

# **Social Networks, Location of Firms and Cluster Formation: The Case of Biomedicine in Chile**

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## **ABSTRACT**

This paper explores the relevance of social relations for the location decision of firms and the growth of the biomedicine cluster in the metropolitan region of Chile. From the analysis of 27 in-depth interviews and survey responses from different actors in the biomedicine sector, it is possible to reconstruct the main aspects in the establishment of companies, their growth and the creation of relations among organisations within the cluster. Main results highlight the importance of social capital for location decision and financial access during the first stages of companies. This study aims to contribute to a deeper understanding of the role of social relations in the creation of a knowledge-based cluster in an emerging economy, and to identify potential difficulties for the future growth of the cluster.

*Key Words*— Biomedicine, social capital, knowledge-based entrepreneurship, cluster formation.

## 1. INTRODUCTION

Programs to promote clusters, as part of industrial policies, have become fashionable in recent years particularly in middle-income countries, such as in Chile and other Latin American countries (Giuliani and Pietrobelli, 2011). A large body of literature has researched the positive effects of clusters on firms' productivity; however, less attention has been paid to cluster formations' drivers and processes (Porter, 1998; Bell and Albu, 1999; Perez-Aleman, 2005; Boschma, 2005; Casper, 2007; Ter Wal and Boschma, 2009).

Companies in a cluster co-locate in a geographical area and might or might not have commercial relations. Co-location of companies does not necessarily imply an increase in firms' productivity (Boschma, 2005). Networks and connections between companies, formal or informal, are fundamental for knowledge spillovers and to exploit the advantages of co-location (Giuliani and Bell, 2005; Giuliani, 2007). Therefore, this study focuses on entrepreneurs' social capital during the formation of new companies, in order to understand the role of social networks and social capital in the emergence of a knowledge-based cluster in an emerging country.

The central hypothesis that this study aims to test is that social relations, as a proxy for social capital, affect the creation and location of start-ups, since social capital will help to overcome financial market failures. In developing countries financial markets and particularly venture capital and angel investors are not well developed. Sectors with significant requirements of capital, high risk of their investments and information asymmetries, like biomedicine, face greater financial constraints. Entrepreneurs' social capital and relations often overcome these market imperfections, allowing them to access different networks of support and affecting the location decision of new companies.

This research follows a case-study analysis of the biomedicine cluster in the metropolitan region of Chile. This cluster was chosen because it is a relatively new sector, which first companies were established in the mid 80's, experiencing a rapid growth in the number of firms in recent years and with different organizations interacting among them. It is also interesting to study the conditions and resources exploited by entrepreneurs in a country with no apparent conditions for the development of a knowledge-based sector. Twenty-seven in-depth interviews and twenty-three surveys with different actors of the cluster were conducted between June and September 2011, including seventeen companies that account for half of the firms in this sector.

Main results suggest that effectively social capital plays an important role overcoming financial constraints, accessing capital from family networks, from successful businessman acting as angel investors, and even from venture capital firms. All these sources of capital affect location decision; however, capital from family sources is often indirect and given as cross subsidies within the entrepreneur' nuclear family. It is not clear for entrepreneurs that family support exerts a mayor role as a capitalist, but it is identified as the main factor for location decision.

This study is exploratory and interpretative in nature and aims to provide some insights on social relations importance on high-tech firms and cluster formation in developing countries. Results suggest that social relations are significant to attract capital from private investors and venture capital funds, in line with previous results (Uzzi, 1999; Hsu; 2007). The lack of a strong and developed financial system for entrepreneurs is compensated with social relations, which form a social network that might function as a parallel system of trust, signalling and financing new projects; especially in sectors with high information asymmetries and risk. Social relations also played an important role in the evolution of the sector, especially in the creation of collective

action, shaping public policies that affect the growth of the sector. In conclusion, it is possible to identify that social relations have a major role for firms and cluster formation and development.

The paper is structured as follows: section two briefly summarize the relevant literature and draw the main hypothesis of the paper; section three describes the methodology employed to collect the data and the representativeness of it; section four present the analysis of firms formation and the role of entrepreneurs' social networks in the location decision; section five present the different actors of the cluster and section six shows how the interaction among actors has affected the growth of the sector; finally, section seven concludes.

## **2. LITERATURE REVIEW**

Literature on entrepreneurship emphasises the role of entrepreneurs in founding new companies that will later form a cluster, recognising the importance of networks of entrepreneurs (Feldman, Francis and Bercovitz, 2005). Also, social networks' literature highlights the importance of social capital in creating links between actors in a network (Powell et al., 1996; Owen-Smith and Powell, 2004). So far, minimal attention has been paid to the role of entrepreneurship and social networks in the formation and evolution of clusters; therefore there is a gap in the literature on the role of social networks and relations in cluster formation.

The structure of a social network could influence the commercial relations that a firm creates, affecting the formation and growth of companies and a cluster (Perez-Aleman, 2005; Whittington et al., 2009). However, it is not clear how clusters are formed and the role of social structures in this process. There is still a need to examine how social interactions within firms in a cluster are structured and how this structure is created (Ter Wal and Boschma, 2009).

Environment plays an important role in the decision to establish a new company in a particular sector and location (Feldman, Francis and Bercovitz, 2005). The environment is shaped by policies and regional factors. Policies, institutions and local factors are relevant for cluster formation, the decision to start a new company and the location of it. Feldman, Francis and Bercovitz (2005) suggest three phases in a cluster's development. Firstly, individual entrepreneurs establish the first start-ups, which are promoted by external shocks like a change in policy. The second phase is characterised by linkages formation, self-organisation between the start-ups and the emergence of venture capitalists. In this phase, social capital between early entrepreneurs and other organisations is very important. The third phase is the maturation of the cluster with public and private financing, and deepening of social ties.

This is consistent with Pitelis's (2012) proposition that clusters emerge because firms and entrepreneurs want to appropriate the value of co-created resources. The location decision of entrepreneurs could help to develop an entrepreneurial ecosystem that might endogenously create a cluster. Yet, location decision in Pitelis's (2012) article is based on Dunning's OLI model (ownership, location and internationalization advantages), which does not necessarily hold for national or small start-ups. Location or co-location of companies may be influenced by local factors like a reduction of transportation and transaction costs, a pool of labour with the requirements for the sector, or reduced taxes. Possible knowledge spillovers are also relevant for location decision. However, knowledge flows occur through formal or informal interactions between agents. Informal interactions are usually based on social relations and social capital, which may influence location decision of new firms, spurring firm agglomeration.

Clusters or firm agglomeration increase the creation of new firms in the same location (Porter, 2000; Pitelis, 2012). However, as Walker et al. (1997) estimate, there is evidence that social capital tends to reproduce network structures over time. They analyse new relations of

start-ups in the U.S. biotechnology sector between 1984 and 1988. The persistence of firms' roles within a network could constrain entrepreneurship. As Uzzi (1996, 1997) analyses, entrepreneurs and start-ups are embedded in a social structure that affect their economic outcomes. The embeddedness of firms allows them to efficiently manage their resources and to adapt to complex environments. Nevertheless, Uzzi identifies an inverted U of benefits. After certain level of embeddedness, or overembeddness, of firms there are negative effects, making firms vulnerable to external shocks and reducing sources of external information and knowledge. Thus, negative effects of networks should be bear in mind.

In relation with funding for entrepreneurs, results from Hsu (2007), on the information and communications technologies (ICT) industry in the USA, identifies the importance of previous ties with venture capitalist to increase the likelihood of being funded. These results are in line with results from Uzzi (1999), who identifies lower interest rates in credits to firms with social ties with their lenders. Therefore, it is possible to identify the importance of entrepreneurs' social capital and networks for financing start-ups.

In summary, social networks of entrepreneurs might facilitate or constrain the linkages that a start-up creates, affecting the growth of the firm and the evolution of a cluster. In developing countries, social networks might be even more relevant for firms and cluster formation since financial markets are less developed, which is crucial for the first stages of a company. Location decision will also consider social capital and networks of entrepreneurs. Social capital and social networks could influence firms' location decision, shaping the formation of a cluster. Previous analysis allows us to conclude that social capital and networks of firms and institutions in earlier phases of firms and clusters are crucial to their development. The hypothesis to test during this study is:

*Hypothesis: Location decision of entrepreneurs will be explained not only for local economic conditions in a region, but also for social relations and social capital.*

### 3. DATA AND METHODOLOGY

Qualitative and quantitative research methods were adopted to provide descriptive, interpretive and empirical data. The approach chosen for the qualitative design was a semi-structured interview methodology, while the quantitative design gathered data from an original survey conducted in the cluster. The interview collected information about the process of establishment a new firm, while the survey gathered information about perceived obstacles to the establishment and growth of firms as well as their commercial and social linkages.

