ETLA
ELINKEINOELÄMÄN TUTKIMUSLAITOS
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
Lönnrotinkatu 4 B 00120 Helsinki Finland Tel. 358-9-609 900
Telefax 358-9-601 753 World Wide Web: http://www.etla.fi/

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Shiri M. Breznitz* – Antti-Jussi Tahvanainen**

CLUSTER SUSTAINABILITY IN PERIPHERAL REGIONS: A case study on Israel's and Finland's biotechnology industries

* Corresponding author
Assistant Professor, Georgia Institute of Technology School of Public Policy, room 307A, 685 Cherry Street, Atlanta, GA 30332 – 0345, Phone: (404) 385-8574

** Research Economist, ETLA, The Research Institute of the Finnish Economy, Lönnrotinkatu 4 B, FIN-00120 Helsinki, Finland, phone:+358 9 60990238 mobile: +358 44 535 1797, email: antti.tahvanainen@etla.fi

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ABSTRACT: Even with globalization, industrial clusters are maintaining their importance in today's economy. With the decomposition of production we find that clusters are becoming focused on specific industries and stages of production. This paper analyzes two peripheral western countries, Finland and Israel, which saw success in their ICT clusters and wanted to duplicate this success building on their knowledge in the life science industry to create biotechnology clusters. This paper focuses on two innovation-based clusters, the biotechnology agglomerations in Rehovot, Israel, and Helsinki, Finland. These industrial districts consist of companies, many spun out of university research, that are either devoted to early-stage R&D (Israel), or choose to conduct the entire business cycle (Finland). Utilizing a multi-method study that includes both quantitative and qualitative research, with a series of in-depth interviews and site visits, archival and statistical data, the paper investigates whether a cluster of young research companies can become the basis of industrial growth and bring economic sustainability to a region. We find that while the firms' strategic choices regarding their focus on certain positions in the value chain do not necessarily have any direct implications on the sustainability of the respective clusters as such, a variety of other characteristics necessary for long-term sustainability are missing in both clusters. These include particularly inter-firm knowledge flows within the clusters, an active and demanding VC market, connections to international expertise, and opportunities to recruit experienced expertise.

Key words: Clusters, Biotechnology, Peripheral Regions, Sustainability

Introduction

Even with globalization, industrial clusters are maintaining their importance in today's economy. There are many reasons why, but mainly, studies found that clusters provide the stickiness required for economic sustainability (Lazonick 1993; Porter M.E 2000; Cooke 2002; Cooke 2002; Casper and Murray 2003; Casper 2007). With the decomposition of production we find that clusters are becoming focused on specific industries and stages of production. This paper analyzes two peripheral western countries, Finland and Israel, which saw success in their ICT clusters and wanted to duplicate this success and build on their knowledge in the life science industry to create biotechnology clusters. Though these countries are similar on many levels, they chose different strategies regarding their respective biotechnology industries. Finland's, and more specifically the Helsinki region, is an integrated biotechnology cluster that does the entire production cycle, while Israel's cluster located in and around Rehovot focuses on biotechnology R&D. This article reviews the development and sustainability of the biotechnology clusters in the two countries and the advantages and disadvantages of each.

The Region has been maintaining its central position as a central social and economic unit in the economy (Jaffe, Trajtenberg et al. 1993; Saxenian 1994; Storper 1997a). In particular, regions learned to use their location, environment, and resources to achieve industry competitiveness in a variety of ways. Some rely on sources of knowledge (Biotechnology, Massachusetts), some rely on social networks (Biotechnology in Cambridge, UK), and others, mainly in developing countries, rely on their labor force and competitive costs (China and India). Studies show that clusters are considered highly important for local economic development (Cooke 2002), and we increasingly find many versions of cluster structures

(Martin and Sunley 2003). More and more, we find peripheral states and regions focusing their cluster strategies around the fragmentation of production. In particular, industries in these locations focus on a particular stage of production. Examples are abound, such as the focus solely on R&D in the Israeli ICT industry or on manufacturing biotechnology in North Carolina, USA (Goodman 2007; North Carolina Biotechnology Center 2007). This paper examines the biotechnology industry in Israel and Finland to reveal how these two countries in the periphery of the western world choose to compete in the global market. Specifically, it focuses on the fragmentation of production in these locations and whether these stage-focused clusters are sustainable.

A recent phenomenon finds clusters in which companies share a similar business strategy[1], where firms focus on different stages of production. This process is parallel to the geographical fragmentation of production and other business functions, a phenomenon also referred to as the second unbundling (Baldwin, 2006). The impact of this global decomposition leads clusters to concentrate on specific production stages. A newer phenomenon is clusters that narrow their output from inception and focus on one stage of production in one specific industry.

This new phenomenon of successful clusters focusing on one stage of production, such as biomanufacturing in North Carolina and Ireland, and our knowledge that biotechnology is a knowledge based industry, which requires a larger number of factors in order to succeed, (Porter 1990; Martin and Sunley 2003) raises questions: can peripheral biotechnology

[1] In this paper we refer to business strategy as the firm's choice to concentrate on a particular stage/s of production – research, development, marketing, manufacturing, etc.

clusters choose to concentrate on one stage of production and still be sustainable? Or can peripheral biotechnology clusters only succeed by completing the entire business cycle?[2] These questions are vital on both the theoretical and policy levels. On the theoretical level, current changes in the international economic system require us to re-conceptualize industrial clusters in order to understand their composition and whether we should continue to rely on their ability to generate economic growth. On the policy level, if industrial clusters have changed their role and their ability to contribute to local economies, changes in policy must follow to assure that we maximize our return from public investments.

A deeper analysis of an emerging peripheral cluster allows us to better understand the advantages and disadvantages of focusing on a specific stage of production or product. This paper examines two innovation-based clusters, the biotechnology industry in Rehovot, Israel and Helsinki, Finland. These industrial districts consist of companies that are either devoted to early-stage R&D (Israel), or choose to conduct every part of the product development (Finland), many of which are spun out of university research. The majority of companies is small and employs the same business model of focusing on one or two products. Utilizing a multi-method study that includes both quantitative and qualitative research, this study investigates whether a cluster of young research companies can become the basis of industrial growth and bring economic sustainability to a region. The study includes a series of in-depth interviews and site visits, archival and statistical data.

