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Are One Track Pony Clusters Sustainable?
The Israeli Biotechnology Industry

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ARE ONE TRACK PONY CLUSTERS SUSTAINABLE?

THE ISRAELI BIOTECHNOLOGY INDUSTRY

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ABSTRACT

Industrial clusters are deemed to be critical for industrial development and local economic growth. These concentrations include related industries which may collaborate as well as compete with each other. One of the factors behind the success of clusters is the combination of a large number of companies, of various sizes, working along many stages of production. The availability of different suppliers, human resources from competing companies or local universities as well as customers promotes the growth of a cluster. However, in the last two decades, many industrial districts have become more specialized in particular stages of production. Considering the above factors for cluster success, important questions rise: what is the danger of specialization? Exactly how narrow a stage of production is too narrow for cluster sustainability? This paper examines an innovation based cluster, the biotechnology industry in Rehovot, Israel.[i] This industrial district, which is the largest biotechnology cluster in Israel, is based on innovative companies, many spun out of university research. This paper used both quantitative and qualitative research methods. The dynamic of the industry was investigated using qualitative methods through field research including site visits and interviews. This paper argues that while innovation can be the base of an industry, and R&D is the base of several successful industrial districts around the world, it may not be sufficient for local economic growth and sustainability.

[i] The city of Rehovot locates inland, half an hour from Tel Aviv. In the city we can find the Weitzman Institute and the Hebrew University's agriculture department. In this paper the Rehovot cluster will include also the firms located in "Kiryat Weizmann", which was built in Nes Tziona, Rehovot's smaller neighbour. The two clusters are closely located, and are less than five minutes apart.

ARE ONE TRACK PONY CLUSTERS SUSTAINABLE? THE ISRAELI BIOTECHNOLOGY INDUSTRY

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Introduction

Industrial clusters or districts deem to be critical for industrial development and local economic growth. Industrial clusters are defined as a geographical concentration of related firms and organizations from the same industry (BRAUNERHJELM and FELDMAN, 2006). These concentrations include related industries which may collaborate as well as compete with each other (LAZONICK, 1993, PORTER, 1990, CASPER, 2007). One of the factors behind the success of clusters is the combinations of a large number of companies, of various sizes, working along many stages of production (PIORE and SABEL, 1984, MARKUSEN, 1996, SAXENIAN, 1994). Another important factor for cluster success is learning combined with upstream and downstream innovation (COOKE and MORGAN, 1998).

In the last two decades, many industrial districts become more specialized in particular stages of production. Two related processes contribute to this specialization: globalization and fragmentation of production. With globalization firms can tap into resources and international markets, allowing them to increase productivity and reduce costs. With fragmentation of production, where certain stages of production are conducted in particular locations, we find “rising specialization in particular stages of the product manufacturing chain and rising international interfirm trade in components” (BREZNITZ, 2007) .Examples of the globalization and fragmentation of production can be seen in R&D clusters such as the ICT industry in Israel or biotechnology in Cambridge, Massachusetts and Cambridge, UK; or biotechnology manufacturing clusters such as biotechnology in Denmark and Ireland.

Cluster development and sustainability are based on many factors including the availability of resources and markets. However, successful clusters have shown that knowledge transfer is one of the most important factors, and can be viewed in clusters through the networking of individuals and firms. Formal meetings arranged through industrial associations as well as and informal meetings at local coffee shops and restaurant contribute to knowledge exchanges and thus cluster development (BREZNITZ and ANDERSON, 2006, FLORIDA, 1995, KEEBLE and WILKINSON, 2000). Moreover, firm collaboration and competition are important factor for cluster development. The availability of different suppliers, humane resources from competing companies or local universities as well as customers promotes the growth of a cluster (COOKE, 2001, COOKE, 2002, CORIAT and WEINSTEIN, 2002, KENNEY, 1986, LAZONICK, 1993, PORTER, 1990). Considering these factors, important questions rise: what is the danger of specialization? Exactly how narrow a stage of production is too narrow for cluster sustainability?