Fieldwork was conducted between August and September of 2011. Interviewees and respondents were CEOs and Research Directors of biomedicine firms, Research Directors of Science and Medicine Divisions of the main Universities, and other relevant actors in public agencies. Total distribution of interviews and surveys conducted are summarized in table 1. Rate of response are 51% for interviews and 43% for the survey.

**TABLE 1**

Distribution of Organizations in the Biotechnology for Health and Medical Diagnosis Cluster in the Metropolitan Region, Chile

|   | Corfo     | Fieldwork | Interviews |                  | Survey    |                  |
|---|-----------|-----------|------------|------------------|-----------|------------------|
|   |           |           | N          | Rate of Response | N         | Rate of Response |
| Companies                                 | 28        | 34        | 18         | 52.94            | 17        | 50.00            |
| Chilean Companies (Services and Products) | 16        | 18        | 10         | 55.56            | 9         | 50.00            |
| Chilean Venture Capital Companies         | 1         | 2         | 2          | 100.00           | 2         | 100.00           |
| Chilean Pharmaceutical Laboratories       | 8         | 7         | 2          | 28.57            | 2         | 28.57            |
| Foreign Companies (Services and Products) | 1         | 3         | 3          | 100.00           | 3         | 100.00           |
| Foreign Pharmaceutical Laboratories       | 2         | 4         | 1          | 25.00            | 1         | 25.00            |
| Universities                              | 12        | 14        | 5          | 35.71            | 3         | 21.43            |
| Research Institutes                       | 1         | 1         | 1          | 100.00           | 1         | 100.00           |
| Technology Centres                        | 2         | 1         | 0          | 0.00             | 0         | 0.00             |
| Associations                              | 1         | 1         | 1          | 100.00           | 1         | 100.00           |
| Technology Consortiums                    | 2         | 2         | 2          | 100.00           | 1         | 50.00            |
| <b>Total</b>                              | <b>46</b> | <b>53</b> | <b>27</b>  | <b>50.94</b>     | <b>23</b> | <b>43.40</b>     |

Source: Based on information from [www.investchile.cl](http://www.investchile.cl) and author's information

#### **4. EMERGENCE AND DEVELOPMENT OF BIOMEDICINE FIRMS**

This section analyses the evolution of companies in the biomedicine cluster in Chile. The analysis is based on in-depth interviews as well as quantitative analysis of some of the questions in the survey. The section will focus mainly on biotechnology firms, excluding pharmaceuticals and universities, because biotech firms are at the centre of the cluster.

##### **Location Decision**

The literature on localised knowledge spillovers suggests that location decision of new firms will be influenced by the existence of local factors, such as skilled labour pools and tacit knowledge that is easily transmitted through face-to-face and every-day interactions (Jaffe, 1989; Feldman and Audretsch, 1999). After the first firms have set up in a region, the location decision of other companies will consider this fact as well as regional advantages. Newcomers will want to locate near other firms in the same sector and geographical area to take advantage of the tacit knowledge flows of the region (Pitelis, 2012). This suggests that firms will create productive agglomerations organically, based on the economic advantages of a certain location and the potential knowledge spillovers that might occur by interacting with similar firms.

Previous literature centres on the commercial and knowledge benefits of the location decision. Yet, according to social network literature, social capital is at the core of network formation (Casper, 2007). Thus, social ties and social capital of entrepreneurs would be the main fundament for the location decision. This was found in the biotechnology cluster in Chile. Interviews determined the most important aspect considered in the location decision of biotechnology companies to be the closeness to entrepreneurs' homes and to be located in the city where they already lived.



For example, an interviewee in the financial sector commented “*nobody will go to live in other regions to do this work*”. For one of the cluster’s first entrepreneurs, locating the firm in the same region was the only option they considered. They lived very close to the firm and personally owned the house where the firm was constituted. They mentioned “*we lived right next door [to the firm] and this house was mine*”. In private companies, constitution is agreed based on the location of the main partners. An interviewee explained that the decision to locate the company in the metropolitan region (RM) was because “*every partner is in the metropolitan region*” and they all share the fact that they were originally from the metropolitan region.

The same result is found in an interview with an expert outside of the metropolitan area. This entrepreneur created a firm with two other partners; all of them were living in the region and decided to locate the firm in the same region because it was “*... a personal decision and made for a better quality of life ... all of us grew up and lived here*”. When questioned about any limitations for the company being outside the capital, they commented that attending meetings in the capital had never been a problem. Transport costs between the metropolitan region and other regions in Chile might not be an intolerable cost. A drawback of being located in another region is the lower access to financial capital. However, when this company had an offer of a new financial partner, they rejected it because it involved moving the company to the RM. The same opinion was shared by an academic that recently moved to the metropolitan region.

Spontaneous answers during the interviews focused on personal reasons, such as living in the same city where they already lived, and did not mention access to knowledge or localised commercial advantages. This might be explained by the findings of Geenhuizen and Reyes-Gonzalez (2007) in the biotechnology sector of Netherlands. They find that location is not important for small and young firms productivity, which are also the main features of Chilean biotech companies.

Nevertheless, when interviewees were questioned about specific advantages of the metropolitan region in comparison with others for the functioning of the firm in the survey, other factors also seemed to be relevant. From these results (see table 2), it is possible to notice that in the metropolitan region there are no advantages to import or export. Yet, the region is perceived to have advantages in concentrating suppliers and clients of biotechnology firms. For example, clients of biotechnology companies which provide services are mainly big hospitals and private health centres located in the RM. This was mentioned as one important explanation of the location decision for such firms.

Firms consider the access and attraction of skilled labour as only marginally better in the metropolitan region. From the interviews, it was possible to confirm that owners of biotech companies consider that scientists in Chile have a good formation and that there is an adequate labour pool in the country.

Access to new technologies and knowledge appears to be slightly better in the metropolitan region. Most interviewees claim that information technologies, such as low-cost internet and video conferences, made it easy to access information around the globe and they considered that it to be the same in other regions. Yet, it is perceived that there are also more facilities to conduct research as well as to innovate in the metropolitan area than in other regions. This is an important driver for location decision that might be related with the possibility to create research collaborations with other agents.

Accordingly, it is possible to notice that closeness to universities and research institutions play an important role. The oldest research universities in medical and biological sciences are in the metropolitan region. Even when there are other important research universities in other regions of the country, past dependency of research and knowledge creation generates an advantage for oldest institutions. This result identifies the important relation between firms and

universities. Universities are important clients of biotech firms, as will be analysed further in the sections below, which support the results found by D'Amore et al (2010) on the centrality of universities in the Italian biotech industry. Additionally, the first entrepreneurs maintain parallel jobs as professors in the universities of the region. These relations are built on previous social ties, reflecting the importance of social networks for these linkages.

**TABLE 2**

**Advantages of being located in the Metropolitan Region in Comparison with Other Regions in Chile**

| <b>Advantage</b>   | <b>Low<br/>Relevance</b> | <b>Medium<br/>Relevance</b> | <b>High<br/>Relevance</b> |
|--|--------------------------|-----------------------------|---------------------------|
| Greater Access to Skilled labour pool                            | 38.5%                    | 15.4%                       | 46.2%                     |
| Greater Attraction of skilled labour                             | 46.2%                    | 7.7%                        | 46.2%                     |
| Better quality of life   | 30.8%                    | 15.4%                       | 53.8%                     |
| Easier to find suppliers from firms in the region                | 30.8%                    | 15.4%                       | 53.8%                     |
| Easier to buy equipment from firms in the region                 | 30.8%                    | 7.7%                        | 61.5%                     |
| Easier to import inputs from abroad                              | 53.8%                    | 7.7%                        | 38.5%                     |
| Easier to import equipment from abroad                           | 61.5%                    | 7.7%                        | 30.8%                     |
| Greater local market demand                                      | 38.5%                    | 7.7%                        | 53.8%                     |
| Greater facilities to export                                     | 61.5%                    | 7.7%                        | 30.8%                     |
| Easier to find new clients                                       | 38.5%                    | 0.0%                        | 61.5%                     |
| Increase reputation of your products or services                 | 53.9%                    | 7.7%                        | 38.5%                     |
| Greater access to new technologies                               | 28.6%                    | 28.6%                       | 42.9%                     |
| Greater access to new knowledge                                  | 28.6%                    | 28.6%                       | 42.9%                     |
| Facilities to innovate and develop new products and services     | 30.8%                    | 15.4%                       | 53.8%                     |
| Greater facilities to research                                   | 23.1%                    | 30.8%                       | 46.2%                     |
| Greater cooperation with research centres in universities        | 14.3%                    | 7.1%                        | 78.6%                     |
| Greater cooperation with private research centres                | 42.9%                    | 14.3%                       | 42.9%                     |
| Greater cooperation with other biotechnology firms in the region | 50.0%                    | 14.3%                       | 35.7%                     |
| Easier to form part of a Consortium or trade association         | 57.1%                    | 0.0%                        | 42.9%                     |
| Greater cooperation with clients                                 | 28.6%                    | 0.0%                        | 71.4%                     |
| Greater cooperation with suppliers                               | 30.8%                    | 7.7%                        | 61.5%                     |

