväxt. Vinnväxt is a program run by Vinnova, the Swedish Agency for Innovation Systems, and the overall objective of this program is to promote sustainable growth and international competitiveness in functionally defined regions through applied research and the development of dynamic regional innovation systems. More information on Vinnova can be found at www.vinnova.se, and a brief description of both the Vinnväxt Program as well as Uppsala BIO is provided below.

The Vinnväxt Program

The Vinnväxt Program has been designed as a competition in which regional teams compete for a package of financial support for a period of ten years (up to 10 million SEK per year for up to 10 years to be matched by an equal amount from regional sources). The program was initiated in 2002 when the first call for regional development proposals was launched. Vinnova received 150 proposals from across Sweden, and of these, 25 proposals made the first cut and received a planning grant to be spent developing a full application. In June 2003, Vinnova then selected three applications as recipients of the Vinnväxt Program grants: Uppsala Bio, Robot Valley (Västerås/Eskilstuna/Örebro), Borderland/Functional Foods (Region Skåne).

Of note is that the Vinnväxt Program continues to expand, with a second competition and call for proposals launched in 2004. Additionally, it is important to note that the design of the Vinnväxt Program as a competition was chosen with the objective of increasing the quality of the project work and only those proposals that exhibit real growth potential receive support. It is also expected, however, that the Vinnväxt program will initiate interactions between industry, research, and public authorities that will positively affect the development of regional innovation systems even in those regions that do not win Vinnväxt grants.

Uppsala BIO – the Life Science Initiative

Uppsala BIO dates back to a pilot project initiated by Vinnova in 2001. The project, titled The Uppsala Innovation System for Biotechnology, was conducted between April 2001 and April 2002, and the aim of the project was to analyze the preconditions for the continued growth of the cluster. One of the main findings of

this project was that collaboration between industry, research, and public policy was a necessary precondition for the long-term growth of the cluster and needed to be increased. Additional experiences and findings of this project are summarized in the report “Vision and Strategy for the Development of the Biotech Cluster in Uppsala”.

In the spring of 2002, the leaders of the pilot project then approached STUNS, the Foundation for Collaboration between Uppsala’s Universities, the Business Community, and Society (Stiftelsen för samverkan mellan universiteten i Uppsala, näringsliv, och samhälle), for support in further developing the project into a proposal that could be submitted to the Vinnväxt competition. After some months of negotiations, the pilot project’s leaders managed to convince STUNS of the project’s importance. STUNS thus approved the creation of a formal working group whose mandate was to develop an action plan based on the results of the initial pilot project for the development of the region in biotechnology. Of importance is that STUNS stipulated that this action plan be able to be implemented regardless of whether it won the Vinnväxt competition or not. In this plan, the working group proposed that Uppsala BIO be created as the owner of the future project. The action plan was then chosen as one of the three winners in the Vinnväxt competition, and STUNS subsequently created Uppsala BIO and delegated operative regional leadership to the project.

The Board of Uppsala BIO reflects the initiative’s and the region’s commitment to increasing collaboration between academia, industry, and government. The Board comprises individuals such as the CEOs of some of Uppsala’s leading biotech companies, top county officials, and influential individuals within Uppsala’s universities. Along with the board, Uppsala BIO’s leaders developed the following vision for the initiative:

Within a period of five years, the Uppsala-Stockholm region will be one of the world’s five leading biotechnology regions supported by a sustainable competitive industrial base, world-class research and education, and a good climate for companies, academics, and employees. In this region, Uppsala will be the center for the research and development of research methods, models, and tools within biotechnology research.

In order to fulfill this vision, Uppsala BIO has selected four areas on which the initiative will focus: 1) Research, 2) Competence and Infrastructure, 3) Innovation, and 4) Marketing and Public Relations. The guiding concept is that Uppsala BIO will use its resources to primarily support ongoing regional activities within each of these areas as opposed to initiating and leading its own activities. Examples of activities receiving support from Uppsala BIO include a) the establishment of a cross-disciplinary center for research on methods, models, and tools for biotechnology, b) the further development of an incubator to provide operative support for the commercialization of research findings, c) the improvement of organizations providing patenting advice, d) the development of biotechnology specific educational programs, and e) a focus on improving the area’s worldwide reputation

as a biotechnology center. More information on Uppsala BIO can be found at www.uppsalabio.com.

We now move from the Vinnväxt Program and Uppsala BIO to the theoretical foundation for the 2004 Uppsala Biotech Cluster Survey in the next chapter.

Chapter 3. Theoretical Foundation for the Uppsala Biotech Cluster Survey

While there are numerous theoretical perspectives that have inspired industrial, innovation, and regional policies during recent years, we have selected to use the work on clusters and regional innovation systems as the theoretical foundation for our survey. Below we provide a brief summary of this work.

Clusters

Since the publication in 1990 of Michael Porter's book, *The Competitive Advantage of Nations*, the cluster concept has become widely circulated and used in both academic as well as in policy circles. However, while the term, cluster, is widely spread, no one universal definition of the term exists. Thus, for the purposes of this report, we define a cluster as a spatial agglomeration of similar and related economic and knowledge creating activities.

Underlying Assertions of Clusters

The work on clusters is based on four broad assertions. First, in today's knowledge-based economy, the ability to innovate is more important than cost efficiency in determining the long-term ability of firms to prosper. Innovation is defined broadly here as the ability to develop new and better ways of organizing the production and marketing of new and better products (Porter 1990; Lundvall 1992; Nelson 1993; Nonaka 1994; Grant 1996). This does not mean that cost considerations are not important, but simply that the combined forces of the globalization of markets and the deepening divisions of labor make it increasingly difficult to base a competitive position on cost-advantage only.

Second, innovations predominantly occur as a result of interactions between various actors, rather than as a result of a solitary genius (Håkansson 1987, von Hippel 1988, Lundvall 1992). This fits with a Schumpeterian view of innovations as new combinations of already existing knowledge, ideas, and artifacts (Schumpeter 1934). Additionally, most innovations are based on some form of problem solving in which someone generally perceives a problem and turns to someone else for help and advice. In an industrial context, these interactions often follow the value chain. A firm facing a particular problem turns to a supplier, a customer, a competitor, or some other related actor to get help in specifying the problem and defining the terms for its solution. From this follows that the level of analysis for understanding the processes of industrial innovation and change is some notion of an industrial

system or network of actors carrying out similar and related economic activity. The cluster is basically then an attempt to conceptualize an industrial system.

Third, and this is where “geography” enters the picture, there are a number of reasons why interactive learning and innovation processes are not space-less or global, but on the contrary unfold in a way where geographical space plays an active role. Spatial proximity carries with it, among other things, the potential for intensified face-to-face interaction, short cognitive distance, common language, trustful relations between various actors, easy observations, and immediate comparisons (Malmberg & Maskell 2002). In short, spatial proximity seems to enhance the processes of interactive learning and innovation; therefore, industrial systems should be assumed to have a distinctly localized component.

Fourth and finally, an implication of the above is that there are reasons to believe that the knowledge structures of a given geographical territory are more important than other characteristics, such as general factor supply, production costs, etc., when it comes to determining where we should expect economic growth and prosperity in today’s world economy.

Thus, the cluster perspective provides a way to describe the systemic nature of an economy, i.e., how various types of industrial activity are related. Porter’s starting point here is the cluster chart (see figure 1). Beginning with the firms in the industry where we find the main producers of the primary goods of the cluster (be they heavy trucks, telecom equipment, popular music, or biotech products), the chart proposes a way to analyze how these firms and industries are connected to supplier firms and industries providing various types of specialized input, technology, and machinery and associated services, as well as to customer industries and more indirectly related industries.

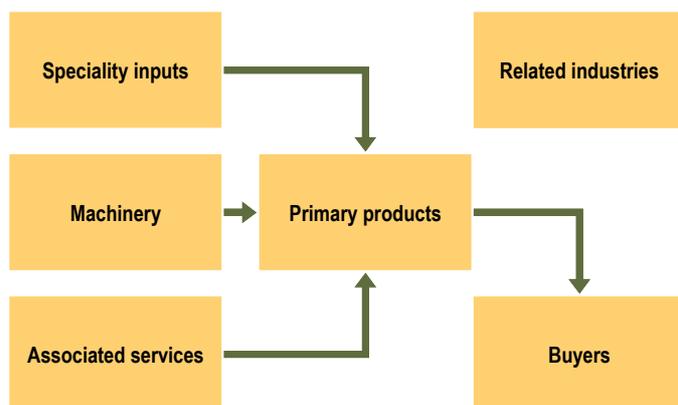


Figure 1. The Cluster Chart: Actors in an Industrial Cluster

This way of approaching the systemic nature of economic activity has much in its favor. It opens up a scope for analyzing interactions and interdependencies between firms and industries across a wide spectrum of economic activity. An additional advantage is that it contributes to the bridging of a number of more or less artificial and chaotic conceptual divides that characterize so much work in economic geography and related disciplines. These include, for example, manufacturing vs.

services, high technology vs. low technology, large companies vs. SMEs, public vs. private activities, etc. Thus, a single cluster defined as a functional industrial system may embrace firms, actors, and activities on both sides of each of these divides.