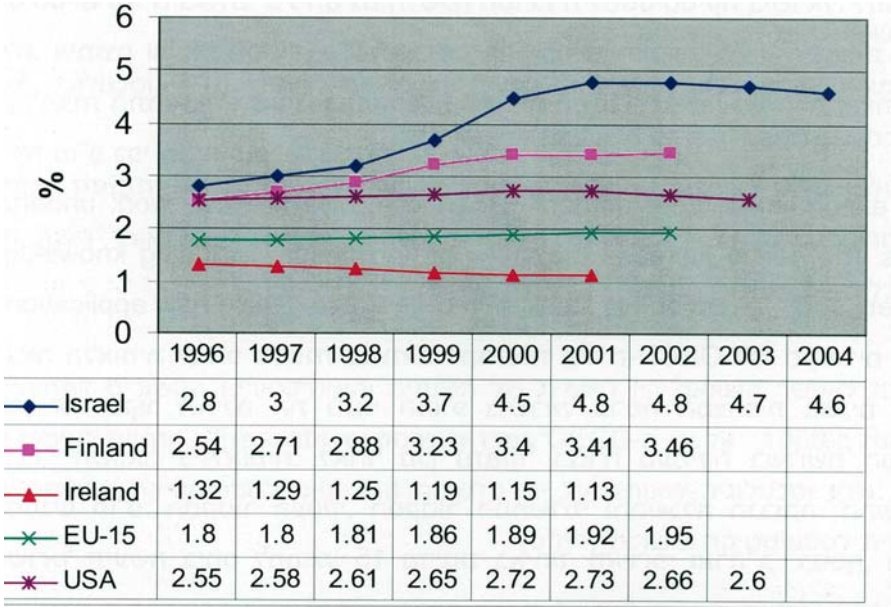
[2] Considering that all other factors do exist – related and supporting industry, local customers, etc.

Case Selection

In order to understand whether the production-stage focused high-tech clusters are sustainable, this study examines two promising biotechnology clusters: Helsinki, Finland and Rehovot, Israel. Both of these clusters locate in the periphery: while Finland is part of the European Union, its northern location, small market size, income tax regime as well as its unique language and culture prevent it from having a pull for MNC's and talented international scientists and employees. Rehovot suffers from similar issues due to security, language, and location reasons. However, despite these issues, both countries are among the leaders in global competitiveness (e.g. WEF, 2009) and have successful ICT clusters.

These two clusters have similar characteristics. There are about 40 biotechnology firms in Helsinki vs 30 in Rehovot. The clusters operate in Israel and Finland, which lead the OECD countries with comparatively high levels of R&D investments per GDP. We find that Israel invests 4.5% and Finland 3.55% respectively (Figure 1).

Figure 1 R&D investments per GDP

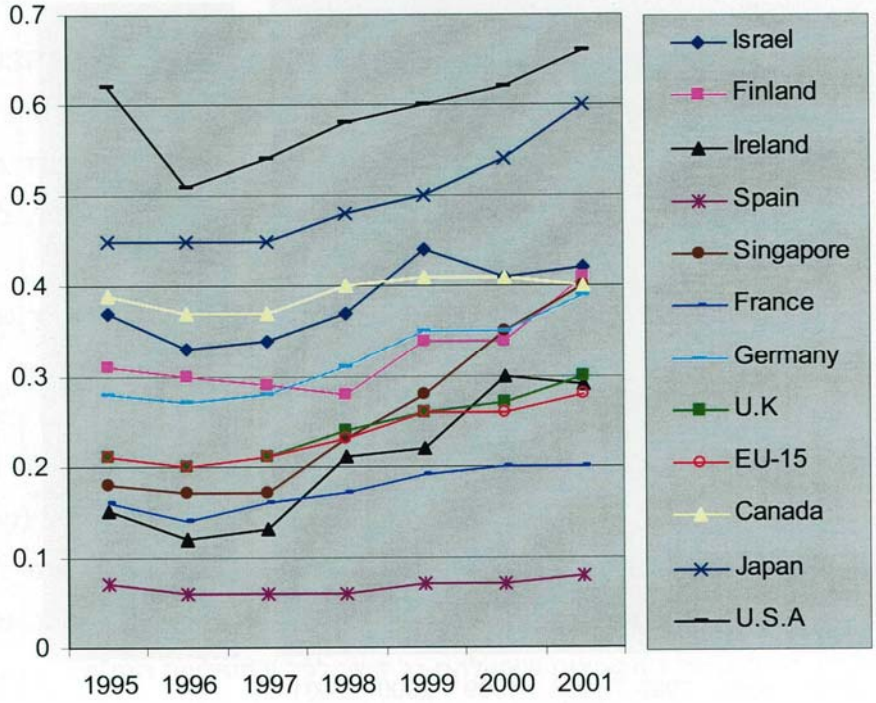


	1996	1997	1998	1999	2000	2001	2002	2003	2004
Israel	2.8	3	3.2	3.7	4.5	4.8	4.8	4.7	4.6
Finland	2.54	2.71	2.88	3.23	3.4	3.41	3.46		
Ireland	1.32	1.29	1.25	1.19	1.15	1.13			
EU-15	1.8	1.8	1.81	1.86	1.89	1.92	1.95		
USA	2.55	2.58	2.61	2.65	2.72	2.73	2.66	2.6	

Source: (OECD 2004; Getz, Mansour et al. 2005)

When we examine patent applications, we find that in 2001 Israel and Finland applied for about 0.4 patents at the USPTO for every $1M invested in R&D, third place after the USA and Japan. If we consider the size and population of the two countries, this indicator shows the strength of these countries as a potential location for high technology and knowledge intensive hubs.

Figure 2 Patent applications at the USPTS per $1M



Source: (OECD 2004; Getz, Mansour et al. 2005)

Moreover, when we examine the existing knowledge base in scientific fields related to biotechnology, we find that Israel and Finland are not just comparable but both countries are competing well on an international level. For example: in Biology and Biochemistry, Israel publishes 7.28% of its total publications while Finland publishes 8.73%. This can be contrasted against the world average of 7.57% in these fields. Similarly, in Molecular Biology & Genetics Israel publishes 3.24% of its total publications compared to 2.94% in Finland and 3.30% for the world. When we compare the number of publications per capita we find Israel

with 112.82%, Finland with 124.38%, and the USA with 65.37% in the field of Biology & Biochemistry for 1M people on average between 1999-2003 (Getz, Mansour et al. 2005).