Source: Author's survey

Another important factor that the metropolitan region has is the potential access to financial markets. Main financial organisations are established in the metropolitan region, as well as public agencies that support entrepreneurial and scientific research projects. There are few venture capital companies in the country and all of them are based in the metropolitan region. The closeness to these actors seems to be relevant. These findings are in line with what is proposed by

entrepreneurship literature. Access to venture capital during the first stages of firms' formation is fundamental for the evolution of the cluster (Feldman, Francis and Bercovitz, 2005). As stated above, one of the experts interviewed pointed out that investors prefer to be geographically close to the firms and projects they finance. Monitoring of the project could be conducted at a lower cost when firms are geographically close (Hagerdoon et al., 2001), supporting a geographical concentration of firms.

In summary, results from interviews suggest that personal relations were significant for location decision. This is supported by the survey results – 54% of the interviewees consider an advantage of the metropolitan region to be that they have a better quality of life there. Survey results also support traditional economic geography literature on agglomeration benefits. Some important advantages of the metropolitan region are the potential of knowledge and research interactions with universities, clients and suppliers. There is also a sufficient skilled labour pool, though it seems that this is not a major strength of the region. The survey found no evidence that in regions there are more difficulties in accessing knowledge or inputs according to the perception of companies and researchers working in the capital city of Chile. It is necessary to conduct further research to study as to what extent this holds for researchers and companies in other regions.

The possibility of engaging in knowledge networks through cooperation with other agents in the cluster and greater access to clients seem to be the most important advantages of locating in the region. This again stresses the importance of relations' formation among the cluster's agents. The high importance given by interviewees to their previous living experience and family ties to locate their firms,, precisely confirms the importance of social capital and social relations on location decision. Yet, this does not undermine the importance of other local factors in creating a comparative advantage of the metropolitan region. Thus, results suggest that there is evidence to

support the hypothesis that social relations are highly relevant for the location decision of a company.

### **Challenges for Start-ups and the Role of Social Networks**

Entrepreneurship literature establishes that in the early stages of cluster formation, the success of the first start-ups heavily depends on financial and commercial linkages (Feldman, Francis and Bercovitz, 2005). As shown in the previous section, it is perceived that firms need to be geographically close to venture capitalists and investors, which are concentrated in the metropolitan region in Chile. However, striking results from the interviews suggest that for the first biotech companies of the cluster, access to financial capital was not an inconvenience for the creation of the firm. For the oldest biotech companies, the capital necessary to start the company was provided by their partners. Warehouses or houses of one of the partners were used as the firms' first establishment. This result evidences the importance of previous personal capital or social relations that helped to bring a partner with important capital, in accordance with Uzzi (1999) and Hsu (2007). Additionally, competition for public funds was less fierce since there were few biotech companies. Other firms created at the end of the 80s obtained funds from industry associations or governmental agencies such as the Chilean Economic Development Agency (CORFO in Spanish). Nevertheless, some of the companies now see these loans as an explanation of their slower growth, due to the financial burden and high collaterals involved.

Another explanation for the relatively low importance of access to financial capital could be due to the double orientation of the first firms in the cluster. They are not only engaged in research and production of their own reagents and diagnostic kits, but they are also distributors of foreign companies' diagnostic reagents. This activity brought those companies cash flow and minimum capital in order to continue their research lines. As clarified by an owner "*a firm that*

*engages in research and development producing limited products requires large amounts of capital. Thus, we developed, on one hand, a commercial area, focusing on providing input and reagents for biomedicine research, an area we knew about and we knew about the needs, equipment and input needed; and on the other hand, we developed a diagnostic service for hospitals and clinics. That gave us the financial soundness to be able to maintain the areas of research and development”.* Thus, there was a cross subsidy between activities inside the firms, continuing until today. Nowadays, the foreign diagnostic reagents’ market is segmented and divided between the two oldest companies and lately the direct establishment of commercial offices from international companies in the country.

Entrepreneurs from the first stage of the cluster were all university professors as well, and many have maintained that status until today. Academic activities were their main income during the first years of the company, and this could explain the slow growth of companies. At some point, owners of companies should decide in which activity they will concentrate. One owner commented that *“at some point a professor must make a decision: to dedicate themselves to the company or the academia, it is clear ... for the company to succeed you have to devote yourself body and soul to it, or find people who can do it and have a more strategic view”*.

This is not the case for new start-ups. New biotech firms are established with the objective of developing new products in health, cosmetics or nutrition as fast as they can. Usually, managers and owners of new start-ups are completely focused on this task. As a manager mentioned *“the conditions in the biotechnology sector are very dynamic; today we could be thinking about one thing and tomorrow a publication or patent changes everything”*, which forces them to produce their research results fast in order to continue or discard the project at the earliest stage possible. For new firms, capital comes from other sources such as venture capital funds or angel investors, and financial partners should understand these conditions. For most of

the younger firms interviewed, lack of capital seemed not to be a major problem. Most of the new start-ups' capital came from different sources: their own capital, an investor with knowledge of the sector (usually the owner of another company), other companies in the biotechnology sector, public funds and/or venture capitalists.

Conversely, results provided in the survey (see table 3), suggest that access to capital from the financial sector and lack of capital were important difficulties faced by half of the biotech companies surveyed during its creation. The few difficulties reported in relation to venture capital companies is because, until recently, these type of companies did not exist in Chile, therefore they were not relevant to the sector's first companies. Additionally, regarding the lack of importance of finding a co-founder, it could be concluded that entrepreneurs with more access to funds from social ties would find capital restrictions less of an issue.

**TABLE 3**  
**Main Difficulties in Firms' Creation**

| <b>Difficulties</b>   | <b>Low<br/>Relevance</b> | <b>Medium<br/>Relevance</b> | <b>High<br/>Relevance</b> |
|---|--------------------------|-----------------------------|---------------------------|
| Lack of capital   | 50.0%                    | 0.0%                        | 50.0%                     |
| Difficulties with getting funds form the financial sector     | 50.0%                    | 0.0%                        | 50.0%                     |
| Difficulties getting co-funders or partner companies          | 91.7%                    | 8.3%                        | 0.0%                      |
| Difficulties accessing Venture Capital companies or Angel Inv | 91.7%                    | 8.3%                        | 0.0%                      |
| Lack of financing form governmental agencies                  | 58.3%                    | 25.0%                       | 16.7%                     |
| Lack of orientation from governmental agencies                | 66.7%                    | 8.3%                        | 25.0%                     |
| Difficulties getting suppliers in the national market         | 66.7%                    | 25.0%                       | 8.3%                      |
| Difficulties getting suppliers from abroad                    | 58.3%                    | 25.0%                       | 16.7%                     |
| Difficulties getting clients in the national market           | 66.7%                    | 25.0%                       | 8.3%                      |
| Difficulties getting clients from abroad                      | 50.0%                    | 8.3%                        | 41.7%                     |
| Bureaucracy to start-up the company                           | 58.3%                    | 8.3%                        | 33.3%                     |
| Legal costs to establish the company                          | 66.7%                    | 0.0%                        | 33.3%                     |
| Legal regulations (Sanitary, Patents, International, etc.)    | 41.7%                    | 8.3%                        | 50.0%                     |
| Difficulties finding adequate qualified human resources       | 33.3%                    | 33.3%                       | 33.3%                     |
| Difficulties accessing leading knowledge and technologies     | 91.7%                    | 8.3%                        | 0.0%                      |
| Difficulties buying leading equipment                         | 75.0%                    | 8.3%                        | 16.7%                     |
| <u>Others</u>   | 0.0%                     | 0.0%                        | 33.3%                     |

Source: Author's survey

This was tested by dividing the percentage of firms that consider lack of capital or difficulties to access the financial system as highly relevant for their creation, by the social capital of the firm and its owners. Social capital in this case was considered as the number of commercial or personal ties. Firms with high commercial social capital were the ones with a number of commercial linkages above average. Similarly, firms with high social capital from the social network were those with owners or managers that had more social relations than the average. Results are presented in table 4. It is observed that a higher proportion of firms with lower social capital in the commercial and social network tend to consider lack of capital, or difficulties in accessing the financial sector, as highly relevant during their creation. Interestingly, different financial difficulties are considered relevant by the same proportion of firms with high levels of social and commercial capital; however obtaining funds from the financial sector seems to be relevant to a relatively lower proportion of firms with low social capital. These results show the importance of social and commercial linkages for access to funds and financial partners.