The Diamond Model

Furthermore, Porter's model of the determinants of cluster competitiveness, known as the diamond model (1990), identifies a number of mechanisms proposed to foster industrial dynamism, innovations, and long-term growth (see figure 2). Essentially, the model is built around four sets of intertwining forces related to 1) factor conditions, 2) demand conditions, 3) related and supporting industries, and 4) firm structure, strategy, and rivalry, each of which is described below.

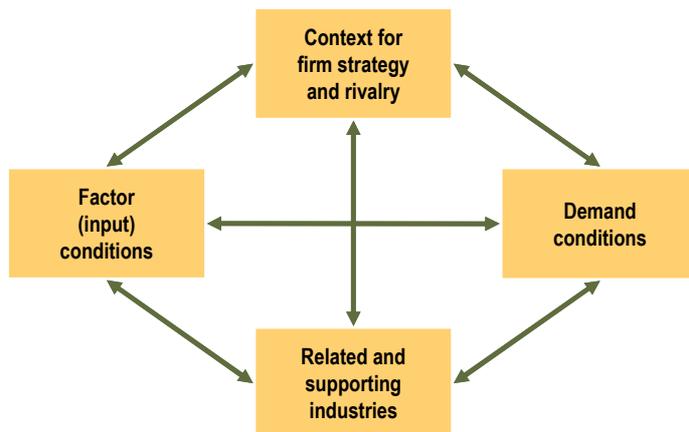


Figure 2. The Diamond Model: Forces that Make a Cluster Innovative and Dynamic (Porter 1990)

Regarding factor conditions, the model directs our focus away from the classical notion of availability and cost for capital, labor, and land towards the type of specialized factor conditions that are developed historically to fit the needs of a particular economic activity, such as the availability of specially trained labor or a research infrastructure that is specifically oriented to the cluster's needs. These conditions are important as factors of location since they are difficult to move and difficult to imitate in other regions.

While the sheer size of the local market can strongly influence local competitiveness, demand conditions are seen primarily as a qualitative factor in the context of an industrial system. Thus, the diamond model alerts us to the fact that it is not the size of the local market that matters, but the degree of the sophistication of demand that influences a cluster's competitiveness. In other words, regional customers for a cluster's products or services may be particularly demanding and thereby pressure regional firms into developing special or innovative products, or they may be trend-setters and in this way convey first-mover advantages to the cluster. Thus, according to this view, the locationally advantaged firm is the one that is in a position to receive and react to signals of sophisticated demand, rather than simply the one who is blessed with "many customers" in the local market.

In terms of related and supporting industries, the principle idea is not that it is generally good for a firm to have its customers and suppliers nearby. Rather, it points to the fact that innovation and competitiveness tend to spill over across firms and industries locally. In other words, the presence of a set of world-leading suppliers in a region may positively impact the upgrading of other firms in the local system by not only helping to streamline production and reduce transportation costs, but by also further enhancing competitiveness through fostering innovation in joint developments. Additionally, the local presence or absence of other industries with activities that are either related or complementary to the cluster's activities can profoundly affect the cluster's competitiveness. For instance, a cluster may be able to share training facilities with a related cluster, or it may benefit from a complementary cluster's reputation or co-use its trade channels.

Finally, the model underlines the importance of local rivalry. The idea is that local rivalry adds intensity and an emotional dimension to the competition that most firms perceive in the global market. Firms in a local environment tend to develop relations of rivalry, where the firm down the road is often seen as the “prime enemy”, a bit like the rivalry between neighboring football clubs. Benchmarking in relation to neighbors is more direct, partly for reasons of local prestige and partly, presumably, because direct comparison is simplified. One could speculate that there are at least two reasons for the latter. First, it is simply easier to monitor the performance of a neighboring firm than a competitor far away. Second, if one firm displays superior performance, it is obvious to everyone that this cannot be “blamed” on different local external conditions, since they are, in principle, identical for all firms in the local environment (cf. Malmberg & Maskell 2002).

Regional Innovation Systems

Very much related to clusters, the concept of regional innovation systems has been defined as the networks of organizations, institutions, and individuals within which the creation, dissemination, and exploitation of new knowledge and innovations occurs (Cooke et al. 2004). The regional innovation system concept has been introduced to describe how the industrial and institutional structure of a given national or regional economy tends to steer technological and industrial development into certain trajectories. As such, there is a stronger focus on innovation and on the way the research system and the regulations for immaterial property rights are organized in the regional innovation systems perspective than in the cluster perspective.

While there are differences between clusters and regional innovation systems, there are also many similarities. Groups of similar and related firms (e.g., large and small, suppliers, service providers, customers, rivals, etc.) comprise the core of the cluster, while academic and research organizations, policy institutions, authorities, financial actors, and various institutions for collaboration and networks make up the innovation system of which the cluster is a part. Both concepts have as their point of departure that innovation and industrial transformation are the result of interactions across sets of actors. Additionally, both adopt a geographical starting

point by emphasizing that this interaction takes place in a spatially defined territory (e.g., countries, regions).

Having briefly discussed the theoretical foundation used in our survey, we now turn to the actual survey in the next chapter.

Chapter 4. The Uppsala Biotech Cluster Survey: Respondents and Design

As mentioned in the introduction, CIND was contracted by Uppsala BIO to follow its development and activities over time. One of CIND's first tasks was to conduct a survey of the Uppsala region in the winter of 2003-2004 in order to gain an understanding of the status of the region's biotechnology cluster at the very outset of Uppsala BIO. This would serve as a baseline description to be used as a comparison with data gathered in future surveys that would then help assess the impact of Uppsala BIO's efforts on the cluster's development.

Selecting Survey Respondents

Our first step was to select the pool of survey respondents; however, there is no generally established method for determining the boundaries of a biotech cluster. Additionally, different studies have applied different definitions of biotechnology firms, e.g., Estades & Ramani 1998; Prevezer 1998; Shohet 1998; Nilsson & Runeberg 2000; Backlund et al. 2000; Sandström et al. 2001; McKelvey et al. 2001; CMA 2001. Thus, combining the definitions from these studies, we arrived at the following overarching definition of the biotech industry:

All companies with applications in drug development (including drug discovery, drug delivery, and vaccines), diagnostics and medical technology (including clinical/contract research organizations), biomaterials, biotech supplies (including bioinformatics and chromatography), health food (including health products, functional food/feed, etc.), agricultural biotechnology, environmental biotechnology; and other miscellaneous (e.g., biotechnical activities in dentistry, energy, cosmetology, etc.).

The challenge with using this definition (or almost any definition of biotechnology for that matter) is that while many public lists do exist, there exists no public register providing a list of organizations that fulfill this definition of biotechnology. Official classification codes (e.g., ISIC, NACE, etc.) are not consistent with this definition, and as a result, firms with a primary operational focus in biotechnology may be found across a number of classification codes.

A second obstacle to selecting the pool of cluster respondents was that biotechnology firms only represented one section of the potential pool. Based on the work on regional innovation systems discussed above, we were also interested in including all the other relevant actors in the region, e.g., academia, government, institutes for collaboration, etc. However, again there was no official register that would facilitate the identification of these organizations.

As a result, we built our pool of respondents based on two sources of data. First, a comprehensive study involving interviews and an analysis of secondary material such as predefined lists of biotech firms and articles and job announcements in the media from 2000 to 2003 provided a list of biotech and supporting firms (Waxell, forthcoming). This list of 141 organizations was then complemented with a list of 222 individuals from across a wide range of organizations that was provided by Uppsala BIO. The basis for Uppsala BIO's list was that these individuals had expressed an interest in biotechnology and in keeping up-to-date with the activities of Uppsala BIO and the Uppsala Chamber of Commerce.

These two lists were then merged, duplicates were removed, and the remaining individuals were sent an invitation by email to participate in the survey. Not unexpectedly, the list had to be further updated due to several reasons, e.g., some persons had moved from one organization to another, some organizations had moved from Uppsala, and some organizations were no longer in business. Additionally, when there were several respondents within the same organization, it was often agreed internally within the organization that only one of the respondents would answer on behalf of the organization. Finally, a few individuals considered their organization's involvement in the Uppsala biotech cluster to be too peripheral and therefore declined to participate. In the end, we reduced the original number of individuals and organizations from the two lists to a final number of 249 respondents. Of these, 106 completed the entire questionnaire for a response rate of 43%. (An additional 80 persons accessed part of the survey, but did not provide complete survey answers and are thus not included in the results presented here.)

Survey Design

We administered the survey using an internet-based tool, designed by Alstra AB, and an example of one of the survey pages is found in figure 3. As mentioned above, we sent each respondent an invitation by email to complete the survey. In this email, we included an explanation of why the survey was being conducted as well as a hyperlink directing them to each respondent's individual online survey form. Thus, by clicking on this link, individuals were then immediately directed to the survey where they could provide their replies online. Additionally, the survey was created in a manner such that respondents could exit the survey to return at a later time without losing any previously entered data.