These questions are vital on both the theoretical and policy levels. On the theoretical level, current economical changes require us to re-conceptualize industrial clusters; to understand their composition and whether we should continue and 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.

An analysis of a specialized cluster will allow us to better understand the advantages and disadvantages for focusing on a specific stage of production or product. This paper examines an innovation based cluster, the biotechnology industry in Rehovot, Israel.[i] This industrial district, which is the largest biotechnology cluster in Israel, is based on innovative companies, many spun out of university research. Majority of companies in the cluster are small and focus on R&D. Following a series of in-depth interviews and site visits, this study investigates whether a cluster of young research companies can become the bases of

industrial growth and bring economic sustainability to a region. This paper argues that while innovation can be the base of an industry, and R&D is the base of several successful industrial districts around the world, it may not be sufficient for local economic growth and sustainability. To achieve further development and regional growth companies require additional factors in the form of other companies in different stages of production, supported by policy, funding, and expertise. Hence, industrial growth and sustainability may require a wider base of production. In the case of the Rehovot cluster, the focus of the biotechnology companies on research and development of one product, without manufacturing or sales, did not lead to a development of an entire industry and jeopardizes the sustainability of the cluster.

Understanding innovation as a factor in regional economic development

"Increasingly clusters—regional concentrations of related firms and organizations—are perceived to be the locus of economic growth" (BRAUNERHJELM and FELDMAN, 2006, p. 1). The importance of these agglomerated firms is their creation of an entrepreneurial environment in which knowledge sharing and new ideas come to life, leading to economic development on a regional and national level (KEEBLE and WILKINSON, 1999, LAWSON and LORENZ, 1999, PORTER M.E, 2000, CASPER and KARMANOS, 2003, COOKE, 2002, DOERINGER and TERKIA, 1995, BREZNITZ and ANDERSON, 2006, LOWE and GERTLER, 2005).

Importantly, the basic idea behind industrial clusters is the ability to reduce cost and have access to factors of production. Firms choose to locate in a cluster to benefit from joint resources. Employees, who are in important base of any industry, choose their work environment and stay in a region when there is a concentration of firms that can offer them job security (BREZNITZ, 2000, EATON and BAILYN, 1999). Companies share resources in the form of labor force and equipment and in particular employees with different experience

in the production chain. Young companies will seek to recruit employees from companies that are further along the value chain in order to benefit from their knowledge and experience. Mature companies will seek to recruit employees from younger firms as well as university graduates to benefit from any new innovation on the market (BREZNITZ et al., 2008, PORTER, 1990). Service providers such as accounting and venture capital firms open branches in areas where they can maximize service to numerous companies. Thus, new firms locating in a cluster enjoy access to services otherwise not available.

Another advantage to clustering is collaboration:

> The concentration of firms in close geographical proximity allows all to enjoy the benefits of large scale industrial production and of technical and organizational innovations which are beyond the scope of any individual firm. (KEEBLE and WILKINSON, 1999, p. 297)

The proximity of firms allows them to learn and cooperate with each other. Particularly, we find collaborative efforts in which many firms contribute different segments of the final product. In their book, *The Second Industrial Divide* Piore and Sable describe the optimal region where small to medium size firms cooperate in matter of research and development, workforce, product design, manufacturing, and marketing (PIORE and SABEL, 1984).

Such collaboration contribute to the innovation base of the region (SAXENIAN, 1994, PORTER, 1990). Existing theories identify innovation as one of the main factors contributing to regional economic success. Systems of innovation and innovative milieu theories both focus on the importance of knowledge transfer, innovation, and collaboration as the basis for economic growth (COOKE, 2002, KEEBLE, 1998, KEEBLE and WILKINSON, 1999, LAWSON and LORENZ, 1999, NELSON, 1993, NELSON and NELSON, 2002, ETZKOWITZ, 1995). Importantly, different combinations of actors will create diverse learning and development avenues that will influence the innovation process. The rapid technological changes in the economy demand that different players support each other in knowledge sharing and learning in order to keep innovating.