**TABLE 4**

**Highly Relevant Financial Difficulties in the Creation of Firms, by Social Capital of the Company and Owners**

| <b>Difficulties</b>                                       | <b>Low Social Capital</b> | <b>High Social Capital</b> |
|---|---------------------------|----------------------------|
| <b>Commercial Network</b>                                 |                           |                            |
| Lack of capital   | 57.1%                     | 45.5%                      |
| Difficulties with getting funds form the financial sector | 42.9%                     | 45.5%                      |
| <b>Social Network</b>                                     |                           |                            |
| Lack of capital   | 75.0%                     | 42.9%                      |
| Difficulties with getting funds form the financial sector | 50.0%                     | 42.9%                      |

Note: High social capital was defined as total number of ties above the mean of total ties in each network.  
Source: Author's survey

Another important issue is fulfilling export, import and sanitary regulations. Other obstacles faced by biotechnology firms are the difficulties in accessing foreign markets; the bureaucracy and cost required to establish the company; and in certain aspects the lack of



qualified human resources. When asked about this last point, interviewees mentioned the lack of managerial human resources qualified in managing technological and biotechnology projects. Particularly, the business and scientific world in Chile do not tend to mix and there are only a few scientists that have management knowledge. Interviewees agreed of the lack of scientists with a specialisation in management or technology management, as well as with work experience abroad. They recognise that it is possible for managers to understand science, but this happens on few occasions and that it could be more difficult to achieve the understanding of the research done by biotechnology companies. In fact, from interviews conducted with one university incubator and venture capital companies, the most common problem with scientists trying to obtain funds from private investors is the lack of a business strategy and vision. It is difficult for scientists to see their research as a product and to develop a business plan. This has reduced the number of start-ups financed by venture capitalists in the sector.

In summary, it is possible to observe that the origins of this cluster have certain interesting features that are not completely in line with entrepreneurship theories. However, it is possible to see that for the first group of companies, capital might not have been a limitation because they faced fewer competitors. The strategy of mixing commercialisation and research to create cross subsidies within the companies is an interesting discovery. Conversely, this actually shows how relevant capital is for research in knowledge-based clusters. Even when companies claim that capital has not been an impediment for their creation and subsistence, it is plausible that their levels of capital delayed research results and companies' growth.

The oldest companies developed their own products, such as reagents or diagnostic kits, during the first years of formation. However, continuous research conducted during these years is just starting to generate significant results, or might have new results in the next few years. Several companies are searching for partners in the country or abroad to develop a drug or

therapy based on their results. Young companies are considering the incorporation of foreign investors at earlier stages to generate a faster escalation of their research results. The long period of research in the biomedicine sector highlights the need for continuous funding (Hernandez-Cuevas, 2007). Clearly, this might hinder companies' growth and will be discussed in the next section.

### **The Role of Social Networks in The Growth of Companies**

The growth of the first firms in the cluster has been diverse. Only one of the firms, BiosChile, has grown to be considered a large firm in sales and in number of employees. It is a key firm in the cluster and the first that has generated a spin-off in the same sector. The owners of the company are renowned as scientists and professors at the best universities in Chile. One of the owners, Pablo Valenzuela, received the National Award in Applied and Technological Sciences in 2002. He studied biochemistry in Chile and received his PhD from Northwestern University before continuing with his postdoctoral studies at the University of California in San Francisco. He was co-founder of a biotechnology company in the US, Chiron Corporation and together with Arturo Yudelevich, a former undergraduate classmate, they established BiosChile in 1986. Arturo Yudelvich studied biochemistry and completed his doctoral studies at the Albert Einstein College of Medicine of Yeshiva University, in the USA. Additionally, they founded Fundación Ciencia Para La Vida in 1997, a private non-profit research institute. This created the grounds for the establishment of the technological park in biotechnology in 2006, in the same location where the firm and institute are based. BiosChile is the biggest biotechnology company in Chile, exporting their products to the US, Latin America and Europe. They also founded a commercial company in the US to facilitate the import and export process.

Besides this successful case, other companies established in the late 80s increased their sales and exports during the last years of the 90s and the last decade; however their exports have fallen due to the international crisis. To increase sales and exports in a dynamic market as biotechnology, a crucial element for the growth of companies is the creation of new products. Firms need to continuously research in this sector in order to create new products such as reagents or diagnostic tests. As previously shown, capital is crucial to maintain research efforts. Nevertheless, when asked about the main difficulties that firms face today for their growth, lack of capital is not the most important (see table 5).

**TABLE 5**  
**Main Difficulties in Firms' Growth**

| <b>Difficulties</b>   | <b>Low<br/>Relevance</b> | <b>Medium<br/>Relevance</b> | <b>High<br/>Relevance</b> |
|---|--------------------------|-----------------------------|---------------------------|
| Lack of capital   | 64.3%                    | 14.3%                       | 21.4%                     |
| Difficulties with getting funds from the financial sector     | 76.9%                    | 0.0%                        | 23.1%                     |
| Difficulties getting co-funders or partner companies          | 84.6%                    | 15.4%                       | 0.0%                      |
| Difficulties accessing Venture Capital companies or Angel Inv | 84.6%                    | 15.4%                       | 0.0%                      |
| Lack of financing from governmental agencies                  | 71.4%                    | 7.1%                        | 21.4%                     |
| Lack of orientation from governmental agencies                | 53.8%                    | 23.1%                       | 23.1%                     |
| Difficulties getting suppliers in the national market         | 84.6%                    | 7.7%                        | 7.7%                      |
| Difficulties getting suppliers from abroad                    | 84.6%                    | 15.4%                       | 0.0%                      |
| Difficulties getting clients in the national market           | 69.2%                    | 0.0%                        | 30.8%                     |
| Difficulties getting clients from abroad                      | 46.2%                    | 15.4%                       | 38.5%                     |
| Legal regulations (Sanitary, Patents, International, etc.)    | 46.2%                    | 23.1%                       | 30.8%                     |
| Difficulties finding adequate qualified human resources       | 46.2%                    | 23.1%                       | 30.8%                     |
| Difficulties accessing leading knowledge and technologies     | 92.3%                    | 7.7%                        | 0.0%                      |
| Difficulties buying leading equipment                         | 76.9%                    | 15.4%                       | 7.7%                      |
| Others  | 0.0%                     | 0.0%                        | 23.1%                     |

Source: Author's survey

The main difficulties for firms' growth are related to finding new clients in the national and international markets. Regulations are important as well, in particular customs regulations regarding the import and export of biotechnology products. Lack of qualified human resources continues to be a problem. As mentioned before, the main shortage of personnel is in the

management area. Interviewees perceived that while local scientists are highly prepared, there is a lack of managers with knowledge of both the scientific and business world.

Lack of capital or access to capital seems to be relevant for nearly 22% of the biotech firms in the region. This striking result could be explained by the natural selection or survival of the fittest firms and death of start-ups. Established firms are the ones that succeeded. We cannot observe firms that faced bankruptcy or entrepreneurs that could not start a company. This might bias the results, undermining the relative importance of capital. Studies of the creation and destruction of companies in Chile show that small companies have a 50% probability of survival during the first seven years (Benavente, 2008). It would be important to study firms or entrepreneurs that did not succeed in order to understand the reasons for failure and how relevant lack of access to capital was. From the case study, it was not possible to identify if a firm has left the market since 2007.

To test for the importance of social capital on firms' funding restrictions and following on from table 4, a cross tabulation between levels of social capital and financial difficulties is presented in table 6.