The invitation emails were sent on December 18-25, 2003. Reminder emails were then sent on December 26, January 8 and January 14, with the last available date for replying specified in the last reminder email as January 16, 2004.

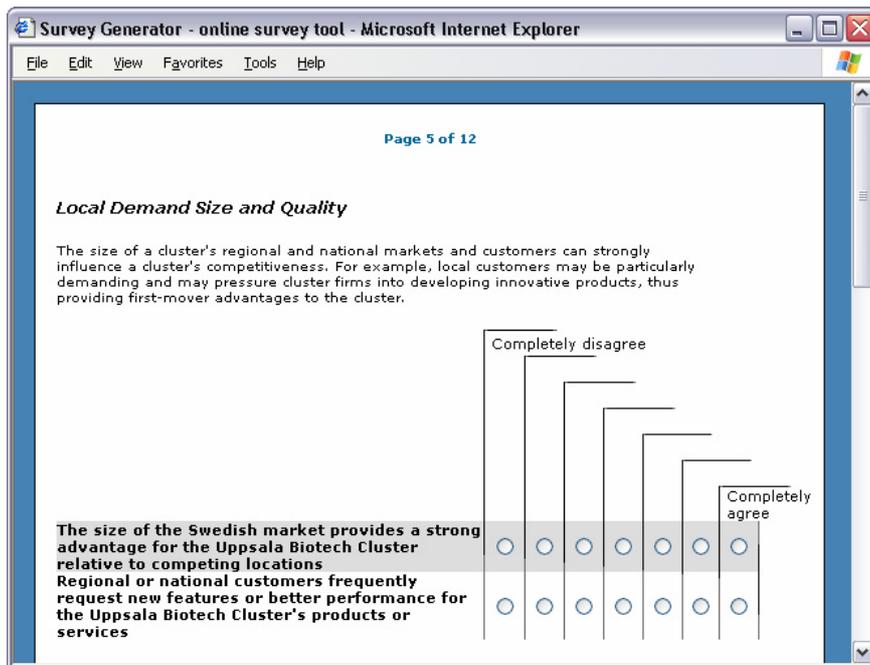


Figure 3. Online Questionnaire

Classification of Respondents

The 106 respondents represent different types of organizations in the cluster and fall into the following main categories:

- Product and research companies, e.g., companies whose operations primarily focus on some aspect of biotechnology
- Financial institutions, e.g., banks, venture capital firms, etc.
- Specialized services companies, e.g., patent bureaus, law firms, recruiting and staffing firms, management consultants, etc.
- Government organizations, e.g., Uppsala Municipality, the National Food Administration, etc.
- Educational, academic, research or healthcare institutions, e.g., Uppsala University, SLU, etc.
- Institutions for collaboration, e.g., Uppsala Bio

In order to present the data in a more compact format in this report, we reduced the original seven categories in the survey to three groups of respondents. The first category of product and research companies remains a separate group and has been labeled “core” companies. The second group consists of “support” companies and is a combination of both the financial institutions and specialized services companies. The third and last group, “government/university”, is based upon the two categories of government organizations and educational, academic, research or healthcare institutions. Finally, we have chosen to exclude the last category, institutions for collaboration, since there were only five respondents in this category. Furthermore, we were unable to combine this last group of respondents with any of the other three groups since their members represent industry as well as government and university. Based on this data reduction, the first group of core companies

consisted of 40 respondents, the second group of support companies of 35 respondents, and the third group of government/university of 26 respondents (figure 4).

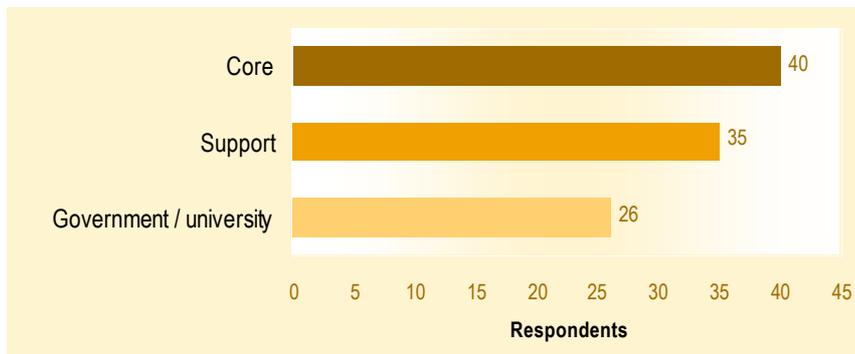


Figure 4. Breakdown of Respondent Groups

Survey Limitations

Several limitations regarding this survey are worth mentioning. First, the selected pool of respondents may be questioned. Since there is no one right way to identify respondents in Uppsala, we created our list of respondents based on an “objective” list (from Waxell) and a “subjective” list (from Uppsala Bio). Thus, our results may be somewhat biased and should be treated with caution when interpreting them. We know very little about the background of the non-respondents; however, we did conduct an analysis of these individuals based on the type of organization that they represent. Results indicate that for the core product and research companies the percentage of respondents was considerably lower than that of the non-respondents, 37% and 46% respectively. For specialized services, we see the opposite picture with the percentage of respondents higher than that of non-respondents, 32% and 26% respectively. Government displays a somewhat similar pattern to specialized services while financial companies; educational, research, and healthcare organizations; and institutions for collaboration were more or less equal.

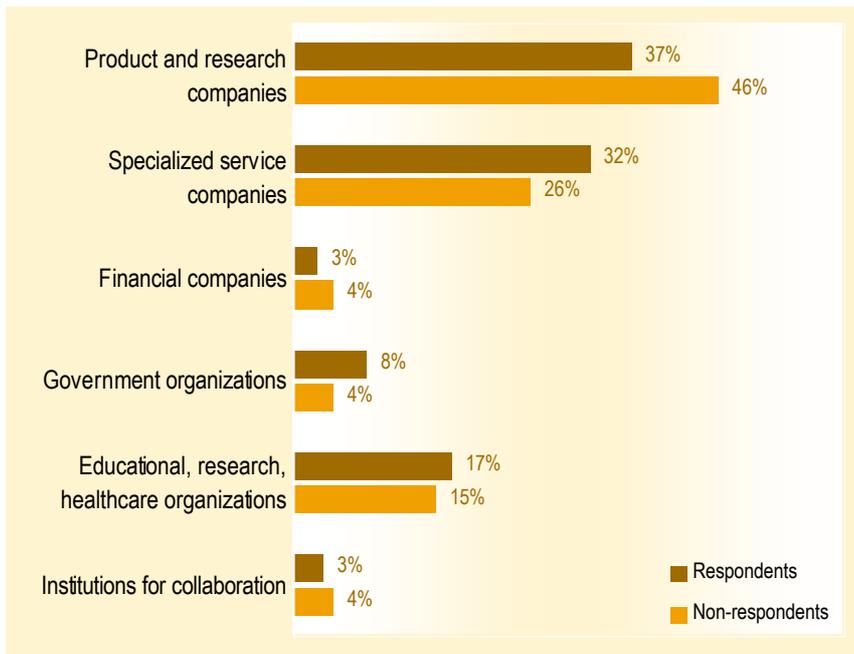


Figure 5. Overview of Respondents and Non-respondents

Note: The percentage corresponds to the number of respondents or non-respondents from that particular type of organization, e.g., product, service, etc., as a percentage of the total number of respondents or non-respondents. Totals may not equal 100% due to rounding.

Second, this survey was only administered to individuals in Uppsala. As a result, we know nothing about how individuals or organizations outside of Uppsala view the cluster in terms of its worldwide competitiveness. Third, we have no other data with which we may compare our results. For example, as we will see below, while our results seem to suggest that the Uppsala biotech cluster exhibits a poor to medium fulfillment of the diamond model’s conditions for worldwide competitiveness, we are unable to compare our results with other clusters across the globe. Thus, we do not know if the Uppsala biotech cluster fulfills these conditions to a greater or lesser degree than other worldwide leading clusters.

We now turn to the next chapter in which we present a set of selected results from the survey.

Chapter 5. The Uppsala Biotech Cluster Survey: Analysis and Results

The 2004 Uppsala Biotech Cluster Survey consisted of three main sections. The first section posed background questions, such as the respondent's position and organization, and provided the information for the respondent classification reported in the previous chapter. The second section focused on the general conditions of the Uppsala biotech cluster and included questions about the perceived quality of the cluster's business environment based on Porter's diamond model, e.g., factor conditions, local demand, rivalry, etc.,² as well as questions on the overall competitiveness of the Uppsala biotech cluster and Uppsala BIO. The third and final survey section was based on regional innovation systems and thus probed more deeply into the cluster's internal relationships by asking the respondents about their organizational and personal involvement in the Uppsala biotech cluster in terms of formal and informal interaction with other actors. Selected results from the survey are presented below in four categories: 1) Quality of the Business Environment, 2) Intra-regional Relationships, 3) Overall Cluster Competitiveness, and 4) Uppsala BIO.