Cooke and Morgan (1998) claim that some regions with innovative organizations, connected through joint research programs, policies, and social networks in an institutional milieu, “combine learning with upstream and downstream innovation capability” (ibid. 71), making them *regional innovation systems*. This represents a regionally based innovative network connecting universities, colleges, and research institutes. In these regions, companies are able to access and test knowledge more easily. In regional systems of innovation, knowledge becomes the “most strategic resource and learning the most important process” of economic development; this is also true for the learning region theory (LUNDVALL, 1994). In order to create economic development, high-level innovation and production processes need to be maintained in the region at all times. These processes are achieved through constant learning and training for employees, an intra-firm learning process that spills over to regional learning, have a direct impact on the success of the cluster (CARLSSON et al., 2002).

Clusters differ from one another by their composition and their achievement in industrial competitiveness (BRAUNERHJELM and FELDMAN, 2006). Mainly, there are two kinds of clusters. In one, we find many small to medium size enterprises collaborating in Production Networks (BREZNITZ, 2007). In these clusters products maybe the final manufactured goods or component. Moreover, these clusters are based on supplier customer relationships, each producing one part of the final product (PIORE and SABEL, 1984, BREZNITZ, 2007). In others, different sizes of firms, each working on their own stage of production, enjoy the benefit of locating in proximity to other firms in the same industry to benefit from resources in the form of labor force, equipment, and knowledge transfer (PORTER, 1990, HARRISON, 1992, MARKUSEN, 1985).

Increasingly we find more of the specialized clusters , such as the “Fabless design houses” who focus on a particular stage or stages of production (BREZNITZ, 2007, GEREFFI, 1994, STURGEON, 2002). These clusters dedicate themselves to one part of the

production process; i.e. R&D, manufacturing, design, etc. Hence, specific stages of production, including R&D, are found in specific regions around the world. We find fragmented clusters in different industries including biotechnology. Some examples can be seen in the manufacturing biotechnology clusters in Ireland and Denmark, and the R&D biotechnology clusters in Cambridge Massachusetts and Cambridge, UK. Similarly, we find ICT R&D cluster in Israel and a software outsourcing cluster in India, which works on part of projects for other software companies around the world.

In summary, cluster literature highlights the importance of *diversity* and depth of activities within the same cluster as a measure of industrial growth and sustainability. In particular, scholars highlight variety in firm size, stage of production, and the importance of knowledge transfer and collaboration.

Research Framework

This study seeks to understand whether specialized clusters are sustainable. In particular, this paper focuses on an important question: what is the danger of specialization? Exactly how narrow a stage of production is too narrow for cluster sustainability? It does so by examining one case study, the biotechnology industry in Rehovot, Israel.

Biotechnology is a particularly appropriate subject for this paper. Biotechnology is a "new science," with the earliest companies established in the late 1970s and the industry relying on the newest research. The Most of this basic research, not a developed product, is found in universities laboratories. Moreover, due to high costs and the length of time between research and development, majority of young biotechnology firms have one to two products and focus on R&D. However, MNC's and large corporations carry out multiple parts of the production chain including development, manufacturing, marketing, and sales. Thus, it is typical to find networking and technology transfer between individuals and between firms in biotechnology clusters; making the industry especially suited to be studied as a specialized

cluster. Moreover, the length it takes to progress in the production cycle of biotechnology tends to make this industry specialized and hence perfect fit for this study.

The number of firms in the cluster makes Israel and the Rehovot cluster a particularly appropriate subject for this paper. Out of the 129 biotechnology firms and 74 pharmaceutical companies in Israel, thirty biotechnology firms are located in the Rehovot cluster. The relative small number of companies, compare to Cambridge Massachusetts or Cambridge UK, allows us to examine the entire industry and learn exactly how many companies are at which product development stage as well as follow company connections and collaborations. The fact that Israel successfully developed a leading ICT cluster, leads us to believe that its a fertile ground for cluster generation and development.