**TABLE 6**  
**Highly Relevant Financial Difficulties in Firms' Growth, by Social Capital of the Company and Owners**

| <b>Difficulties</b>                                       | <b>Low Social Capital</b> | <b>High Social Capital</b> |
|---|---------------------------|----------------------------|
| <b>Commercial Network</b>                                 |                           |                            |
| Lack of capital   | 48.9%                     | 25.0%                      |
| Difficulties with getting funds form the financial sector | 33.3%                     | 25.0%                      |
| <b>Social Network</b>                                     |                           |                            |
| Lack of capital   | 60.0%                     | 21.4%                      |
| Difficulties with getting funds form the financial sector | 40.0%                     | 23.1%                      |

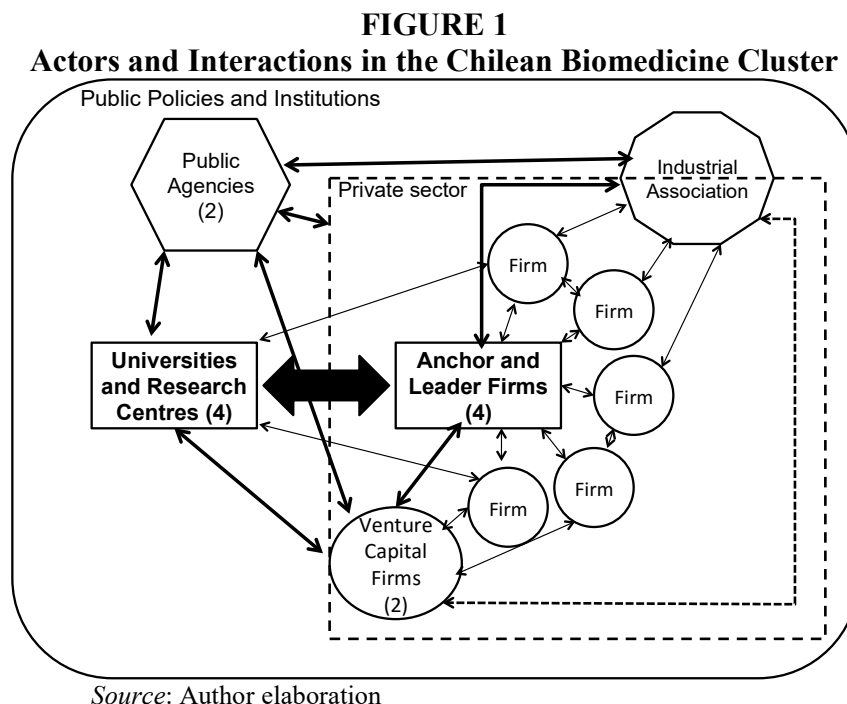
Note: High social capital was defined as total number of ties above the mean of total ties in each network.

Source: Author's survey

Results confirm the relevance of social capital for access to financial capital. Additionally, as mentioned in the previous section, founders of the first biotech companies were professors in local universities and continued researching and teaching in those institutions, which reduces the amount of capital needed to conduct research on the company. Collaboration in research projects with universities could also reduce the cost of research for companies. These linkages will be analysed further in the following sections.

## 5. MAJOR ACTORS OF THE BIOMEDICINE CLUSTER IN CHILE

The above discussion presented the conditions and difficulties faced by biotech firms in their origins and growth. However, there are other relevant actors in the sector that interact among them. This section will introduce these actors, analysing their role in the formation and evolution of the cluster. Different actors and their interactions are shown in figure 1, which is the result of the observation and analysis of this case study.



There are a series of events that show the path-dependent growth of the sector in line with results from different life science clusters in Canada (Gertler and Vinodrai, 2009). Public policies' discontinuities, historic pre-conditions and interactions between actors shape the development of this cluster. Nevertheless, the role of universities has been central; however the most important push for the sector comes from a dominant actor.

### **Public Policies and Institutions**

National policies that promote the development of the biotechnology sector have been irregular. As described by Feldman, Francis and Bercovitz (2005), policies are fundamental and can cause an external shock that changes the conditions for entrepreneurs, establishing the conditions for the development of a cluster. Porter (1998) also considers the role of institutions as key in the development of clusters. In the particular case of the biomedicine cluster in Chile, policies focused on developing the sector have been infrequent.

The creation of the biotechnology division in CORFO was an important signal for the market. During this time, several research centres were created and financed by public research grants from the National Commission of Science and Technology (CONICYT in Spanish). A technological park focusing on biotechnology was financed by CORFO and established in Santiago, in the same location where BiosChile and Fundación Ciencia para la Vida were based. Therefore, public research grant schemes have helped to establish the relevant biotechnology research foundations in universities and the private sector.

It was important to note from interviews and surveys that most common collaborations between firms and universities were done under government programmes that promote collaborative research in CONICYT and CORFO. In this particular cluster, based on knowledge

and research, collaborative research grants act as indirect subsidies in research for biotech companies.

The focus of innovation policy on the development of specific clusters, such as food, mining and aquaculture, caused biotech companies in the health sector to start research lines associated to those sectors. Companies have included research on vaccines and the health of salmons, fruits and vines and animal health, in order to obtain funds from government grants. It is not clear if these new research areas will continue after the latest changes in policy. Government agencies have withdrawn the prioritisation of these sectors in the distribution of research for innovation. Additionally, a division in CORFO focused only on biotechnology was eliminated. This change might cause biomedicine firms to only focus on human health research. Yet, if they perceive these research areas to be able to give them high returns, they will continue and increase research on them. The potential effects of these changes in policies cannot be evaluated yet. As mentioned by one of the experts interviewed “*three years that the government cut the funds to support biomedicine projects are three years lost and ten years to recover [the research]*”.

### **Universities and Research Institutions**

Universities are fundamental actors in this cluster. The scientific research base for medicine and biology has a long tradition in the oldest universities of Chile, located in the metropolitan region. The scientific knowledge base provided by local universities was fundamental for the creation of other biotechnology clusters in Canada and Vienna (Gertler and Vinodrai, 2009; Todtling and Tripl, 2009) and is observed in the Chilean case as well.

Most entrepreneurs in the first stage of the cluster studied biochemistry at the University of Chile. They met there and established long-term friendships. Young entrepreneurs or managers of new start-ups also met the first biotech entrepreneurs as they were their university professors.

The first entrepreneurs have become mentors of young scientists. Thus, universities have an important role in generating networking and social capital for scientists.

Another role of universities is to provide scientists and a labour pool for the cluster. The first entrepreneurs, BiosChile's owners, promoted the creation of the Biotechnology degree at the University of Chile in 1996. Today, there are 15 universities with a degree in biotechnology or biotechnology engineering, contributing, together with biochemistry and other biology related studies, to create an important scientific pool for the cluster.

A third and final role of universities in this cluster is the research conducted in several areas of human health. As research centres, universities act as clients of some biotech companies since they require reagents and input for the research process. Furthermore, universities are research partners for many biotech companies. These alliances could provide the advantage of reducing research costs for both partners and increasing the probability of obtaining resources from public research grants. Additionally, they could reach economies of scale in the use of equipment and input for research. A possible disadvantage is that research conducted in universities has different timetables and objectives than research with productive orientation.

The founding of Fundación Ciencia para la Vida, the first world-class private research centre in biotechnology in Chile, has been a major breakthrough. It was founded by the owners of BiosChile, yet they could apply for public research grants and research in other areas not directly associated to BiosChile's main core. It is an important actor in the cluster, being the recipient of important research grants and having established international agreements with universities in the US. Today the centre is economically independent from BiosChile. University research centres, on the other hand, seem to be sensitive to public funds. Some research centres funded with public funds in 2006 were no longer functioning as a centre after public funding ended. Those centres



were located in departments of the main universities, which imply that researchers working in the centres continued doing so within the university.

To conclude, universities have three main roles in the biotech cluster. Firstly, they educate the scientists that will work in the cluster in the future. Secondly, social capital of scientists is built in the interaction between teachers and students as well as among students. Finally, they conduct research not only at universities but also collaborate with biotech firms, reducing costs and reaching economies of scale of research.

### **Lead and Anchor Firms**

Lead or anchor firms are important firms that, for their size and importance in a cluster, can attract other entrepreneurs and also create several spin-off companies (OECD, 2009). In this context, anchor firms are seen as the starting point from which a cluster develops (Felzensztein and Gimmon, 2009). In Denmark (OECD, 2009) and in some regions of Canada (Gertler and Vinodrai, 2009), the role of anchor firms in biotechnology clusters is important for their development and growth.

The history of BiosChile, presented in previous sections, is a clear example of a leading firm in the biomedicine cluster of Chile. Furthermore, its owners are what could be called star-scientists, i.e. national or international leading scholars in biotechnology research (Gertler and Vinodrai, 2009). Owners of BiosChile are renowned scientists at national level, with continuous linkages with international biotech firms and universities, which keep them in a leading position. The leadership of these owners is so relevant in the national aspect that they are also counsellors for investment companies. Thus, their sustained leadership comes from the social capital of their owners and because they are part of an international knowledge flow in biotechnology.