Quality of the Business Environment

Analysis

As mentioned, this section of the survey was primarily modeled after Porter's diamond model, thus we posed questions regarding factor conditions, demand and supply, and rivalry and cooperation. The majority of these questions were based on a seven-point scale from 1, "completely disagree" to 7, "completely agree", with 4 representing a neutral answer. Thus, for these questions, responses greater than 4.0 indicate a positive perception while those below 4.0 indicate a negative perception. In order to facilitate the reporting of the results here, we have reduced the data

² We would like to thank the Clusters and Competitiveness Foundation, an independent foundation resulting from the collaboration between Michael E. Porter and the Catalanian government, for their comments and discussions regarding the formulation of this section of the survey on the diamond model.

through combining questions.³ We then compared the results across the three groups of core companies, supporting companies, and government/university organizations. For these group comparisons, a difference denoted as “significant” has been established by applying a t-test for equality of means with a 5% significance level.⁴

Factor Conditions

First, we take a look at factor conditions, and an overview of the results is presented in figure 6. We find that respondents perceive the cluster’s geographic location to be a considerable advantage while the general physical infrastructure and the cost of doing business is a slight advantage. However, we do find that respondents consider the poor availability of capital for new and medium-sized firms to be a considerable weakness of the cluster. This applies to Swedish sources of capital and even more so for foreign sources. A further analysis revealed that there were no significant differences between the three respondent groups.

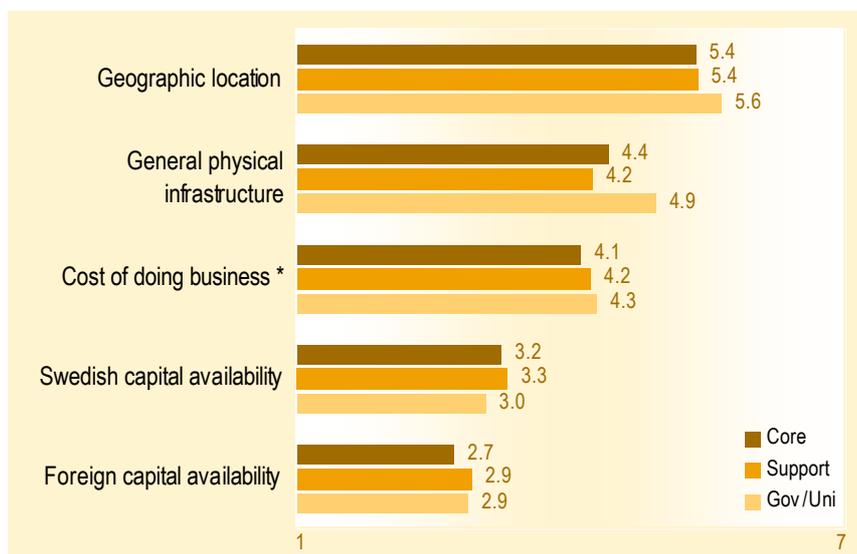


Figure 6. Factor Conditions

Note: Survey scale: min=1, max=7. * Reverse coded.

While financial capital is scarce, human capital is more readily available to the cluster (figure 7). Respondents agree that high schools (gymnasieskolor) and universities in Uppsala, Stockholm, and elsewhere in Sweden do provide reasonably skilled potential employees and that such persons are easy to recruit. However, on an

³ In order to reduce the data, we first conducted a factor analysis of questions based on the 1-7 scale. Using these results and reverse coding where necessary, we subsequently built eleven constructs of two to four questionnaire items each that were based on our initial theoretical concepts. With the exception of one construct with a Cronbach’s alpha of 0.67, these eleven constructs had a Cronbach’s alpha of greater than the recommended minimum level of 0.70 (Nunnally & Bernstein 1994).

⁴ Levene’s test for equality of variances has been applied with a 10% significance level.

international level, the cluster is less attractive. Respondents are of the opinion that it is considerably more difficult to recruit employees with special skills from outside Sweden. Again, we find no notable differences between the three respondent groups.

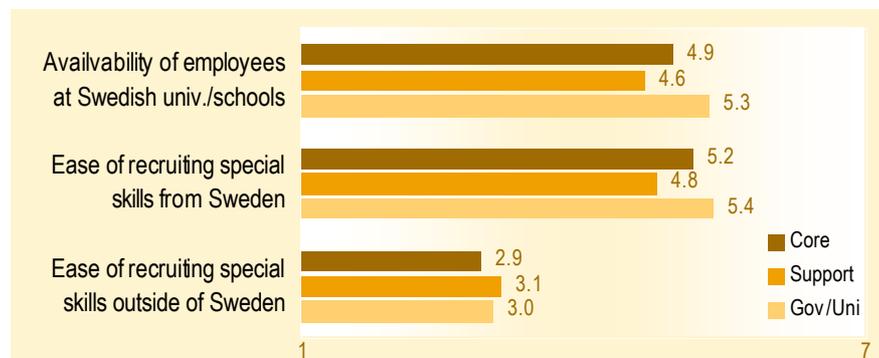


Figure 7. Factor Conditions (cont.)

Note: Survey scale: min=1, max=7

Demand and Supply

The second area of investigation regarding the quality of the business environment focused on the cluster's demand and supply conditions. In summary, these conditions are found not to be strengths of the Uppsala biotech cluster (figure 8). Not unexpectedly, the size of the Swedish national market is not considered to be an advantage. Moreover, local customers are not found to request new features or better performance to the products and services provided by the clusters.

A lack of sophisticated local demand could potentially be partly compensated through strict regulatory standards. However, we find that respondents consider national and international standards affecting the cluster's products to be neither very lax nor very demanding. There is not much help from the supply side of the cluster either. Local suppliers of components, materials, equipment, and specialized services are considered to only be on par with those in competing locations.

When we compared the three respondent groups, we did find that the government/university group has a somewhat more positive view of the cluster's demand and supply conditions than the core companies. This difference is statistically significant both for local demand for new features and for regulatory standards.

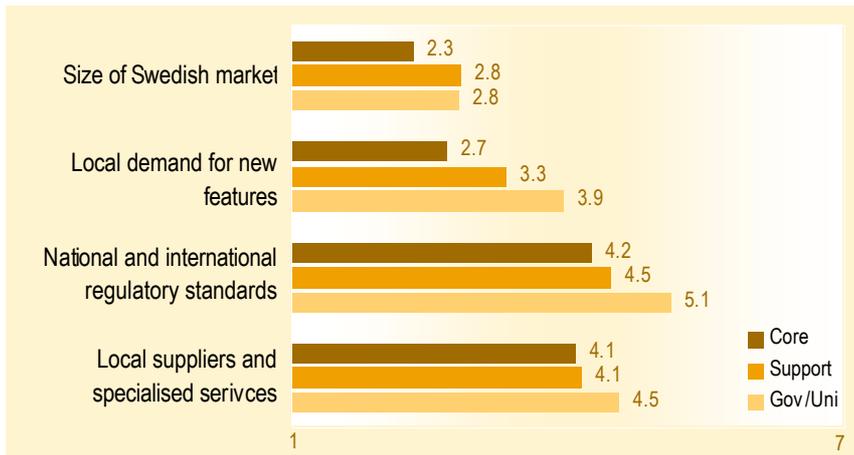


Figure 8. Demand and Supply

Note: Survey scale: min=1, max=7

Rivalry and Cooperation

Turning to rivalry, respondents suggest that rivalry in terms of the number of competitors and intensity of competition is quite low in the Uppsala biotech cluster (figure 9). A contributing factor could be that competition laws, such as antitrust laws and merger control, are considered to be somewhat lax. An alternative explanation could be that there are considerable entry barriers for domestic start-ups and foreign entrants. However, respondents indicate that barriers to entry for both domestic start-ups as well as international actors are low, thus facilitating the ease with which new entrants may establish themselves in the cluster.

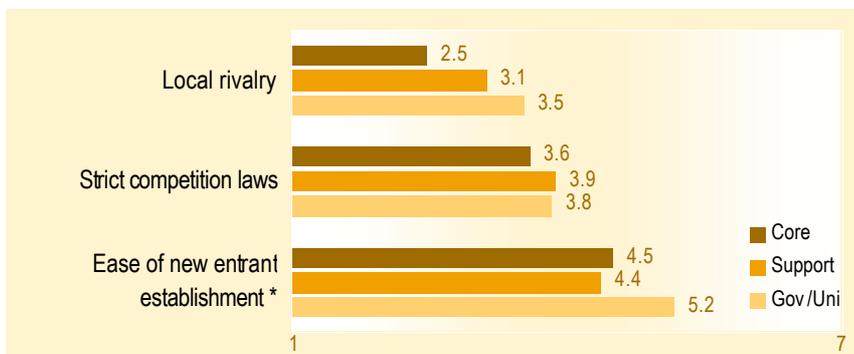


Figure 9. Rivalry

Note: Survey scale: min=1, max=7. * Reverse coded.

As for cooperation (figure 10), respondents indicate that cooperation between cluster actors is moderately strong, as is labor mobility between cluster companies, another phenomenon knitting the cluster more tightly together. Cross-disciplinary cooperation in research, too, is moderately strong.