In this paper, quantitative methods provided the foundation of the research with information on the industry's growth rate, emergence of new companies, and their specialization level. The dynamic of the industry was investigated using qualitative methods through field research including site visits and interviews. Twenty open-ended interviews were conducted in the life science industry in Israel and eleven interviews were conducted in Finland. Interviewees included company executives, researchers, government representatives, VC's, and technology transfer offices.

Industrial Clusters

Scholars define industrial clusters as a geographical concentration of related firms and organizations from the same industry (Porter 1990; Saxenian 1994; Feldman 1999; Braunerhjelm and Feldman 2006). These concentrations include related industries which may collaborate as well as compete with each other (Porter 1990; Lazonick 1993; Casper 2007). One of the major factors identified as the source of cluster success is the combination of a large number of companies in various sizes working along all stages of production (Piore and Sabel 1984; Saxenian 1994; Markusen 1996).

Cluster development and sustainability are based on many factors including the availability of resources and markets. According to Porter (1990) domestic market demand for new and improved products sets off a chain of demand in the cluster. The demand from the market to improve the product translates into demand from the company to its suppliers, with the

outcome being a dynamic industrial district that continuously improves and innovates. Successful clusters have shown particular strength with knowledge transfer through the networking of individuals and firms within the cluster, many of them working at different stages of production. Formal meetings arranged through industrial associations or scientific advisory boards as well as informal meetings at local coffee shops and restaurants contribute to knowledge exchanges and, thus, cluster development (Florida 1995; Keeble and Wilkinson 2000; Breznitz and Anderson 2006). Moreover, studies have shown that the social networks of firms within clusters and between clusters are crucial for economic growth and development (Casper and Murray 2003; Owen-Smith and Powell 2004; Kenney and Patton 2005; Casper 2007).

Firm collaboration and competition are also an important factor in cluster development. The reliance on different suppliers, human resources from competing companies or local universities, as well as customers promotes the growth of a cluster (Kenney 1986; Porter 1990; Lazonick 1993; Cooke 2001; Cooke 2002; Coriat and Weinstein 2002).

In highly sophisticated industries there is a need for more than one resource to achieve higher success; usually a combination of several parts is the key for the success of such an industry. This is because they need constant improvement and innovation, which can be achieved by sophisticated homebuyers and suppliers who innovate rapidly by themselves. According to Porter (1990), firms need a global approach to strategy, i.e. firms need to locate activities in other places in the world, in order for them to have a competitive edge over other firms (Porter 1990).

In sum, there are many ways to achieve economic growth and sustainability. Not all the cluster characteristics listed above are required. However, studies have shown that at least a combination of some of these factors will lead to economic growth. The question we would like to focus on in this paper is whether peripheral biotechnology clusters can choose to concentrate on a single stage of production without compromising sustainability. Implicitly we want to further inquire whether, alternatively, the only way for peripheral biotechnology clusters to succeed lies in managing the entire business cycle.[3]

The Biotechnology Industry in Finland

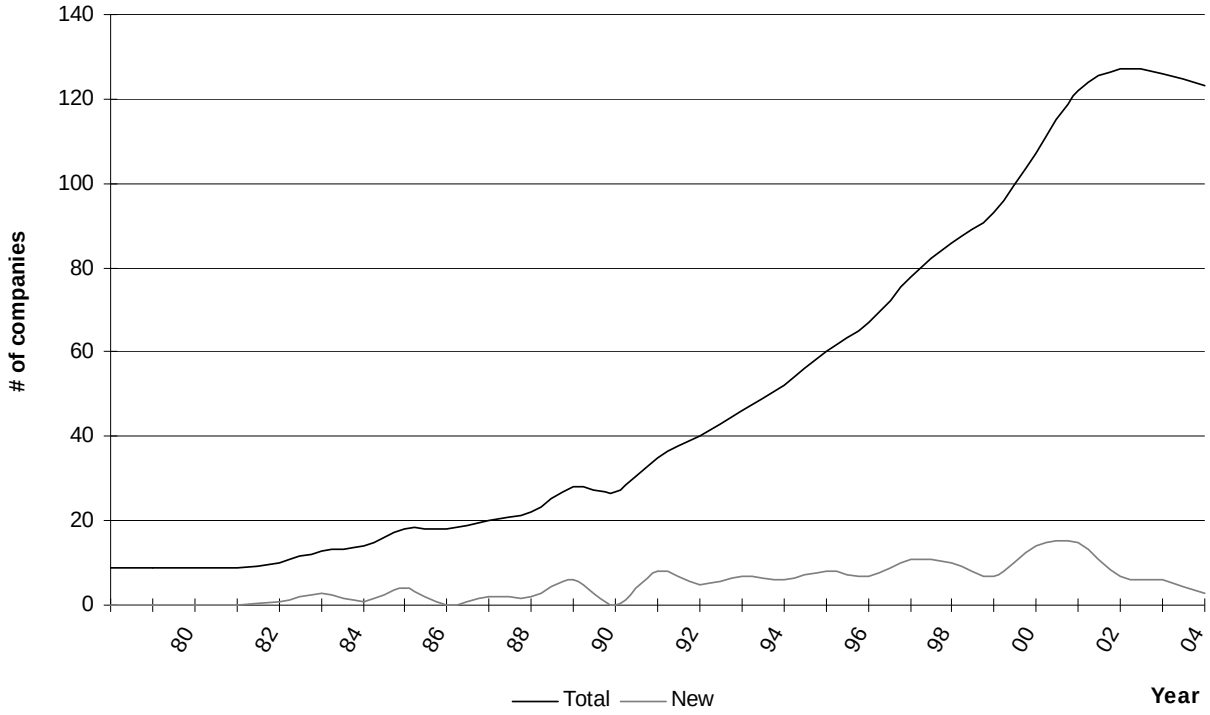
The number of biotechnology companies in Finland grew sharply until the beginning of the millennium. At the end of 2004, there were about 120 biotechnology companies in Finland, with no significant change from year 2001.[4]Figure 3 reveals the slowdown in the foundation activity of companies around the turn of the millennium coinciding with the burst of the ICT-bubble. Despite the stagnation in growth, the number of the Finnish companies constitutes almost seven percent of the entire population of biotechnology companies in the European

[3] Considering that all other factors do exist – related and supporting industry, local customers, etc.