International linkages are crucial in maintaining international knowledge flows from external sources of the cluster. As Gertler and Vinodrai (2009) suggest, external knowledge sources are fundamental for the innovation and dynamics of biotechnology clusters in Canada. It also confirms the importance of external knowledge for the renewal of clusters to avoid their decline, as proposed by Menzel and Fornahl (2009) and Uzzi (1996, 1997).

Some drawbacks of this leadership can emerge, especially if there is only one important firm in a small cluster like this. As Christopherson and Clark (2007) studied, the power of multinationals in a network of firms could detriment the growth of local companies if they exert that power for the consecution of their interests, which could be unaligned with national companies' interests. A similar situation might occur in a cluster if there is only one relevant firm that might have relatively more power than others and also if their interests are different from the rest of the firms in the cluster. Another potential downside of having only one leading firm, is the possibility of generating a lock-in of the knowledge in the cluster, however international linkages reduce this potential weakness (Uzzi, 1996 and 1997; Menzel and Fornahl, 2009; Gertler and Vinodrai, 2009).

Linkages of this anchor firm and its owners have been crucial for the development of the cluster. In particular, the successful example of this company might act effectively as a leading firm in the cluster, attracting other entrepreneurs and firms to locate their firms in the region. The firm, through Fundación Ciencia para la Vida, has generated awareness of the relevance and economic potential of biotechnology in the political and scientific realm. They run a workshop on genetic engineering for 'opinion leaders', in which politicians, journalists and presidents have participated. In the academic world, owners and researchers of the firm still teach some courses in different universities, and promote international student exchanges with Universities in San Francisco.

In summary, this firm and its owners play a relevant role in the promotion of the biotechnology sector in Chile. They are an important example of a successful firm and have mentored and taught several scientists. They maintain international linkages and promote the awareness of biotechnology between politicians and opinion leaders. The firm can be considered as a leading firm, which has been fundamental for the development of the sector in Chile.

### **Industrial Associations**

There is one industrial association of biotech firms, the Asociación de Empresas de Biotecnología (Asembio). It was founded by a group of the first entrepreneurs in the sector in 2004. The idea was established at an informal meeting at a biotechnology congress in Concepcion in 2003. An entrepreneur from a small company that provides consultancy services for biotech firms attended the International Convention of the Biotechnology Industrial Organisation (BIO), in 2001 and 2002, this being one of the most important international biotechnology fairs in the US. After attending those two years, he was aware of the different perspectives and strong organisation that biotechnology companies had abroad. In 2003, in the National Biotechnology Congress, he met with the owners of the first two biotech companies in Chile, BiosChile and Biosonda. They decided to form Asembio in that meeting and the first office of the association was within the facilities of Biosonda.

During the first years of Asembio, the focus was to establish connections with international organisations and to promote the importance of biotechnology in Chilean governmental agencies, such as CORFO. Attending BIO Conventions were the main activities.

The change of directive in 2010 has made a change. They have two projects financed and supported by CORFO. The first aims to promote the Chilean biotechnology sector in the US by promoting Chile as a country of high biotechnology potential. The second project aims to

increase relations between 'bioentrepreneurs' and investors and to generate a favourable environment for entrepreneurship in the biotechnology sector in Chile.

Asembio today not only congregates biotechnology companies from all areas, but also venture capital companies, research institutions and universities, government institutions and lawyers firms, whom today are all partners of the association. The association has an important role in promoting networking between biotech companies, since 11% of the linkages identified by companies related to partners in Asembio. Another role that Asembio has taken on is to encourage innovation policies towards the promotion of the sector. However, some firms have said they have not benefited much from participating in Asembio during interviews.

There are other industrial associations that could play an important role in the sector; however there is no interaction between these associations. There are two associations of pharmaceutical laboratories. One congregates national laboratories and the other international laboratories. Nevertheless, the two largest national pharmaceutical laboratories are not involved in any association. There might be scope for national laboratories to collaborate with local biotechnology companies, as this interaction is observed in other biotech clusters in developed countries. International laboratories could also collaborate with local biotech companies and public policies could promote such associations in the country. Asembio could promote these new interactions in the sector, including other relevant actors.

According to Gertler and Vinodrai (2009), industrial associations are relevant for the development of biotech sectors when they align interests and resources of different stakeholders in the cluster (p.251). The incorporation of new partners into Asembio is recent. For some of the partners, it is not clear how Asembio's new partners, directive and projects will benefit them in practice. Yet, the cluster life cycle model of Menzel and Fornahl (2009) identifies the process of building institutions to promote collective actions and lobbying for the achievement of the needs

of a cluster, as a sign of a growing cluster. If industrial associations manage common resources, effectively promote collective actions and reduce the probability of free riding (Ostrom, 2000), firms could benefit from the positive externalities of agglomerations, which might reinforce linkages and sustained growth of the cluster. In the case of this cluster, Asembio seems to be in the early stages of promoting collective actions. Results of the new policies could be fundamental for the future development of the cluster.

### **Venture Capitalists and Investors**

There are 22 venture capital (VC) companies in Chile<sup>1</sup>, and only two of them invest in the biomedicine sector. These two VC firms were founded in 2007 and 2008 with the support of CORFO, being new actors in the cluster. The reduced number of VC companies investing in the biotechnology business might be due to the sector's high risk as well as information asymmetries between scientists and investors. Venture capitalists need to know about the sector, research time and the production process. If investors do not have knowledge of the sector, they need advisors who do. In the biotech sector, advisors are not only scientists, but most importantly, they should be experienced businessmen in biotechnology. Since the sector in Chile is small, not many persons fulfil these requirements. This could become a risk of knowledge and entrepreneurship lock-in (Walker et al., 1997; Menzel and Fornahl, 2009; Gertler and Vinodrai, 2009). Social and knowledge networks play a fundamental role in promoting cluster growth and avoiding its declining. Thus, it is extremely important to have access to international knowledge, networks and assessors in biotech.

Gertler and Vinodrai (2009) show that in the biomedicine sector in Canada, private sources of capital of biotechnology companies came from angel investors, family and friends. The

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<sup>1</sup> Asociación Chilena de Fondos de Inversión (ACAFI), 2011. Reporte de Venture Capital y Private Equity en Chile. 2010 – 2011.

analysis conducted above established the importance of personal relations in funding biotechnology companies in their first years. Venture capital firms were not important for the first entrepreneurs because the venture capital industry in Chile did not exist. Since 2000, the industry has been developed with the support of CORFO. For new entrepreneurs, VC funds are more relevant; however there is still a low number of biotech companies financed by VC firms.

Managers of VC funds meet with several entrepreneurs to listen their business plan and ideas; however if another manager, investor, client or business partner previously recommends the person and the project, they will consider that the business idea *“has passed a first filter”* and might have higher probabilities of success. One of the VC managers explains that *“if another investor is funding a company and it has already completed the analysis and research of the project, it gives more credibility [to it]”*. Another manager mentioned *“in general you work very much based on relationships because there are few companies, few investors”*. It is important to know the person with whom you are investing in a business and it is crucial to build trust. An interviewee commented that *“life is based on relationships with people and in a globalised world like this, to know another person is our main asset”*. This reflects the crucial role of personal relations and trust in funding biotechnology companies. Yet, the small number of firms and investors might hinder the cluster’s growth, particularly if entrepreneurs have a big entrance barrier, which is to know or form part of the social network of the sector.

In this respect, pharmaceuticals have a new role in the cluster. The two major national pharmaceutical laboratories are recently acting as investors and partners of biotechnology companies. Pharmaceuticals have traditionally collaborated with researchers in universities, giving discounts on reagents and equipment or financing conferences. In the last four years, two large national pharmaceuticals have engaged in research projects or invested in biotech

companies. As discussed above, the entrance of new investors might be crucial for the development of the cluster.

In the Canadian case, venture capitalists also provided business planning, strategy formulation and coaching (Gertler and Vinodrai, 2009). This is also found in the Chilean biomedicine cluster; however the number of firms financed is limited. CORFO and a university incubator launched a business-planning program in biotechnology in 2008. During the different phases of the program, they selected only the projects with high commercial potential. From the 97 applications, only a couple of them had a clear or feasible business plan. There is the need for the development of these skills in the scientific world. Universities have recently included business courses in their biotechnology programs; however other programs such as biochemistry and biology might also benefit from these courses. Venture capital investment in the biomedicine and biotechnology sector in Chile is in its first stages. The role that these companies might potentially have in the development of the sector is important. In particular, they change the environment for entrepreneurship in the sector. However, the heavy reliance of investors on social capital and relations might become a problem for the cluster if this contributes to the knowledge and business lock-in.