Again, we find that the government/university group has a consistently more positive view than the core companies, with significant differences in their views on both local rivalry and cooperation. On a more detailed level (not shown in the

Financial Incentives, Policies

- Too little money is spent by the government in supporting start-up companies with seed capital.
- A more SME tax friendly environment is required.
- Lack of seed and early stage financing as well as the uncertainty around Teknikbrostiftelsen's future has hurt the international competitiveness of the cluster.
- When Nutek's responsibility for seed capital was transferred to Industrifonden, it became much more difficult for new companies and new ideas to acquire financing.
- Teknikbrostiftelsen's responsibility will cease within three years. While the Teknikbrostiftelsen have been positive for the cluster, the uncertainty about its future has been at the same time negative.
- The current taxation policies reduce the incentives to innovate and commercialize.
- Sweden needs a completely new approach to sharing value created among employees. The current tax system (both salary taxation and equity) is a serious limitation to building new successful companies. (Note: This comment is *not* only directed towards Biotech or Uppsala)
- Lack of tax incentives for R&D and startups have hurt the cluster's development in comparison with the EU and US regulations.

Other

- Uppsala kommun (municipal community) must realize that Uppsala cannot stay a "Smallville" forever. Better communications with Arlanda, Stockholm and especially Kista are crucial! Housing and the level of services (both public and private) must improve dramatically in order to keep and recruit competent people from abroad. For instance, a highly educated work force would require cultural activities (compare with the lengthy discussions about the Musikens Hus), international cuisine, etc. More important is that the so-called interest organizations are more interested in showing that they are doing something than actually making things happen. The social network among the cluster is way too centered around former Pharmacia and people in their fifties, effectively promoting narrow perspectives. You should have worked thirty years at Pharmacia in order to be recognized...
- Basic research also needs to be expanded at the university level. Science education is not stimulated sufficiently at the high school and university levels. This lack of interest for scientific education will create future problems.
- The establishment of regional universities has taken away funds from established universities that have the ability to develop and educate within specific competence areas.

Table 1. Survey Comments on Government Policies

Intra-regional Relationships

As mentioned above, we were also interested in going beyond the companies in the cluster to investigate the degree of interaction between the various groups of actors within the Uppsala regional innovation system. Thus, we probed into both the respondent's personal and his or her organization's involvement in the Uppsala biotech cluster. This interaction between the various actors was measured in several ways in the survey; however, we have chosen to report only two of these here. Additionally, we posed several questions looking at the degree of openness in the cluster as well as the degree of loyalty to the cluster. These selected results are reported below.

The first measure of interaction reported here asked respondents to rate how important formal or informal interaction on a regular basis with different groups of actors was for their *organization's success*. Replies were rated on a seven-point scale from 1, "no importance whatsoever" to 7, "critical for my organization's success". The second measure of interaction asked respondents to rate how much time they personally spent together with people from various categories of actors of the Uppsala biotech cluster on *social occasions*. In this case, replies were rated on a seven-point scale from 1, "not at all" to 7, "to a great extent". Actors were categorized

upon the classification provided in the background section of the survey: core product and research companies; financial institutions; specialized services companies; government organizations; educational, academic, research or healthcare institutions (denoted academic/research in the figures); and institutions for collaboration.

In order to conduct this analysis, we calculated the average degree of interaction (based on the 1-7 scale) between each of the above six categories of actors and every other category of actors for both types of interaction, importance for organization's success and social occasions. To better display the relationships graphically, we then calculated distances between the two categories of actors and drew the two graphs depicting the different levels of interaction using Pajek, a network visualization software (Batagelj & Mrvar 2003).⁵ In these graphs, the length of the arrows indicates the degree of interaction between the two respective categories of actors, e.g., a short arrow indicates a relatively higher level of importance or frequency of interaction between two actors than a long arrow (both directions taken into account). In addition, we have indicated the average degree of interaction for each pair of actors on the graphs and have circled the most important or frequent relationship for each category of actors. In short, a high number corresponds to a short distance in the graph, indicating a high level of importance or frequency of interaction between the two categories of actors.

Interaction for Organization's Success

In terms of importance to the organization's success, the overall outcome is illustrated in figure 12 below. When we look more closely at the different relationships, we find that the level of importance of interaction between the different categories of actors in the cluster does vary. For example, as reported by government, the importance for this organization of regular interaction with academic/research organizations is 5.7, while the importance for government organizations of interaction with specialized services companies is only 3. (The number farthest from the government node on the line between government and academic/research is the level of importance that academic/research reports that it has for government.)

⁵ We used the Kamada-Kawai energy function to calculate these distances.

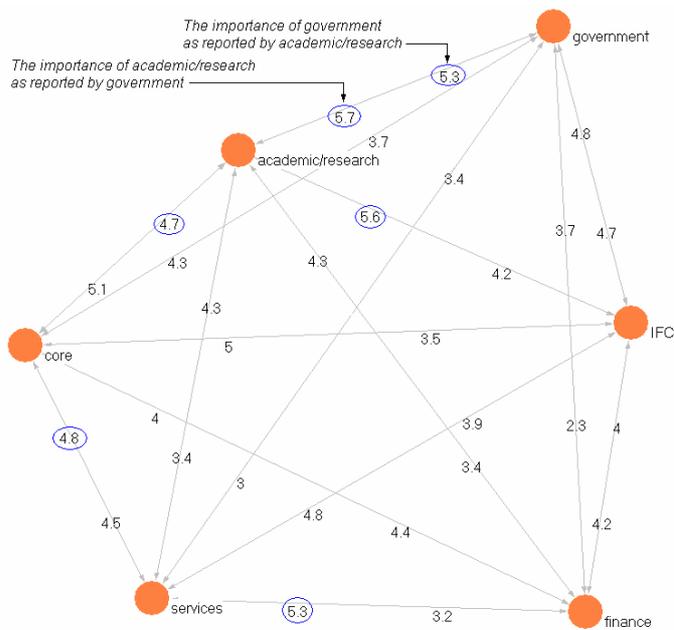


Figure 12. Interaction Between Cluster Actors and the Importance for the Organization's Success

Note: Circled numbers indicate the most important relationship for the group of actors indicated in the node farthest from the number on the line between the two nodes.

Based on the above results, table 2 presents the most important and least important categories of actors for each category of actors. We find that academic/research organizations play a central role in the cluster since in three of the six respondent categories, interaction with academic/research organizations is indicated as the most important for the category's organizational success. Additionally, we find in figure 12 that government has a close relationship with academic/research organizations, but it is quite distant from the three commercial actor categories. Of interest and not too surprising based on the previous survey findings is that financial companies are the least important category of actors for four of the six respondent categories.

Respondent Category	Most Important Other Category of Actors for Respondent Category	Least Important Other Category of Actors for Respondent Category
Core Companies	Academic/Research	IFC
Financial Institutions	Specialized Services	Government
Specialized Services	Core Companies	Finance
Government Organizations	Academic/Research	Finance
Academic/Research	Government	Specialized Services, Finance
Institutions for Collaboration	Academic/Research	Finance

Table 2. The Most and Least Important Category of Actors for Each Respondent Category

Personal Social Interaction

As mentioned above, the second area of interaction investigated the respondent's level of personal interaction during social occasions with others from the different categories (figure 13). We find a similar picture to the one in figure 12 above in that

the level of frequency of interaction between the different categories of actors in the cluster varies in the same manner. For example, as reported by government, the frequency of interaction by government organizations with academic/research organizations is 4.0, while the frequency of interaction by government with financial actors is only 1.7. Again, the academic/research category and government organizations are close to each other while government is distant to all types of commercial actors. Another interesting observation is the degree to which the actor in general interacts with other categories. For example, the financial services category reports by far the highest overall degree of inter-category personal social interaction while the government category reports the lowest.

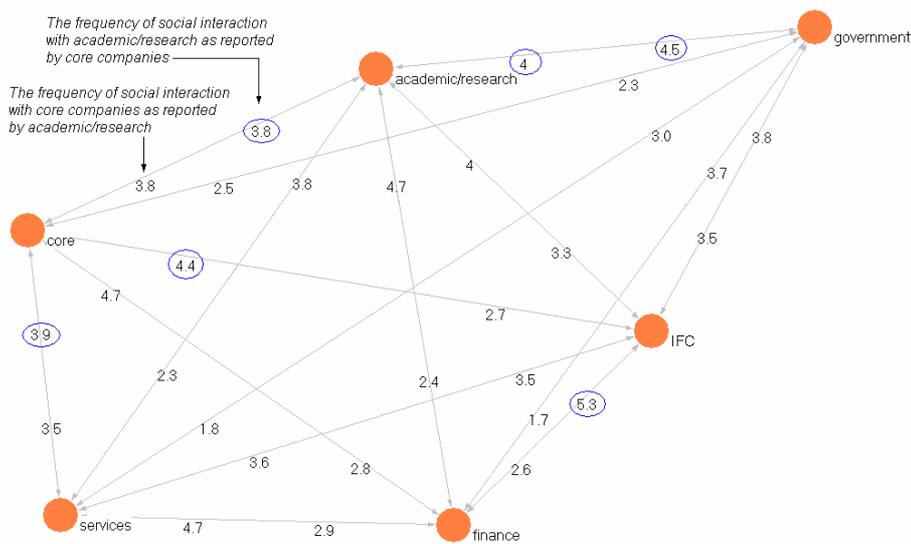


Figure 13. Personal Social Interaction Between Cluster Actors

Note: Circled numbers indicate the most frequent relationship for the category of actors indicated in the node farthest from the number on the line between the two nodes.