[4] Most recent data on the Finnish biotechnology industry comprehensive enough to provide an in-depth cross-section for the purposes of this paper's descriptive part dates back to 2004 when the Research Institute of the Finnish economy implemented its latest biotechnology industry survey. Due to a lack of systematic statistical monitoring of the industry in Finland only scattered data is available on more recent periods. In the following depiction of the industry we therefore revert to the 2004 ETLA Survey data. The empirical evidence of the survey is based on data collected via a telephone questionnaire in the late autumn 2004. It is supplemented by financial statement data from The National Board of Patents and Registration (NBPR). All data describing the state of companies represent 2003 figures. In some individual cases financial statement data from NBPR originates from periods prior to 2003 as 2003 statements were not submitted to NBPR by all sample companies. However, no data from NBPR is used that originates from periods prior to the year 2001.

Union (EU). This is a considerable amount, if we contrast it to Finland's population of 5 million, which is about 1.3 percent of the EU population in 2004. Thus, Finland can be considered a biotechnology intensive country.

Figure 3 Distribution of Finnish biotechnology companies by year of foundation



Source: (Luukkonen 2005).

However, Finnish companies are limited in their size and ability to exploit their market potential: about 110 of the Finnish companies were small or medium-sized (SMEs). When we examine the regional agglomerations of the industry we find that the Helsinki region is specialized in diagnostics, Turku in food and feed, Tampere in biomaterials and Oulu in providing R&D services to other companies.

In examining the financial capabilities, we find that Finnish biotechnology SMEs obtained 233 m€ in equity. The largest owner group is private venture capital companies with a 27

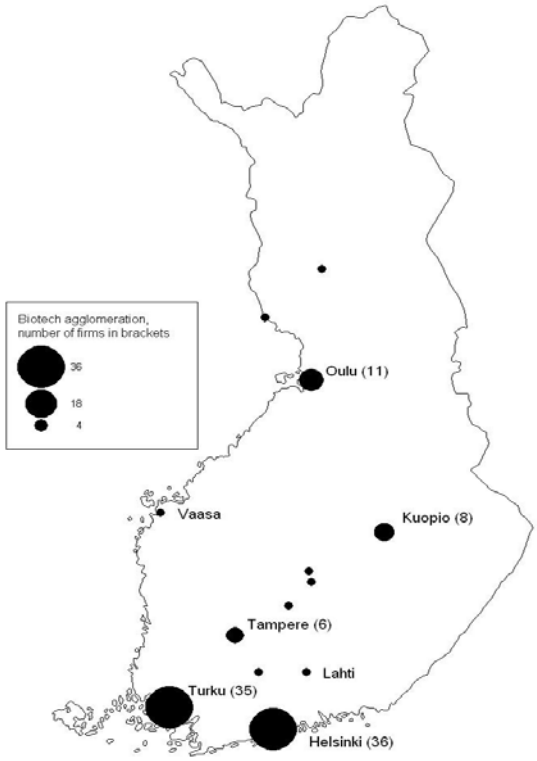
% share of the companies' total equity. Companies' personnel and external individuals form the second largest owner group with a 24 % ownership share. State venture capital institutions also form a significant group of players in the field. The most active player has recently been Sitra, the Finnish National Fund for Research and Development, the ownership share of which is almost 15 % of the biotechnology SMEs' equity. Other companies own over 17 % of the industry.

However, biotechnology SMEs also rely heavily on capital loans, comprising 25.1 % (90 m€) of total funding. Therefore, they are an important backbone, vital for company survival. Capital loans are more expensive than conventional debt but do not have to be paid back in the absence of profits. Capital loans are therefore more suitable for companies operating in high-risk investment projects such as the biotechnology sector. The largest single capital loan provider is Tekes, the Finnish Funding Agency for Technology and Innovation. Cumulatively, Tekes has provided biotechnology SMEs with nearly 60 million euros in terms of capital loans. Tekes typically invests in research-intensive projects, whereas other companies invest in projects closer to market. The relative importance of capital loans over debt is noticeable, as biotechnology SMEs rely on debt only for 10.3 % of their funding.

The Helsinki Cluster

The Finish biotechnology industry is agglomerated around several geographically dispersed locations. These are the Helsinki, Turku, Tampere, Kuopio and Oulu regions, of which the Helsinki and Turku regions alone account for two thirds of the industry's 120 companies. All five regions boast universities active in biotechnological research.

Figure 4 Geographical Distribution of Finnish Biotechnology



Source: Tahvanainen and Hermans (2008)

The Helsinki region is currently the single biggest hub of small and medium sized biotechnology companies with close to 35 % of the population. Being strong especially in the fields of diagnostics and drug development, the region generated the majority (~ 60%) of revenues of the entire biotechnology SME industry in 2003 with close to 200m€. The Helsinki cluster features specific cluster characteristics including firm agglomeration, resources in the form of knowledge, experience, public and private capital as well as a client base and competition related dynamics.

Helsinki constitutes a central hub in the most extensive R&D collaboration network of the industry enabling the absorption and, more importantly from a regional perspective, the dissemination of knowledge to a diversity of partners. The region is home to several

world-known universities and research institutes. For instance, in 2008 University of Helsinki was ranked 91st overall in the world according to The Times Higher Education index and 68th according to the Jiao Tong ranking. The university boasts several world-class units and departments in the field of biotechnology such as the Institute of Biotechnology in the university's Viikki Biocenter and the Neuroscience Center. Furthermore, under the university's umbrella organization called Biocentrum, 600 people are conducting research in molecular biology, molecular medicine and biotechnology.