This paper used both quantitative and qualitative research methods. Quantitative methods provide 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. Eighteen open-ended interviews were conducted with the life science industry in Israel. Interviews were conducted with company executives, researchers, government representatives, VC's, and technology transfer offices. Majority of the interviews were done in the cities of Ness-Ziona and Rehovot.

The Life Science Industry in Israel

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

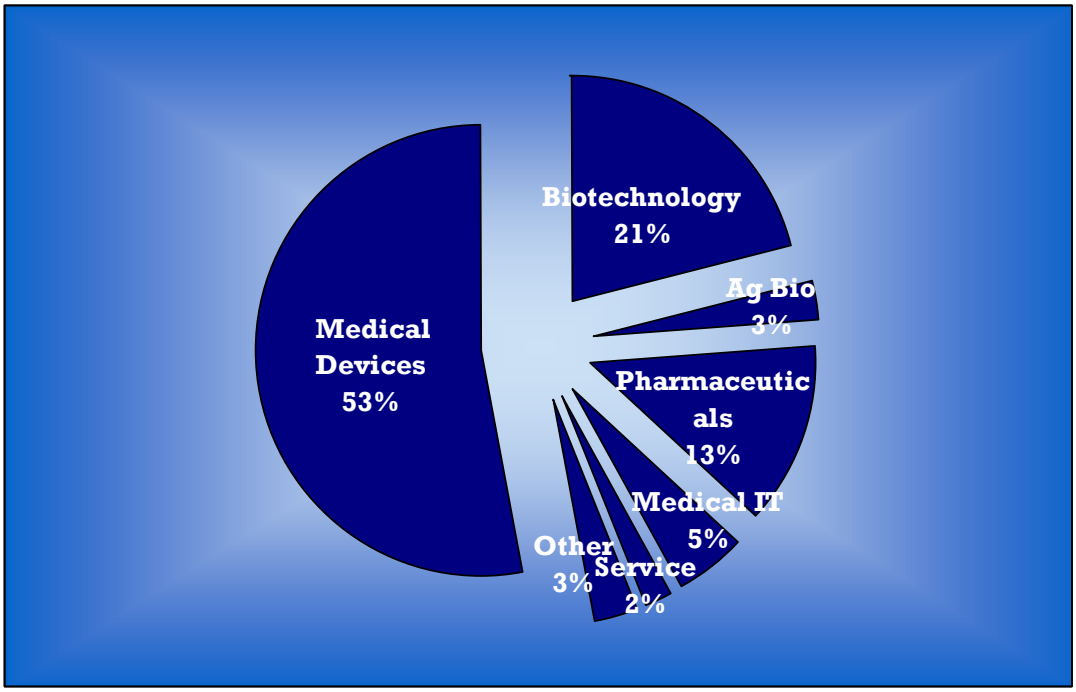

Figure 1: Israel Life science industry by sector. Source: ILSI, 2007.

Israel's life science industry is ranked eight in the world by number of companies (ERNST & YOUNG, 2005). However, the industry is very young. 45% of the companies were established in the last seven years.