Table 3 presents the categories of actors with whom the respondent category most frequently and least frequently personally interacts on social occasions. Comparing tables 2 and 3, we find that the personal social interaction patterns are similar to the interaction importance patterns, with only three of the twelve pairs different between the two tables (highlighted in italics).

Respondent Category	Most Frequent Other Category of Actors for Respondent Category	Least Frequent Other Category of Actors for Respondent Category
Core Companies	Academic/Research	Government
Financial Institutions	IFC	Government
Specialized Services	Core Companies	Finance
Government Organizations	Academic/Research	Finance
Academic/Research	Government	Specialized Services
Institutions for Collaboration	Core Companies	Finance

Table 3. The Most and Least Frequently Encountered Category of Actors in Social Occasions for Each Respondent Category

Note: Actors in italics represent different relationships than those in Table 2.

Openness and Loyalty in the Uppsala Biotech Cluster

In addition to the above two questions investigating interaction, we also posed several questions about the degree of openness in the cluster as well as the degree of loyalty that respondents have to the cluster (figure 14). Respondents do not find people in the cluster to be particularly secretive about their ideas, and they agree that there is a considerable degree of loyalty to the Uppsala biotech cluster. Of note is that the perception of openness within the cluster is one of the very few areas where core companies are more positive than government/university. The difference, however, is not statistically significant.

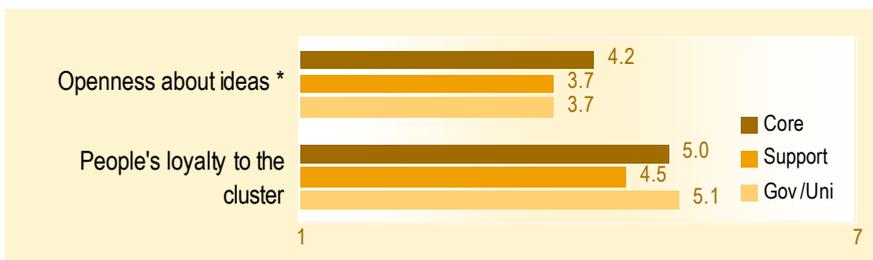


Figure 14. Openness and Loyalty

Note: Survey scale: min=1, max=7. * Reverse coded. The original rating in the questionnaire referred to secrecy, not openness.

Overall Competitiveness of the Uppsala Biotech Cluster

The next set of questions focused on developing an understanding of the perceived overall competitiveness of the Uppsala biotech cluster. Respondents were first asked to assess the general competitiveness of the cluster (figure 15). When asked to rate the competitiveness of the Uppsala biotech cluster compared to other clusters worldwide on a scale from 1, "uncompetitive" to 7, "world leading", the entire set of respondents indicated that they feel that the cluster is moderately competitive. However, government/university respondents indicated a significantly higher answer than core and support companies.

Respondents also indicated to what degree they would agree that Uppsala is one of the world's five leading biotech regions. Overall respondents chose a slightly

higher than neutral answer (from 1, “completely disagree” to 7, “completely agree”), and again government/university was significantly more positive.

The next question asked whether the Uppsala biotech cluster is a distinct system in relation to the wider cluster of the Stockholm and Mälardalen region. Interestingly, government/university respondents indicated that they do see the two regions as distinct; however, core and support companies do so to a lesser degree.

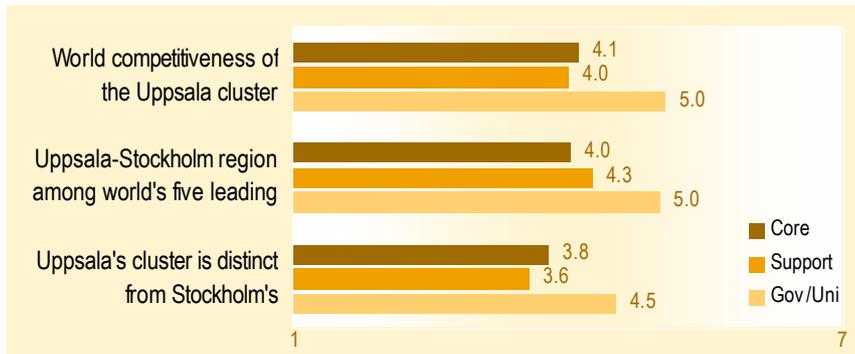


Figure 15. Competitiveness of the Uppsala Biotech Cluster

Note: Survey scale: min=1, max=7

While respondents may not consider the cluster to be very highly competitive or a world leader, we were interested in determining in what areas respondents do feel that the cluster is most innovative. Thus, respondents were first asked to assess the level of the cluster’s innovation within different biotechnology fields. Figure 16 presents an assessment of six fields. All groups agree that methods and tools for discovery is the most innovative field in Uppsala, followed very closely by diagnostics. These fields are followed by general life sciences, drug discovery, health food, and stem cell research, with all groups providing roughly the same order of assessment.

In general, government/universities consistently consider the level of innovation to be higher than the core companies do. The average responses differ significantly for diagnostics, drug discovery, and health food.

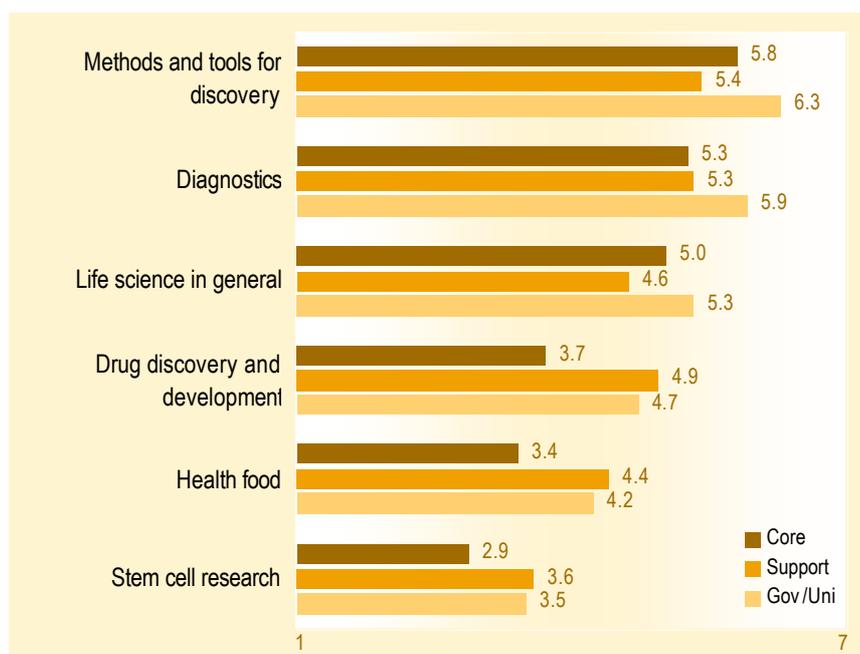


Figure 16. Uppsala's Innovation Level in Different Biotechnology Fields

Note: Survey scale: min=1, max=7

In addition to the above questions, respondents were asked to indicate which clusters they felt were the most competitive. These responses were then ranked in terms of the percentage of times they were cited by respondents. Boston/Cambridge, USA and Cambridge, UK were indicated as the leading clusters with Medicon Valley following closely.

Cluster	% Responses*
1. Boston/Cambridge, USA	18%
2. Cambridge, UK	16%
3. Medicon Valley	14%
4. San Diego, USA	13%
5. San Francisco/Palo Alto, USA	11%
6. Stockholm	7%
7. Other, e.g., Germany, Japan, etc.	21%
Total	100%

Table 4. Most Competitive Clusters Indicated by Respondents

*Note: n = 160. Total n is more than 106 since respondents could indicate up to three clusters.

Uppsala BIO – the Life Science Initiative

The fourth set of results presented here specifically focuses on Uppsala BIO (figure 17). In general, respondents do not consider institutions for collaboration to be a particular strength of the Uppsala biotech cluster. However, it is important to note that there are significant differences between core companies and government/-universities with the latter having a significantly more positive view of the efficiency of local and national institutions for collaboration.

When specifically asked about Uppsala BIO, respondents do agree that Uppsala BIO has an explicitly formulated vision and that there are clearly stated objectives. They expect Uppsala BIO to strongly improve the cluster's competitiveness and indicate that so far the initiative has been poor to moderately effective in doing so. This latter result is not too surprising given that the initiative has just recently started.