The Helsinki University of Technology (HUT) is another locale of research on biotechnology in the Helsinki region. It is ranked 210th in the overall 2009 rankings according to QS Top Universities. Furthermore, the biotechnology focused branch of the Technical Research Center of Finland (VTT) located in the vicinity of HUT conducts applied research on a variety of issues emphasizing the effective use of renewable natural resources in the production of industrial chemicals, biofuels and materials using enzyme biotools and cell factories. VTT, being the biggest multi-technological applied research organization in Northern Europe and nominated by the Academy of Finland, hosts the Centre of Excellence in White Biotechnology – Green Chemistry. Finally, Biomedicum Helsinki, the center for medical research and training, offers facilities for over 1,700 researchers, graduate students, and support staff of the Helsinki University Central Hospital, University of Helsinki, the National Public Health Institute, and the Folkhälsan Research Center. It also provides premises for research-based companies in an effort to promote cooperation between academic and commercial entities.

Until January 1st 2007, Finish universities did not own rights to faculty's research and were owned either by the inventor or the corporate sponsor. As a result, as evident in our sample, the source of inventions in the Finish biotechnology cluster is wide. Some licensed the technology from the inventor either directly or through the university, some have developed their own inventions, and many have licensed technologies from other companies. Thus, the academic strength of the Finish universities cannot be directly linked to these institutions.

Fifty percent of interviewed firms have licensed technology and established long term relationships with local academic institutions.

The relatively mature and viable state of the industry in the Helsinki region is strongly reflected in the equity base of the companies. Helsinki-based companies have been able to attract and create (via revenues) almost 50 % of all privately held equity and capital loans of the industry, which in part is rooted in the confidence of investors in the future and performance of companies active in the region. Corporate investors, in particular, have been eager to finance activities in the Helsinki region, as the area also generates close to 60 % of the total revenues of the Finnish small and medium sized biotechnology industry. Export markets clearly provide the greater bulk of revenues. By 2003, the export share of total sales in the industry approached 80 % (Luukkonen, Tahvanainen and Hermans 2004). Including the big biotechnology companies, such as Orion, renders the exports share smaller down to roughly 40 %. According to Luukkonen, Tahvanainen and Hermans (2004) EU countries represent the largest single export market with over 65 % of Finnish biotechnology SMEs exporting goods and services into the region. 35 % of companies are reported to have

exported to the US and another 26 % to Asia. Looking at the geography of domestic sales we find the companies in our sample are similarly concentrated: the capital region around Helsinki represents a vital market generating somewhere between 40 and 50 % of sales of the sample, with the Turku region, located in the west, trailing with roughly 25 to 30 %. Pharmaceuticals and diagnostics represent the major customer sectors of the industry (Luukkonen, Tahvanainen and Hermans 2004).

That being said, Helsinki lacks several important cluster characteristics such as social networks, experienced employees, and basic intra-regional proximity, which generally promote knowledge flows. Examining social networks and geographical proximity, firms in the Helsinki cluster are highly isolated. The biotechnology firms are dispersed in the capital region between several locations, mostly in the cities of Helsinki, Espoo, Vantaa and Kauniainen. Moreover, with the exception of one firm interviewed for this study, companies did not locate within a science park and did not see the importance of geographical proximity to each other or other sources of knowledge. Since most firms are spinoffs either from universities or from big industry, they are in niche areas. Consequently, they believe that cooperation with each other is unnecessary or not relevant. The location of firms and their loose connections to research institutes and universities allows for minimal knowledge flows and cooperation between firms as well as between firms and research institutes. Corroborating these findings, none of the respondents regarded their respective companies as being embedded in a cluster of other actors:

> *I do not feel that we are in a cluster. We are not talking to other firms. It is important to be aware of who is out there, but there is nothing to share. If we need something we know who to contact.*

> *There is no knowledge transfer. We belong to the biotech association and only attend TEKES and SITRA seminars. I don't see an advantage in the actual location of the company, but we did get some help from the university.*
>
> *Our managing director is very old fashioned and does not want to cooperate with other companies. The research group does collaborate and there is an advantage. If you don't compete <directly> with other firms then they are quite open. The location does not matter.*

Aggravating the network problem further, eighty percent of interviewed firms did not have a Scientific Advisory Board (SAB) and did not see the need to have one for a number of reasons. For instance, interviewees claimed that their company has a rather "specific knowledge base" that is not available elsewhere and, hence, finding experts endowed with the relevant expertise was considered difficult. Furthermore, SABs were argued to be too rigid and burdensome to exploit when compared to potential benefits. It was argued that, for the SAB to be effective, considerable effort must be invested not only to related administrative tasks, such as coordinating international SAB-meetings, but even more so to keeping the SAB up-to-date about the status-quo of R&D.

In the stead of SABs, preference is given to informal networks of expertise comprising of leading professionals and academics in the respective fields in Finland and abroad. These informal networks are maintained and expanded through conferences, conventions, personal and professional ties etc. Furthermore, many of the Finnish companies interviewed for this study are endued with a "hybrid" board of directors that often comprise to a large extent of scientific experts in fields relevant to the business of the company. These boards usually consist of Finns exclusively. As a third alternative to a formal SAB, some companies revert to the use of hired consultants.

> *I think SABs are for show. People from Germany, Sweden – its marketing.*
>
> *We do not have a Scientific Advisory Board. We had a consultant. Now we do not. We use consultants on demand. Most are from Finland and we do not need to pay them.*
>
> *We have consultants for specific projects. Most of them are from Finland.*

When examining employees and management experience in the cluster, we find that most employees in R&D have been recruited directly from universities, and the companies interviewed have expressed their satisfaction with the level of knowledge these employees have. However, skilled management with relevant industry experience is difficult to recruit and has been identified as one of the major weaknesses and threats of the Finnish biotech industry (Tahvanainen 2004). The lack of experts with a suitable background to manage biotechnology is mostly attributable to the lack of Finish pharmaceutical firms. Unlike Sweden that had firms such as AstraZeneca, historically, Finland has never had a well developed industry in the relevant industrial sectors of biotechnology. Hermans and Kulvik (2006) have hence proposed to utilize management expertise that has accumulated in successful Finnish ICT companies to infuse commercial skills into biotechnology (Hermans and Kulvik 2006). Right now, however, the culture and the system in Finland does not support risk taking for experts to switch from well-paid, high-ranking jobs in big corporations to small and risky growth businesses.