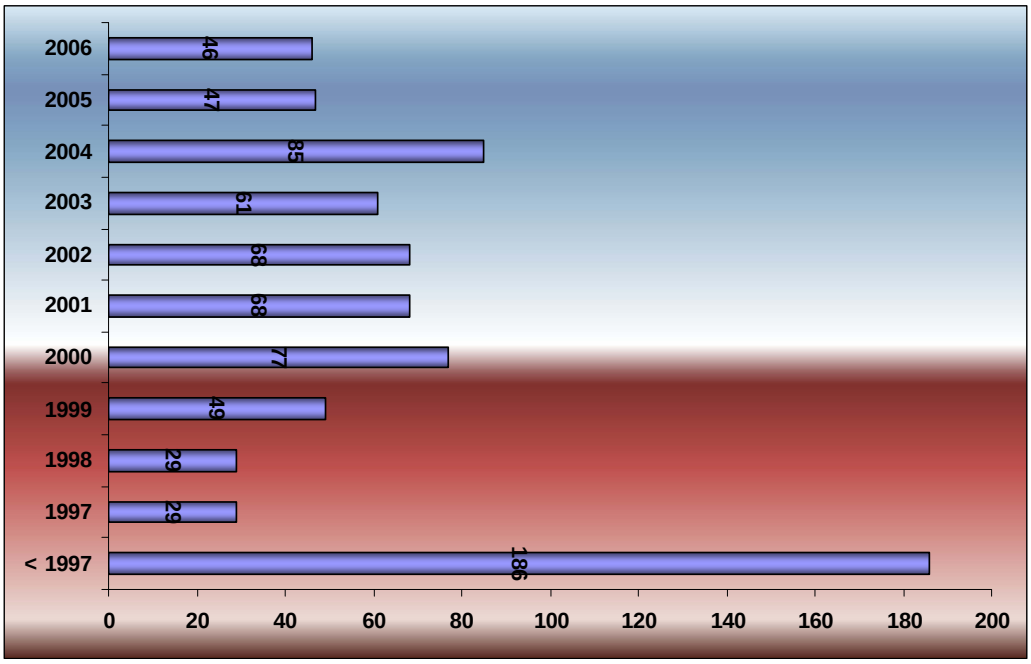

Figure 2: Israel's life science industry by companies. Source: ILSI, 2007.

Israel is one of the world leaders in life sciences research. Its universities are ranked as some of the world's top universities, particularly in 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 represented in the amount of life sciences companies. Many of these companies were founded by academics and are located in proximity to academic institutes (THE TIMES HIGHER EDUCATION, 2004). Similarly to other biotechnology firms and especially biotechnology spinouts, these firms are small to medium size and are R&D intensive (NEED TO ADD CITATION).

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 the first round in 2000, to funding mainly later stage companies in 2004 (ERNST & YOUNG, 2005). This trend did not skip the Israeli market. In general the Israeli VC industry does not invest in the early stage companies. Thus, Israeli biotechnology firm suffer from funding shortage. This shortage is especially felt at two

stages of the production cycle: at the early stage, moving the invention from an academic setting to the industry and at the bridge, and prior to the proof of concept, before you can show a product to investors. Much of the funding of early stage life science companies arrives 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 continues the downward budget trend of recent years: 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 OCS funds the technological incubators in Israel. Today there is only one life sciences incubator in Jerusalem, Bioline. However, Bioline is a project based incubator, it does not develop companies. Although the governmental support for a life science company at an incubator is double the amount of any other company, incubators are not inclined to take on a biotechnology company. The time, knowledge, and equipment required for such development are more complex and not necessarily available with in the existing funding base. Incubators that do take biotechnology companies do not have the resources to mentor and support them. Mostly, these companies have to work alone to make the connections and recruit their funding.

The Rehovot Cluster

The Rehovot Cluster is one of the largest biotechnology clusters in Israel representing thirty out of a total of 129 companies in Israel. It is situated in the center of Israel in close proximity to the Weitzmann Institute and the Hebrew University’s Department of Agriculture, in the town of Rehovot, twenty minutes drive from Tel-Aviv. This study finds that while on one hand the Rehovot cluster incorporates distinctive cluster characteristics it is missing many others. The lack of some of these factors questions the sustainability of this cluster.

There are qualified employees in the cluster, mostly graduates from both the Weitzmann Institute and the Hebrew University, and like in many clusters, we can see movement of employees between companies. Furthermore, these employees share common background and together create a social and technological network, sharing information and equipment as needed. Numerous companies' founders are graduates of one of the departments or of the former incubator at Weizmann. Many still hold close connections with their former departments and peers at Weitzmann and the Hebrew University. Some companies that spun-out of these institutes require assistance with equipment, consult with faculty, and use the universities' libraries. Some of these 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 its informal, between people, not necessarily between managements. Interview with a biotechnology executive A

Thus, faculty interest in the company, both financially and academically, leads to provision of services for young start-ups. A third cluster characteristic is the availability of a variety of industry suppliers and some Contract Research Organizations (CROs). The large number of biotechnology firms allows and attracts suppliers to locate in the region, providing daily services.