This section has described the different actors and their role in the biomedicine cluster in Chile. The next section will analyse the interactions among them and how these relations shape the knowledge flows within the cluster.

## **6. LINKAGES AND KNOWLEDGE FLOWS BETWEEN ACTORS**

This section will examine the relations between the actors and the consequences of it on the knowledge flow, emergence and development of the cluster.

### **Interaction Between Actors of the Cluster**

From figure 1 we observe that there are linkages between all agents in the cluster; however, it is possible to identify four main types of interactions: universities and biotech firms, venture capitalists and biotech firms, pharmaceutical and biotech firms and pharmaceuticals and universities.

Interactions between universities and firms have taken several forms. The most frequent is the interaction in research projects funded by both parts and public research grants. This is the main core of the cluster's knowledge base. Another type of interaction occurs when owners of biotech firms teach at universities. These interactions build social relations, establishing the social network of the cluster. Finally, universities are clients of biotech companies. They buy reagents and diagnostic services, which is an important source of capital for biotech firms to maintain their in-house research.

Interactions between venture capital firms and biotech firms are at an early stage. Venture capital funds were established in 2008 as presented in the previous section. Since investors rely heavily on social relations and the advice of star-scientists and businessmen, knowledge flows between these two actors seem to be from earlier entrepreneurs to venture capital firms. These relations should increase in the future and venture capital firms might have an important role in networking between local firms and international investors, promoting fast growth of biotech firms.

Pharmaceuticals and universities usually collaborate on research projects financed by government grants. In 2004, CORFO and CONICYT promoted and subsidised the creation of technological consortiums, which are private companies founded by universities and other private companies, focusing on producing technological innovations. There are two consortiums in the health sector, created under this scheme in 2006 and 2008. Pharmaceuticals and universities are



partners in these consortiums. Consortiums are in their early stages and have not produced a breakthrough innovation. Alvarez et al. (2012) find that the main difficulties for consortiums are the differences between academic oriented and commercial oriented research timelines, which is supported by the interviews in this study.

Interactions between large Chilean pharmaceuticals and biotech firms are at an initial stage. Pharmaceuticals are engaging in research and investing in biotechnology firms. These relations might be crucial for the future development of the sector, since the two largest Chilean pharmaceutical companies, Recalcine and Andromaco, started an internationalisation phase during the last decade of the twentieth century. Nowadays, they are important producers and sellers of drugs in Latin America. The perspective to establish stronger linkages between these two groups of firms and its implications for the biomedicine cluster should be considered and studied further. These associations might enhance applied research in biotech firms and could be an interesting pipeline to speed up the development of the biomedicine sector, particularly because of their important market share in the region. In this sense, linkages with pharmaceuticals with a presence in the Latin American region should be considered as an interesting possibility for increasing the economies of scale and competitiveness of the sector.

### **Human Resources and Star-Scientists**

As noted from the above analysis, knowledge flows are fluid between universities and firms. Nevertheless, high concentration of firms and research centres in a cluster could impede clusters' growth if the knowledge base and technology is similar (Menzel and Fornahl, 2009). Thus, external linkages appear to be crucial for knowledge heterogeneity and to renew technology used by actors in the cluster (Menzel and Fornahl, 2009; Gertler and Vinodrai, 2009)

The most important external knowledge diffusion is made by Chilean scientists, owners and managers in companies and universities, who studied in leading international universities. During their studies, fundamental linkages for the growth of companies and to conduct frontier research are created. This was the case with BiosChile, for example. Experience abroad seems to be crucial not only to learn advanced research techniques, but also to establish contacts and maintain external knowledge flows with international researchers and to learn about the business model of biotech companies in leading countries in biotech.

The importance of external knowledge flows in cluster life cycle is fundamental for cluster renewal and survival (Menzel and Fornahl, 2009). It is also found in the life science sector in Canada and the Netherlands that external knowledge flows are important for the innovative performance of firms (Geenhuizen and Reyes-Gonzalez, 2007; Gertler and Vinodrai, 2009). In agreement with the findings of Casper (2007), Gertler and Vinodrai (2009) and Lawton and Waters (2011), qualitative and social network analysis seem to highlight the role of working or professional relationships as the main structure for knowledge flows within the biotech cluster.

According to Casper (2007), labour mobility was the main channel of knowledge transfer between biotech companies in San Diego. Lawton and Waters (2011), find considerable labour mobility of highly skilled scientists in Oxford and Cambridge. In the Chilean case, from interviews it was possible to identify that, while there is labour mobility between junior researchers, senior researchers' mobility is low, which is consistent with the biotechnology cluster in Vienna (Todtling and Trippl, 2009). This result illustrates that professional relations in the Chilean case are maintained in the long run among senior researchers in different institutions. These might be the foundations of repeated research collaborations between biotech firms and universities, for example.

Another potential problem for the development of the sector is the low number of cases where employees create new biotech firms and the low number of spin-offs and start-ups. According to the interviewees' perception, only recently has the idea of being an entrepreneur become a real alternative for younger generations of scientists. Star-scientists have been important models for younger generations and could have contributed to changing preconceptions and negative biases of local scientists about commercialisation of research results. A star-scientist in a cluster might attract other important scientists (Lawton and Waters, 2011; Gertler and Vinodrai, 2009).

Labour experience abroad seems fundamental as well. Scientists and managers with international labour experience bring new knowledge and dynamism to the sector. In the newest start-ups, venture capital funds and research centres, there is a group of young professionals with international study and labour experience. The generational change that is occurring at the moment in the sector might cause important transformations in the cluster.

Alternatively, Chilean scientists and professionals that settle down abroad might play an important role in cluster growth. For example, a biotech company contacted a Chilean scientist working in the US to visit their facilities and understand how the firm worked. This tacit knowledge transfer was possible because there was a Chilean working in an American company. Additionally, an investor commented about the importance of opening a new market to generate collaboration abroad. The importance of nationality and trust in the international context should be the subject of future research. As Portes and Sensenbrenner (1993) show, citizenship is important for generating trust. They analyse examples from immigration literature to conclude that citizenship, phenotypes and cultural similarities generate solidarity and trust between immigrants. These interactions generate social capital within immigrant groups that have positive effects on entrepreneurship and informal social and capital safety-nets.

Finally, as noticed in previous sections, there is an important lack of managerial skills in the cluster. The required managerial skills are a mix between scientific knowledge and technology management and diffusion. This is also found in the Vienna case (Todtling and Tripl, 2009), raising important questions about the global pool of managerial workers with scientific knowledge. Labour experience in this particular area and studies abroad might be crucial in knowledge-based sectors. Public policies on study abroad scholarships, such as BecasChile, might be in the right direction; however it is important to consider the diasporas' role in cluster development. Further research is needed in this respect.

## **7. CONCLUSION**

This paper analysed the formation of the biomedicine cluster in the metropolitan region of Chile. Based on qualitative evidence from in-depth interviews, it is possible to identify that social relations have a major role in cluster formation and development in its first stages. Results from in-depth interviews suggest that social relations are significant to attract capital from private investors and venture capital funds, in line with results of Uzzi (1999) and Hsu (2007). This is particularly important for firms' growth when firms need to increase their capital to scale up the results of their research. It is perceived by the interviewees that the relevance of social relations to attract capital is more important in the biotechnology sector than in other sectors. Furthermore, it seems that location decision is not only influenced by commercial possibilities or other features of the region, but what is more important for an entrepreneur is to establish his/her company near where they live. These results highlight the importance of social relations and social capital on firms' creation. Therefore, social relations are essential for location decision, access to investors and capital and to establish commercial and research collaborations, giving support to the

hypothesis in this study. In summary, social relations are fundamental in the creation and first stages of cluster formation, as established by Francis, Feldman and Bercovitz (2005).

From a cluster life cycle perspective, following Menzel and Fornahl (2009), the biomedicine cluster in Chile is still in the formative stage, however, for the last five years there have been relevant changes in the cluster. The creation of the industrial association, the creation of venture capital funds investing in biotechnology and the foundation of new start-ups and spin-offs, might be seen as a major change in the cluster evolution. The cluster seems to be in an early phase of growth, with new players and relations among them. How the cluster will develop and evolve from this stage might depend on how institutions evolve.