Finally, it is critical to discuss the strategy companies have chosen to pursue regarding their position in the value chain. Companies of the Helsinki biotechnology cluster differ strongly from their Israeli counterparts in this respect. The clear majority of interviewees attested to an integrated strategy according to which a company carries out every

function of the value chain – R&D, production and marketing – in-house. Only single companies were committed to out-licensing or sell-out strategies. The most frequent argument in defense of the integration of functions emphasizes the unsurpassed ability to control the quality and content of the entire development, production and sales process and, thereby, to guarantee an uncompromised outcome. Moreover, many companies see the importance of conducting the entire process as a national issue for industry growth and sustainability.

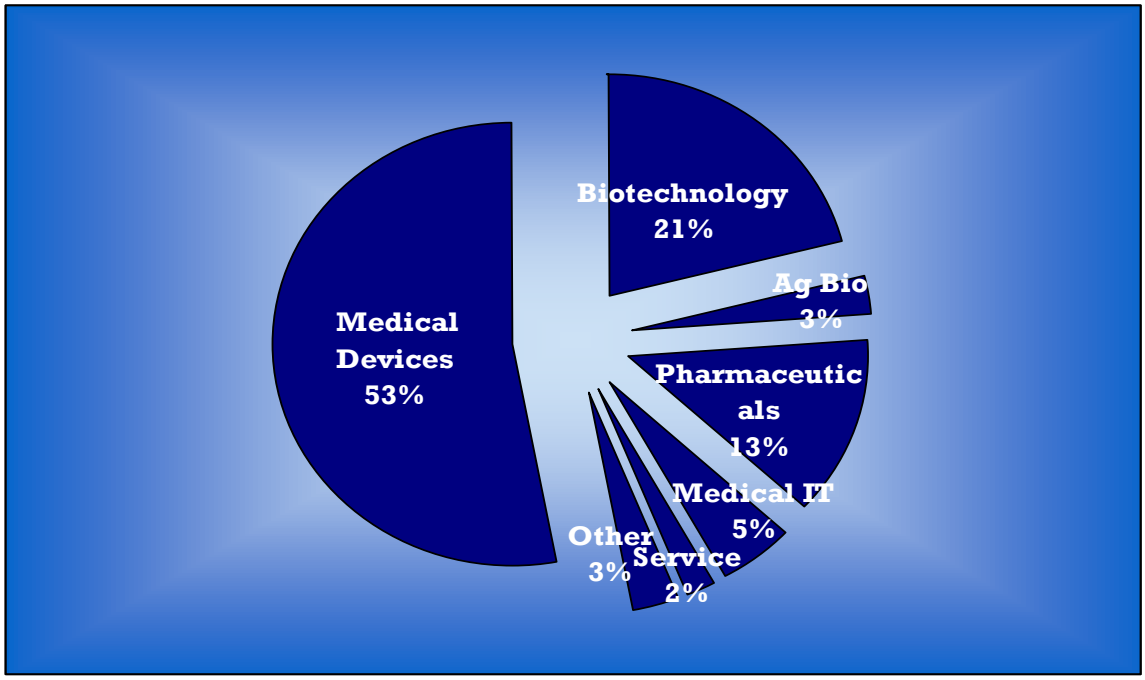
> *It is typical for Finnish companies that their strategy is to do everything. It is like companies in the 1980s. They still think they can have a block buster like Orion. But Orion <itself> has changed from that strategy.*

Some drawbacks were identified as well. For instance, fully integrated companies were regarded as rather inflexible in the face of possible market price fluctuations because they could not be passed on in the value chain. In these circumstances integrated companies represent, by definition, "the end of the line". Full integration was further argued to be very resource-intensive. Given the relatively small size of Finnish biotechnology companies, resources are scarce, and their allocation necessarily implies making trade-offs. Marketing in particular is one of the functions that tend to suffer from sub-optimal resourcing.

The Biotechnology Industry in Israel

According to the Israeli Life Science Industry Association (ILSI) there are 500 life science companies in Israel. This includes 285 Medical device, 129 biotechnology, 74 pharmaceuticals, and 21 Agrobiotech companies. About 22% of these companies were established before 1995, with Teva, the oldest Israeli Pharmaceutical company, established in 1901.

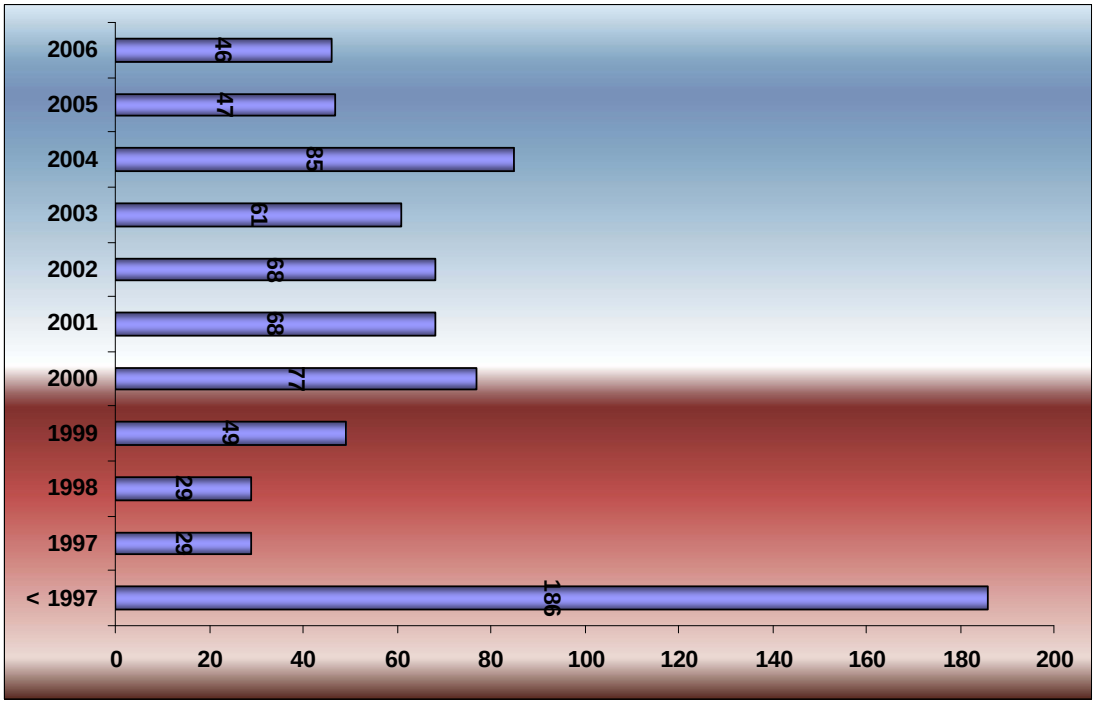
Figure 5 Israel Life science industry by sector



Source: ILSI, 2007.