On the other hand, the Rehovot cluster is missing some cluster advantages. More importantly, it is missing many of the factors that we listed as important to cluster success, in particular diversity. Since national and regional resources are directed solely to R&D, in an attempt to duplicate the success of the Israeli ICT industry, the industrial concentration of companies in the Rehovot cluster is highly specialized and focuses on the R&D.

The Rehovot cluster has skilled employees in the research stage, many of which are new graduates from the local research institutions. Moreover, these institutions provide the

base from which many of these companies draw new knowledge, expertise, equipment, and employees. While academically Israel's scientists are ranked as ones of the best in the world, the industry lacks employees with industry experience, especially in the management, development, and manufacturing levels. Partly, this is due to the development stage of the industry in Israel. Only 12% of companies are at the clinical stage, while majority of companies are at the seed stage (ISRAEL LIFE SCIENCE INDUSTRY, 2007). There are only a few companies in Israel that succeeded in getting a product from the research stage to production, such as Teva, BTG, and XTL. 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. One, 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, shortage of mature companies leads to a shortage of skilled employees at all levels of the production chain. Both these issues have a direct impact on the ability of the industry to further develop (BREZNITZ and ANDERSON, 2006, PORTER, 1990, CASPER and KARMANOS, 2003).

This study confirms that the Rehovot cluster has a crucial problem with later stages of production. The cluster does not have enough qualified managers or employees with expertise and knowledge required by biotechnology companies in the different stages. Many of the employees, who are coming directly from academia, lack the knowledge and "know-how" of working in an industrial laboratory. Companies face these problems in several ways: some chose to invest time and personnel in the training of new workers, others choose to collaborate with international companies or build their development stages in other countries, leaving only the research phase in Israel.

> There is a lack of experience in development and manufacturing. Today, our company has two employees who are working for [a bigger company] in order for them to gain the knowledge we need.
>
> Interview with Biotechnology executive B.

> Humane resource in science – excellent. In business very few have the knowledge. In our company we have two people that moved to this industry from ICT. Interview with Biotechnology executive A.

> It is hard to find people that have seen a product through all stages of production. Most people have only the clinical base. The academic background is important but it is just the base. We are missing people that know how to develop. We need people with industry experience.
> Interview with Biotechnology executive C.

Knowledge transfer in the Rehovot cluster, which in other clusters is mainly achieved through social networks, 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 formal connections, contract based, between companies and the academic institutions. As a result, the social networks in this cluster are linear and are based on one connection per company. Importantly, the lack of mature companies does not provide another way to resolve this issue.

Israeli funding for biotechnology, both public and private, directs the industry towards R&D. Governmental funding for the industry arrives from the Office of the Chief Scientist (OCS). As it is, the office funds in general high technology companies in the R&D stages. Moreover, due to the nature of government investment in R&D there is no investment in Contract Research Organizations (CROs) that can advance companies in particular research stages. Hence, with the lack of mature companies that can train or transfer knowledge on later stages of production, it leaves the companies to focus on R&D. As was explained in the previous section, there is hardly any VC investment in the Israeli life science industry.

Direct investment by the Chief Scientist is as well directed to basic research. The OCS has very little investments directed to the life science industry in general. Only one program: "Nofar" invests particularly in biotechnology at $100,000 per project. This program

funds biotechnology projects at academic institute that collaborate with industry. The OCS funds 90% and industry funds 10% of the project. In comparison, just the NIH, in the US, invests over $27 billion annually in medical research. Hence, there is no funding for a new start-up that does not have a project with a university and there is no funding for equipment.

> The OCS funds only half a project. You still have to find funding for the other half. They ask for a lot of paperwork and place many restrictions on how and what is needed to spend the funding. Interview with company executive D.