An important aspect to consider is the possible drawbacks of social relations in the evolution of the cluster (Uzzi, 1996 and 1997). Knowledge lock-in might hinder a cluster's growth (Menzel and Fornahl, 2009). External linkages and relations are crucial to reduce this risk. In this case, academic external linkages potentially reduce this risk; however it seems more important to establish industry connections through work experience abroad. Another negative aspect is the high importance of social relations for fundraising, which might reduce the creation of firms in the cluster. The small number of firms and investors might hinder the cluster's growth, particularly if entrepreneurs have a big entrance barrier. In biotechnology capital requirements are high, therefore access to capital is an entrance barrier. In addition, to know or form part of the social network of the sector, particularly networks of scientists and business owners, might also relate with access to capital and could be thought as an additional entrance barrier.

In summary, it is possible to identify that social relations were fundamental in the creation of the cluster and are crucial today for the cluster's growth. Social relations are also important for the linkages between different firms and between firms and universities. It can be concluded that in sectors with high information asymmetries and risk, social relations have an increasing

importance in generating trust between entrepreneurs, researchers and investors. Additionally, social relations are crucial when the sector and the cluster are in the earlier stages of development, as suggested in entrepreneurship literature. Institutions, or not fully developed institutions, have a crucial role in this context. The lack of a strong and developed financial system for entrepreneurs is compensated with social relations, forming a social network that functions as a parallel system of trust, signalling and financing, shaping location decisions of entrepreneurs. Therefore, social relations play a major role in the generation of new firms and firms' growth, shaping the emergence and developing of a cluster.

## REFERENCES

- Álvarez, E. R., Benavente, J. M., Contreras, C. and Contreras, J. L., 2012. Consorcios Tecnológicos en Argentina, Chile, Colombia y Uruguay. *Trimestre Económico*, 79(1): 227-256.
- Asociacion Chilena de Fondos de Inversion (ACAFI), 2011. *Reporte de Venture Capital y Private Equity en Chile. 2010 – 2011*. Santiago, Chile.
- Bell, M. and Albu, M., 1999. Knowledge Systems and Technological Dynamism in Industrial Clusters in Developing Countries. *World Development*, 27(9): 1715-1734.
- Benavente J.M., 2008. Dinámica Empresarial Chilena: 1999-2006. Ministerio de Economía, INTELIS, FUNDES y Foro Pro Innovación. Santiago, Chile.
- Boschma, R. A., 2005. Role of Proximity in Interaction and Performance: Conceptual and Empirical Challenges. *Regional Studies*, 39(1): 41–45.
- Casper, S. 2007. How do technology clusters emerge and become sustainable? Social Network formation and inter-firm mobility within the San Diego biotechnology cluster. *Research Policy*, 36: 438-455.
- Christopherson, S. and Clark, J., 2007. Power in Firm Networks: What it Means for Regional Innovation Systems? *Regional Studies*, 41(9): 1223 – 1236.
- Corporacion Nacional de Fomento Productivo (CORFO), 2006, *Biomedicina en Chile: Tendencias y Oportunidades*. Santiago, Chile, December 2006.

- D'Amore, R., Iorio, R., Stawinoga, A., 2010. The Role of Institutions and Firm Characteristics in the Networks of Firm Publications: An Analysis of the Italian Biotech Sector Through the Social Network Analysis. *World Journal of Management*, Vol. 2 (3), pp. 81-100.
- Feldman, M. P., and Audretsch, D. B., 1999. Innovation in cities: Science-based diversity, specialization and localized competition. *European economic review*, Vol. 43 (2), pp. 409-429.
- Feldman, M., Francis, J. and Bercovitz, J. 2005. Creating a Cluster While Building a Firm: Entrepreneurs and the Formation of Industrial Clusters. *Regional Studies*, 39(1): 129-141.
- Felzensztein, C. and Gimmon, E. 2009. Social networks and marketing cooperation in entrepreneurial clusters: An international comparative study. *Journal of International Entrepreneurship*, 7: 281–291.
- Geenhuizen, M. and Reyes-Gonzalez, L., 2007. Does a clustered location matter for high-technology companies' performance? The case of biotechnology in the Netherlands. *Technological Forecasting and Social Change*, 74: 1681–1696.
- Gertler, M, and Vinodrai, T., 2009. Life Sciences and Regional Innovation: One Path or Many? *European Planning Studies*, 17(2): 235–261.
- Giuliani, E. and Bell, M. 2005. The micro-determinants of meso-level learning and innovation: evidence from a Chilean wine cluster. *Research Policy*, 34: 47–68.
- Giuliani, E., 2007. The Selective Nature of Knowledge Networks in Clusters: Evidence from the wine industry. *Journal of Economic Geography*, 7: 139-168.
- Giuliani, E. and Pietrobelli, C. 2011. Social Network Analysis Methodologies for the Evaluation of Cluster Development Programs. Inter-American Development Bank, Capital Markets and Financial Institutions Division (ICF/CMF). TECHNICAL NOTES No. IDB-TN-317, November 2011.
- Hagedoorn, J., Link, A. and N. Vonortas, 2000. Research Partnership. *Research Policy*, 29: 567–586.
- Hernandez-Cuevas, C., 2007, Collaborative Innovation: The Future of BioPharma. *Journal of Technology Management & Innovation*, 2(3): 1–3.
- Hsu, D. H., 2007. Experienced entrepreneurial founders, organizational capital, and venture capital funding. *Research Policy*, Vol. 36, pp. 722-741.
- Jaffe, A. B., 1989. Real effects of academic research. *The American Economic Review*, 79(5): 957-970.
- Lawton Smith, H., and Waters, R., 2011. Scientific Labour Markets, Networks and Regional Innovation Systems. *Regional Studies*, 45(7): 961 – 976.
- Menzel, M., and Fornahl, D., 2009. Cluster life cycles – dimensions and rationales of cluster evolution. *Industrial and Corporate Change*, 19(1): 205–238.
- OECD, 2009. *Cluster, Innovation and Entrepreneurship*, ed. by Jonathan Potter and Gabriela Miranda. Paris, France.

- Ostrom, E., 2000. Collective Action and the Evolution of Social Norms. *Journal of Economic Perspectives*, 14(3): 137-158.
- Owen-Smith, J. and Powell, W., 2004. Knowledge Networks as Channels and Conduits: The Effects of Spillovers in the Boston Biotechnology Community. *Organization Science*, 15(1): 5-21.
- Perez-Aleman, P. 2005. Cluster formation, institutions and learning: the emergence of clusters and development in Chile. *Industrial and Corporate Change*, 14(4): 651-677.
- Pitelis, C., 2012. Clusters, entrepreneurial ecosystem co-creation, and appropriability: a conceptual framework. *Industrial and Corporate Change*, Advance Access published March 24, 2012.
- Porter, M., 1998. Clusters and the new economics of competition. *Harvard Business Review*, 76(6): 77-90.
- Porter, M. E., 2000. Location, competition and Economic Development: Local Clusters in a Global Economy. *Economic Development Quarterly*, 14(1): 15 – 34.
- Portes, A., & Sensenbrenner, J., 1993. Embeddedness and immigration: Notes on the social determinants of economic action. *American Journal of Sociology*, 1320-1350.
- Powell, W., Koput, K. and Smith-Doerr, L., 1996. Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly*, 41(1): 116-145.
- Ter Wal, A. and Boschma, R. 2009. Applying Social Network Analysis in Economic Geography: Framing Some Key Analytic Issues. *Annals of Regional Science*, 43: 739-756.
- Todtling, F. and Trippel, M., 2009. The Biotechnology Cluster of Vienna, Austria, in *Clusters, Innovation and Entrepreneurship*, Ed. by OECD, 2009. Paris, France
- Uzzi, B., 1996. The Sources and Consequences of Embeddedness for the Economic Performance of Organizations: The Network Effect. *American Sociological Review*, 61: 674-698.
- Uzzi, B., 1997. Social Structure and Competition in Interfirm Networks: The Paradox of Embeddedness. *Administrative Science Quarterly*, 42: 35-67.
- Uzzi, B., 1999. Embeddedness in the Making of Financial Capital: How Social Relations and Networks Benefit Firms Seeking Financing. *American Sociological Review*, 64:481-505.
- Walker, G., Kogut, B. and Shan, W., 1997. Social Capital, Structural Holes and the Formation of an Industry Network. *Organization Science*, 8(2): 109-125.
- Whittington, K., Owen-Smith, J. and Powell, W., 2009. Networks, Proximity, and Innovation in knowledge-intensive Industries. *Administrative Science Quarterly*, 54: 90–122.