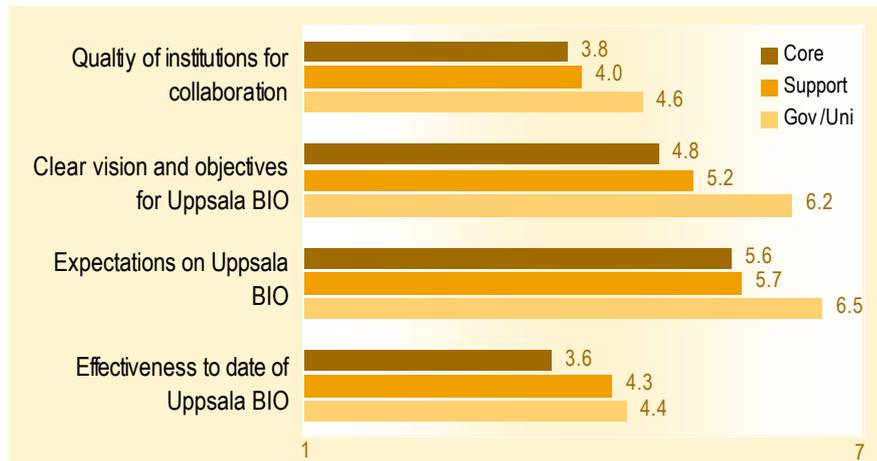


Figure 17. Institutions for Collaboration and Uppsala BIO

Note: Survey scale: min=1, max=7

In addition to the above, respondents were asked about their involvement in Uppsala BIO, and results revealed that this varies considerably among the three groups (figure 18). Seventy percent of the government/university respondents are either directly or indirectly involved through their organization in Uppsala BIO. The corresponding number for core companies is 44% although they are personally involved to a higher degree than government/university respondents (33% and 26% respectively). The lowest degree of involvement is found among support companies. Here only one out of four respondents is involved in Uppsala BIO with only 9% personally involved. (These results should be interpreted with some degree of caution since we have little information concerning the level of Uppsala BIO involvement of non-respondents.)

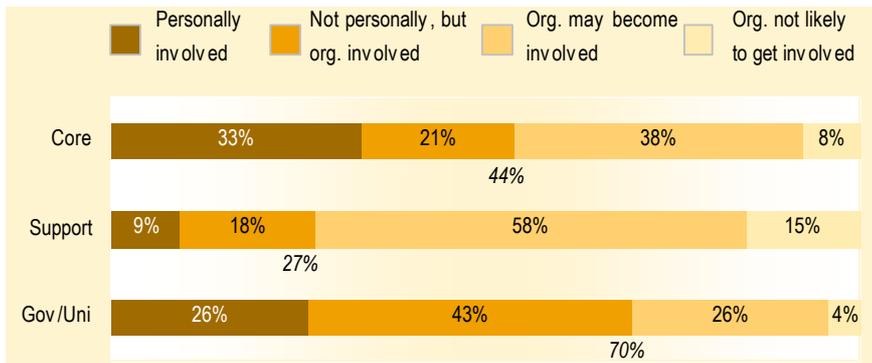


Figure 18. Respondent Involvement in Uppsala BIO

Note: Survey scale: min=1, max=7

A further analysis revealed that the level of expectations on Uppsala BIO as presented in figure 18 is significantly correlated to the level of the group’s involvement to which the respondent belongs. In other words, if the respondent exhibits a higher degree of involvement in Uppsala BIO, then the respondent has a higher level of expectations on Uppsala BIO.⁶ Here we find that the government/university group has significantly higher expectations than core companies, correlating with their higher degree of involvement in Uppsala BIO.

Similarly, views about the clarity of the vision and objectives vary significantly between groups and are again significantly correlated to the group’s level of involvement in Uppsala BIO. However, the perception of Uppsala BIO’s effectiveness to date does not significantly differ between groups nor is it correlated to the level of involvement.

A final question posed about Uppsala BIO asked respondents which activities they felt were the most important for the initiative to conduct (figure 19). Results indicate that the most important activity is “to promote the expansion of the cluster through supporting commercialization and spin-offs and attracting new firms and talent to the region” while the least important is “to provide technical and/or management training for the cluster”. All groups agree that cluster expansion is the most important objective, while technical training is the least. Measured across all respondent groups, the highest-ranking objective is significantly higher than number two, and number six is significantly lower than number five. The order between numbers two to five is less clear-cut.

Differences between respondent groups are only significant for innovation and for training, where government/university is somewhat more eager than core and support companies.

⁶ This correlation is affirmed using Somers’ d, significance 0.022.

figure), views are significantly disparate regarding a) the level of cooperation between core companies and financial institutions and b) the level of cooperation between core companies and academia.

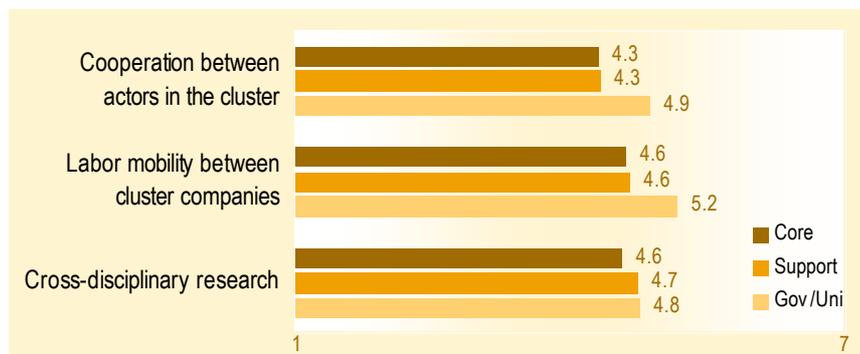


Figure 10. Cooperation

Note: Survey scale: min=1, max=7

In addition to the above, we also investigated the local or regional climate for investment since this climate affects the incentives companies have for investing in innovation, workforce development, or production capabilities (figure 11). We find that survey respondents consider taxes and regulations as discouraging such investments to some degree while the protection of intellectual property is effective.

Interestingly, respondents disagree on the quality of the local and regional government. As before, there is a significant difference between the core companies and government/universities; however, in this case, core companies are joined by the support companies in their less positive evaluation of government quality.

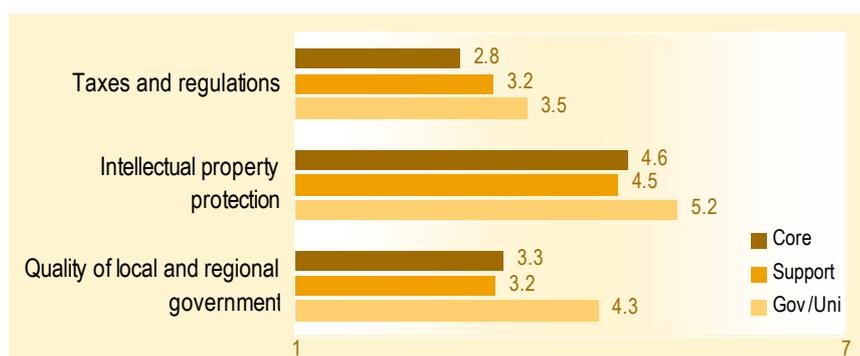


Figure 11. Investment Context and Government Quality

Note: Survey scale: min=1, max=7

In addition to the 1-7 scale questions presented above, respondents were also posed one open-ended question asking them to indicate if there had been any specific policies that had hurt the cluster’s competitiveness. Answers could be divided into two categories: 1) financial incentives/policies and 2) other. Examples of some of these responses are included in table 1.

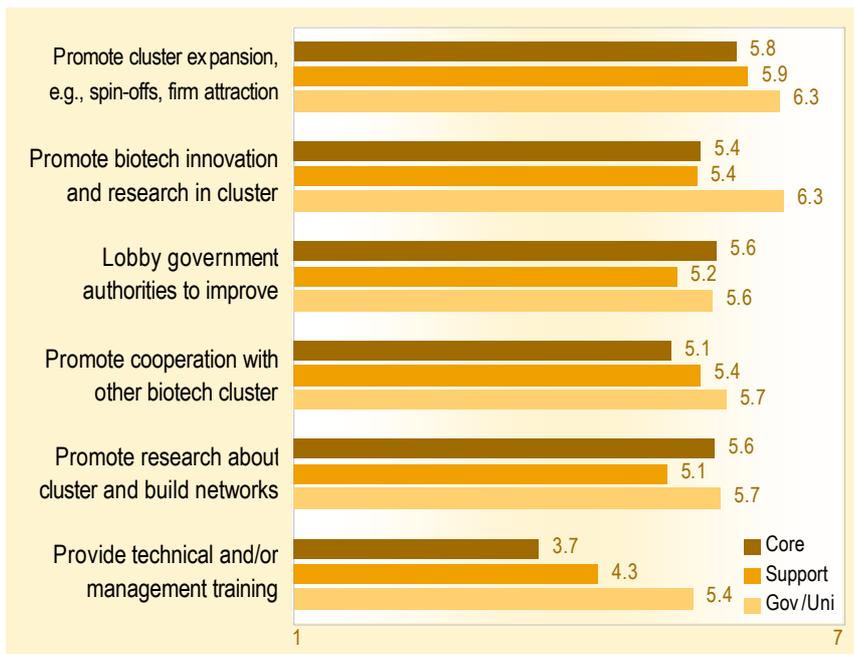


Figure 19. Preferred Objectives for Uppsala BIO

Note: Survey scale: min=1, max=7

Finally, respondents were also asked an open-ended question as to whether there had been any specific government policies that had helped the cluster (This question was located in the above survey section on business environment quality.) The five comments responding to this question all focused on Vinnova’s Vinnväxt program, indicating that these efforts have helped the cluster. For example, one person commented, “Vinnova’s Vinnväxt Program has enhanced the awareness in the region of the importance of the cluster and has added some resources.”