Funding through the OCS is available only for R&D. Thus, Contract Research Organization (CRO), an organization that offers clients a wide range of pharmaceutical research services which are vital to the biotechnology industry, are not eligible for funding. Services offered by CROs include: product development and formulation, clinical trial management (preclinical through phase IV), central laboratory services for processing trial samples, data management services, and many other complementary services. CROs can offer their clients the experience of moving a new drug from its conception to FDA marketing approval without the drug sponsor having to maintain a staff for these services, which often have limited duration. Thus, creating a shortage of CROs for the industry and requiring many of the companies to look for services abroad. Moreover, companies at the technological incubators do not have the financial capabilities to pay for services (animal testing, proteins, etc), and their governmental funding does not allocates funding for services and/or equipment.

In summary, existing theories view firms' diversity and collaboration in a cluster as the base for innovation and regional economic growth and sustainability. Importantly, the literature reviles that further development of each cluster requires a variety of players, in different stages of production. This study's analysis of the Rehovot biotechnology cluster in Israel finds a growing industry. However, this cluster consists of small to medium size enterprises, majority of which are in their research stages. There are almost no companies in their development, manufacturing, marketing and sales stages in the cluster, resulting in

shortage of qualified employees for later stages of production and experienced managers. Moreover, the cluster lacks the networking and communication that is typical to industrial districts. The companies base their survival through their product development with very limited resources, leaving them with little opportunity to network. Due to these difficulties, many companies focus on “the one molecule company” strategy, i.e. companies that have developed only one product based on one molecule with a strategy to sell the molecule at the proof of concept stage. Thus, these companies do not even plan on getting to the development or manufacturing stages. All future products will be sold to multi national companies overseas, where they would create new jobs in production and marketing instead of in Israel.

Conclusions

Biotechnology clusters can be found around the world. Successful cluster are characterized with many kinds of companies, in different sizes, product specialization, and stage of production. Hence, the clusters encompass a variety of skills and knowledge that are transferred within the cluster through social networks. Germany, France, UK, Ireland, and Denmark, all have been developing regional biotechnology clusters (CASPER and MATRAVES, 2003, LEMARIÉ et al., 2001, ERNST & YOUNG, 2007). Unlike the Israeli cluster approach to promote R&D, these concentrations of firms focus on bringing life-science multi national companies to their region. Ireland and Denmark promoted the availability of green fields and policy incentives to draw in multi nationals that are interested in opening new manufacturing facilities. For these countries, manufacturing creates a wide base of good paying jobs but also brings the know-how to their region.

In France, UK, and Germany, many multi nationals chose to open R&D facilities tapping into the local knowledge base and expertise, and especially the availability of human resources with experience in pharmaceuticals. Hence the new clusters are characterized by many firms, from a diverse background, in different stages of production, collaborating and

competing in a growing industrial cluster, which allows them to continue to develop and result in sustainable clusters (ERNST & YOUNG, 2007).

The biotechnology industry has a global market. Building on Israel's academic strength can lead to positioning Israel as a leader in life sciences. However, with the lack of R&D tax incentives, experience labor force, and mature companies, this industry is facing extreme developmental issues. As we have seen from the Rehovot Science Park, companies are struggling to survive. Unlike the Israeli ICT industry life science companies require large sums of funding especially from public source, which are currently not available. Moreover, while there are mature ICT companies in Israel there are very few pharmaceutical companies and no mature biotechnology firms. Thus, there is a lack of qualified labor force that can lead this industry in the upcoming steps of the production chain. Hence, this paper finds that the narrow base of the Rehovot biotechnology cluster may not be sustainable and the survival of firms in this cluster is in danger.

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[i] The city of Rehovot locates inland, half an hour from Tel Aviv. In the city we can find the Weitzman Institute and the Hebrew University's agriculture department. In this paper the Rehovot cluster will include also the firms located in "Kiryat Weizmann", which was built in Nes Tziona, Rehovot's smaller neighbour. The two clusters are closely located, and are less than five minutes apart.