The industry is ranked eighth in the world by the number of companies (Ernst & Young 2005). However, the industry is very young as 45% of the companies were established in the last seven years.

Figure 6 Israel's life science industry growth by year



Source: ILSI, 2007.

Israel is one of the world leaders in life sciences research. Its universities are ranked among some of the world's top universities, particularly in the sciences (the Hebrew University and the Technion), and in Biological sciences (the Hebrew University and Tel Aviv University). The academic capability in life sciences is reflected in the amount of life science companies. Many were founded by academics and located in close proximity to academic institutes (The Times Higher Education 2004). Similarly to other biotechnology firms and especially biotechnology spinouts, these firms are small to medium sized and R&D intensive (The Times Higher Education 2004).

Funding life science companies, especially at the seed stage, is difficult all around the world. According to the 2005 Ernest & Young report, the venture capital industry had moved from funding biotechnology companies at their early stage in 2000 to funding mainly later stage companies in 2004 (Ernst & Young 2005). The Israeli market did not escape this trend. In general the Israeli VC industry does not invest in the early stage companies, and as a result the firms suffer from funding shortage. This is especially evident at two stages of the production cycle: at the early stage, moving the invention from an academic setting to the industry, and prior to the proof-of-concept stage, before you can present a product to investors. Much of the funding of early stage life science companies originates from the Office of the Chief Scientist (OCS) in the Ministry of Trade and Industry. The Chief Scientist's budget for 2005 was NIS 1.2 Billion (approx. US $275 million), compared with NIS 1.3 Billion in 2004. This is the continuation of a declining trend: the budget has been steadily decreasing from NIS 1.6 Billion in 2003 and NIS 1.8 Billion in 2002. In comparison, the US Federal agencies spent $106.5 billion in support for R&D in FY 2005.

The Rehovot Cluster

The Rehovot Cluster is one of the largest biotechnology clusters in Israel representing 23% of companies in Israel. It is situated in the center of Israel, in the town of Rehovot, a twenty minutes drive from Tel-Aviv. The firms in this cluster, as in the rest of Israel, attempt to find a solution for their peripheral location and focus specifically on the research stage. 23% of firms in this location engage in the bioinformatics, drug discovery, as well as genomics and proteomics sectors of biotechnology. Another 19% develop diagnostic kits and 19% engage in tissue engineering. This concentration of biotechnology firms bears many cluster characteristics, such as qualified employees, research institutes, social networks, and suppliers.

This cluster has two world-known research institutes, the Weitzmann Institute and the Hebrew University's Department of Agriculture. These institutes provide cluster resources in the form of technology, employees, and are the bases for local social networks. Hence, employees share common backgrounds allowing information sharing and equipment as needed. Numerous biotechnology firm founders are graduates of one of the departments or of the former incubator at Weizmann. Sixty percent of the interviewed firms spun out from a university or a research institute. Thus, many still hold close connections with their former departments and peers at Weitzmann and the Hebrew University. These connections allow companies to request assistance with equipment, consult with faculty, and use the universities' libraries. Some of these networks connections are official but most rely on the generosity and curiosity of the faculty.

> *People are moving between companies. You stay friends (from academia) and you transfer knowledge and help each other. There is knowledge transfer with the academic departments but it's informal, between people, not necessarily between managements.*

Thus, faculty interest in the company, both financially and academically, leads to provision of services for young start-ups. Moreover, ninety percent of firms in this study are located within a science park. The implicit firm proximity allows for knowledge transfer, both formal and informal. With respect to current challenges regarding a viable business strategy and the projected development path of the cluster the Israeli firms emphasize the necessity to expand social networks. Hence, many have SABs with international scholars from around the world. Specifically, we found that 50% of firms have a SAB comprising internationally recognized researchers. Through this process the firms hope to reach international customers as well as potential buyers for their firms.

Another cluster characteristic is the availability of a variety of industry suppliers and some Contract Research Organizations (CROs). The large number of biotechnology firms in this region allows and attracts suppliers to locate in the region to provide daily services. There are nine firms within the cluster and another ten firms in Tel-Aviv[5] that are categorized as service providers for the industry.

On the other hand, the Rehovot cluster is missing some cluster advantages and, more importantly, it is missing many of the factors that we listed as important to cluster success and sustainability. While Israel's scientists are ranked among the best in the world in terms of academic achievements, the industry lacks employees with industry experience; especially in the areas of management, development, and manufacturing. Partly, this is due to the development stage of the entire biotechnology industry in Israel. Only 12% of companies are at the clinical stage, while the majority of companies is at the seed stage (Israel Life Science

[5] The distance between the cluster and Tel-Aviv is about 20 minutes drive.

Industry 2007). There are only a few companies in Israel that have succeeded in getting a product from the research stage to production, such as Teva, BTG, and XTL, of which only XTL locates in the cluster. Moreover, there is hardly a representation of MNC's in the life science industry in Israel.

The lack of mature companies creates two major hurdles for the life science industry in Israel. First, there are not enough companies that can transfer their knowledge in later stages of production to younger companies in the country, and contribute to the development of the industry. Secondly, a shortage of mature companies leads to a shortage of skilled employees at all levels of the value chain. Both these issues have a direct impact on the ability of the industry to develop further (Porter 1990; Casper and Karmanos 2003; Breznitz and Anderson 2006). In order to solve some of the problems of non-experienced employees, companies in this cluster choose to collaborate with international companies or build their development stages in other countries, leaving only the research phase in Israel.