Having presented selected results from the survey, we now turn to a concluding discussion in the next chapter.

Chapter 6. Discussion and Concluding Comments

As mentioned in the introduction, the purpose of the 2004 Uppsala Biotech Cluster Survey was to gather baseline data that would facilitate the future evaluation of the impact of Uppsala BIO on the cluster's development and competitiveness over time. We may also provide some reflections based on this first round of data collection.

Worldwide Competitiveness of the Uppsala Biotech Cluster

If we look at the first set of results that focused on the quality of the business environment in Uppsala based on Porter's diamond model, we find that the cluster seems to fulfill the model's conditions for a high level of worldwide cluster competitiveness only to a poor to medium degree. Observed cluster weaknesses based on the respondents' replies are the following: 1) local and foreign capital is difficult to obtain, 2) foreign labor with special skills is difficult to recruit, 3) local demand is neither large nor sophisticated, 4) local suppliers are not considered to be particularly competitive compared to competing locations, 5) rivalry is modest despite the low barriers to entry, and 6) government organizations and policies are considered to be ineffective in furthering the cluster's competitiveness.

While the above paints a rather bleak picture, if we go beyond the diamond model and look at the larger regional innovation system in Uppsala, we begin to see quite a different picture. As mentioned in our discussion of clusters and regional innovation systems in Chapter Three, one of the main differences between these was that while groups of similar and related firms (e.g., large and small, suppliers, service providers, customers, rivals, etc.) comprise a cluster, the cluster is only part of the greater regional innovation system that includes numerous other actors, such as academic and research organizations, policy institutions, authorities, financial actors, and various institutions for collaboration and other networks. Within these greater regional innovation systems, the creation, dissemination, and exploitation of new knowledge and innovation occur through the interactions between the various groups of actors. Thus, regional innovation systems that have a higher degree of interaction between the various groups of actors are argued to exhibit a higher degree of knowledge creation and innovation (Malmberg 2002).

Looking at the Uppsala biotech cluster as a regional innovation system, the results of the survey provide support that the region is a fairly tightly knit innovation system: 1) there is a high level of labor mobility between organizations, 2) there is a moderate to high level of interaction on both organizational and personal levels between the groups of actors, and primarily between academia/research

organizations and several of the other groups of actors, 3) there is a fairly high level of cross-disciplinary research, 4) there is a moderate degree of openness between individuals, and 5) there is a considerable degree of loyalty to the region.

Interestingly, when we performed our analysis looking at the discrepancies between the responses of the three groups, we find that the group of government/university respondents consistently has a more positive picture of the cluster than the other two groups, and in particular more so than the core product and research companies. This may be due to the more distant relationship that government has with the marketplace. As revealed in our analysis of intra-regional relationships, government organizations have relatively more distant relationships with the core, specialized, and financial companies than with academic/research organizations or institutions for collaboration.

Evaluation of Uppsala BIO

In addition to investigating the worldwide competitiveness of the Uppsala biotech cluster, an additional purpose of this survey was to collect data on a number of questions regarding Uppsala BIO. In summary, while we found that Uppsala BIO has been successful in formulating and communicating its vision and objectives, respondents indicate that Uppsala BIO has still to prove its effectiveness in improving the cluster's competitiveness. This latter result is not unexpected since Uppsala BIO only recently received funding and became active. However, expectations from respondents on Uppsala BIO to improve the cluster's competitiveness are high, and respondents suggest that the most important activity for Uppsala BIO is "to promote the expansion of the cluster through supporting commercialization and spin-offs and attracting new firms and talent to the region". Interestingly, here we find that there is a correlation between the respondent's involvement in Uppsala BIO and expectations on Uppsala BIO, i.e., those who are more highly involved in Uppsala BIO indicate a higher level of expectations on Uppsala BIO.

Strategic Issues for Uppsala BIO

Based on the survey results, we may also highlight several strategic issues for Uppsala BIO:

Further Developing a Dynamic Regional Innovation System. The results from the survey section on intra-regional relationships indicate that government is considerably distant from core companies, but even more so from specialized services companies and financial actors. Thus, one potential action area for Uppsala BIO is to improve the degree of interaction between these actors, such as explicitly involving financial actors and specialized services companies in their ongoing projects involving government actors to a greater degree.

Defining the Boundaries of the Regional Innovation System. A second issue to be addressed regards the boundaries of the Uppsala biotech cluster. As indicated in the results on overall competitiveness of the Uppsala biotech cluster, there is a discrepancy among respondents as to whether Uppsala is a distinct system in

relation to the wider cluster of the Stockholm and Mälardalen region. The government/university group clearly sees Uppsala as distinct while the core and support companies do not view the region as distinct. This discrepancy calls into question the degree to which Uppsala BIO should emphasize the distinctness of the region as well as the degree to which the initiative should focus on integrating certain activities with the wider Stockholm-Mälardalen region. For example, the majority of Swedish financial actors are located in Stockholm, thus if the degree of interaction with these actors is to be improved, as suggested above, then Uppsala BIO needs to cast its net wider than the immediate region of Uppsala.

Defining the Focus of Uppsala BIO. While there are several areas that Uppsala BIO cannot significantly impact, e.g., national and international regulatory standards, national taxes and regulations, etc., the survey did provide some areas that the initiative may influence, e.g., foreign capital availability, ease of recruiting foreign skills, etc. These latter results are in line with respondents indicating that their preferred objective for Uppsala BIO is to promote cluster expansion, e.g., encouraging spin-offs, attracting new firms and talent, etc. However, in order to avoid spreading its resources too thinly, one issue to be addressed is whether Uppsala BIO should focus its activities more narrowly on research and innovation within the specific field of biotechnology or more broadly on development of the Uppsala region as a whole.

Defining the Technological Focus of the Cluster. Survey results also indicate that respondents agree that the Uppsala biotech cluster has a high level of innovation in the area of methods and tools for discovery with the area of diagnostics immediately following thereafter. This supports Uppsala BIO's vision to be the center for the research and development of research methods, models, and tools within biotechnology research within the greater Uppsala-Stockholm region. Thus, one issue for Uppsala BIO is to ensure that it "restricts" itself to this focus to a sufficient degree such that its resources are effectively used.

A final strategic issue for Uppsala BIO as well as the Vinnova/Vinnväxt Program in general relates to performance measurement.

Assessing the Performance of Uppsala BIO. As with any development program, it would be most beneficial if Uppsala BIO could evaluate its performance in terms of its impact on the development and worldwide competitiveness of the Uppsala biotech cluster. However, this is a very complicated task to accomplish due to the difficulty in determining cause and effect. For example, while more objective measures such as the number of patents sought per year, new start-ups, and new jobs in biotech as well as the amount of money spent on biotech-related R&D can be tracked, it is difficult to determine whether Uppsala BIO's efforts have any significant impact on the increase or decrease of these over time. A second means to assess performance is to measure people's perceptions of Uppsala BIO's impact on the cluster. As mentioned, the 2004 Uppsala Biotech Cluster Survey was designed to gain a baseline understanding of the current "state of affairs" in the cluster as well as an evaluation of Uppsala Bio's activities so that we may then compare future survey results with these baseline results. CIND plans to conduct this survey on a

biannual basis with the next survey to be run in spring 2006. While tracking these changes over time will help us better understand the impact of Uppsala BIO on the cluster, perceptions are subjective and easily influenced, e.g, by current events or the media. Additionally, this type of local assessment does not provide us with any indication of how the Uppsala biotech cluster is perceived *in other areas of the world*. Thus, in order to assess the performance of Uppsala Bio, a combination of both objective and subjective means as well as a further development of indicators allowing for cross-cluster comparisons are necessary and deserve attention

Conclusion

In summary, the purpose of this report was to present the background and results from the initial Uppsala Biotech Cluster Survey in 2004. As mentioned, this survey was designed to gain an understanding of the current “state of affairs” in the Uppsala biotech cluster. These results will serve as baseline data with which we will be able to compare future survey results in order to better understand the impact of Uppsala BIO on the development and competitiveness of the Uppsala biotech cluster. CIND plans to conduct this survey on a biannual basis with the next survey to be run in spring 2006. It will be interesting to see how these results change over time.

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