Knowledge transfer in the Rehovot cluster, achieved through social networks in other clusters, is based on direct and informal relations with either the faculty or alumni of the Weitzmann Institute or the Hebrew University's Department of Agriculture. There are minimal formal relations between companies and between companies and the academic institutes. Mostly, connections with the academic institutes are with a researcher or faculty with whom the founder or one of the company's researchers has past connections. Thus, there are hardly any formal connections, contract based, between companies and the academic institutions. As a result, the social networks in this cluster are linear and based on single connections.

In order to circumvent the above difficulties and survive for the time being, many companies focus on "the one molecule company" strategy, i.e. focusing on the development of a single product based on a specific molecule with a strategy to sell the molecule at the proof-of-concept stage. These companies do not plan on getting to the development or manufacturing stages with future products being sold directly to multinational companies overseas, where they would create new jobs in production and marketing instead of in Israel.

Discussion

While analyzing the results of this study we realized that comparing the Israeli and Finnish biotechnology industry is difficult. The two locations share similarities, however, they also have many differences. The Helsinki biotechnology cluster is roughly a decade older than the Israeli one with the respective companies having been established in the early 1990s (Hermans and Luukkonen 2002). However, only a small proportion of companies have sales and revenues.[6] Importantly, the majority of companies in the Helsinki cluster conduct the entire production cycle including marketing and sales while in Rehovot, companies focus on R&D with the hope of getting to the proof-of-concept stage and making an exit thereafter. Fitting the industry location in Europe, the biggest market of the Finnish biotechnology industry is the European Union while the Israeli industry believes in its future in the USA. Both clusters focus on diagnostics which has shorter development and approval cycles than therapeutics.

Interestingly, the Finish Biotechnology industry, as reflected in the Helsinki biotechnology district, is not as "clustered" as we would like to think. Social networks are minimal and most

[6] According to a survey from 2004 only 25% of Finnish Biotechnology firms show revenues compare to 31% of Israeli firms noting that the Israeli data is from 2008.

companies that are physically located in different science parks have little to no connections with each other. Mostly, these companies focus their efforts on relationships with their suppliers and customers. Moreover, many of the companies do not have SABs as they are not convinced of their added value. As a result, the cluster shows minimal knowledge flows. The Finnish language, unfavorable income tax regimes and the isolated Northern location pose additional barriers for companies' recruitment efforts; hence most firms employ mainly Finns curtailing the access to the international knowledge pool further. In addition, the majority of employees are recruited directly from the university lacking industrial business experience.

Finland has a limited number of venture capital firms, and as such the industry is heavily dependent on public funding from SITRA and TEKES as well as private funding from company founders and private angels. While, on the surface, this does not seem to pose a problem, the relatively patient and enduring nature of such capital might well provide a rationale for why most of these companies, after up to twenty years in the business, still do not show significant revenues or growth rates.

This study finds that the business approach of the Finnish firms to conduct the entire product cycle from development to marketing and sales does not currently present a problem for the development of the industry in itself. As long as the industry focuses on the development of diagnostics and medical devices – both of which require far smaller down-stream assets than drug development, for instance – as well as the European Union as its primary market, the industry shows promises to succeed. The problem we identified in this study lies in the fact that the biotechnology industry in Helsinki does not function as a cluster, and, hence, vital information and knowledge transfer mechanisms are jeopardized.

Existing studies both in the UK and the US have shown that social networks are vital for the development and sustainability of a cluster (Owen-Smith and Powell 2004; Myint, Vyakarnam et al. 2005; Casper 2007).

Aspiring to imitate the success of the Israeli ICT industry and understanding the difficulties of its location and market in conducting the entire production cycle, the biotechnology industry in Israel chose to focus on R&D, an entirely different approach to the Helsinki region. Many of these firms are small and focus on one or two products, and due to the lack of a mature pharmaceutical industry in Israel and the peripheral location of the country, there is a lack of experienced employees in the areas of industrial development and manufacturing. As a result, the focus on R&D for the Israeli biotechnology industry may be proven wrong. Most companies employ graduates and have direct relationships with two academic institutes at the Rehovot cluster, the Weitzman Institute and the Hebrew University Agriculture department. While companies have strong ties with these two entities, they have limited connections with other companies. This lack of business to business relationships reduces knowledge transfer and creates a limited social network. All of these issues reveal other potential issues in the attempt of Israel to create a sustainable biotechnology clusters. Adding to these challenges, companies in the Rehovot cluster show signs of stagnation due to severe funding deprivation and limited recruitment opportunities.

Conclusion

The main focus of this article was to understand whether peripheral clusters that choose to focus on a particular business strategy relating to stages of production have the same potential to succeed as centrally located clusters. Companies in both Helsinki and Israel

made a realistic decision and chose to focus on specific sectors and stages of production that suit their technological and resource base capabilities. Helsinki, Finland, chose to focus on Diagnostics due to costs, lack of venture capital, and the speed of product development. These companies also chose to conduct the entire product cycle due to its location in close proximity to the EU markets. Rehovot, Israel, chose to focus on R&D in diagnostics due to issues related to funding and security.

On the surface it seems that both locations made reasonable choices considering their academic strength in the field and their peripheral location. However, the push to create biotechnology firms in Finland without the professional back-up of venture capital and professional human resources created an agglomeration of firms that currently do not and, in the future, may not be able to achieve their goal of developing a product from start to end. It is not as much due to its peripheral location, but more so because basic cluster characteristics are lacking in Helsinki. Given the active production of related literature and constant studies regarding the performance of the national innovation system by the Finnish government, it is surprising to see the lack of focus on establishing infrastructure facilitating the development of necessary supporting industries such as the VC industry, on the one hand, and the transfer of professionals from established industries to emergent ones such as biotechnology, on the other. In Israel the case is similar. There is a lack of basic industry development factors that are missing. In both cases, and in view of our findings, it is questionable whether the industry may be sustainable in its current form. Further studies should be done on other clusters in both countries as well as in other countries to evaluate whether it is possible for a peripherally located industry to focus on a specific product cycle strategy.

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