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# Agglomeration and Embeddedness of Belgian Biotech Firms: The Role of Venture Capital

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**Abstract.** The existing literature on cluster embeddedness largely neglects the impact of finance on the development of firms' network linkages. This is striking in so far that particularly venture capital is often referred to as 'smart money' providing firms not only with funds but also with network contacts. In order to answer to what extent venture capital impacts portfolio firms' territorial and network embeddedness and whether the geographical location of the venture capitalist has an effect on start-ups' local anchoring, we apply social network analysis [SNA] to data on venture capital flows. The empirical results retrieved deliver first evidences suggesting that investors exert an influence on the structural network position of their target firms.

*Keywords:* Venture Capital, Biotechnology, Networks, Knowledge Spillover, Embeddedness  
*JEL classifications:* R10, G24

## Introduction

In the transition towards a sustainable low carbon industry, particularly the biotech sector attained a pioneering role and is recently enjoying much attention by policy makers. Inspired by successful firm agglomeration such as Silicon Valley and legitimated by previous research that points out that regional clusters enhance firm innovation and performance and that they function as important drivers of regional economic growth (Hill & Naroff, 1984; Porter & Stern, 2001), more and more regions are striving after the development of innovative clusters.

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In this respect, especially the strengthening of promising knowledge-intensive sectors such as biotechnology and IT is at the forefront.

Commonly, it is anticipated that the agglomeration of firms leads to a number of advantages such as reduced transportation costs, a specialized labor force, optimized subcontracting and knowledge spillovers that increase competitiveness and innovation and do not occur to isolated firms (Bunker Whittington et al., 2009).

With respect to the creation of dynamic clusters and regional economic growth, a sufficient level of small innovative firms is deemed essential (Saxenian, 1990; Audretsch, 2001). In the biotech field, particularly venture capital [VC] forms an important source of young firm funding. Due to the riskiness of their business, insufficient hard assets, and the often long-term and capital intensive development processes, innovative biotech startups are generally unable to get capitalized by more conventional sources of money i.e. public securities markets, bank lending and insurance companies

Despite the mentioned advantages arising from co-location, not all regional clusters are performing equally well. Consequently, it cannot be assumed that firm agglomeration leads to higher firm performance and regional growth per se (Audretsch, 1998; Bathelt, 2002, p. 585; Cooke et al., 2005; Martin & Sunley, 2003). Instead, specific cluster endogenous characteristics such as the strength and development of a cluster's networks play a decisive role for a cluster's successfulness (Giuliani, 2010). Dense knowledge networks that are characterized by frequent interactions and valuable knowledge spillovers between well-embedded actors are assumed to stimulate the innovative behavior and by that the global competitiveness of firms (Giuliani, 2010).

The existing literature in economic geography on cluster embeddedness however largely neglects the impact of finance on the development of firms' network linkages. To our knowledge, there are so far no studies that straightforwardly measure the impact venture capitalists exert on their portfolio firm's territorial and network embeddedness. This is striking in so far that particularly VC is often referred to as 'smart money', providing firms not only with funds but also with network contacts. Given this 'social' character, we consequently hypothesize that VC is an important driver of start-ups' network embeddedness.

Thus, we intend to quantitatively assess if the structural position of local venture capitalists in the VC network impacts startups' embeddedness. Said differently, the geographic spread of startups' financing linkages and the impact investors exert on the local and global network and territorial embeddedness of young biotech firms is subsequently analyzed.

We strongly believe that the article's findings have important implications for the development of regional growth strategies. A sufficient level of finance is crucial for the stimulation of innovation and entrepreneurship. To be able to design efficient policy recommendations tackling potential shortfalls regarding the financing of entrepreneurial activity in the biotech sector, a detailed overview of VC investment patterns is indispensable. So far, the established literature has however mainly concentrated on assessing the spatial distribution of venture capital in the US. Studies analyzing the social topography of venture capital investment are however, with the exception of Sorenson and Stuart's (2001) seminal work, still rare. Using social network analysis, this article indicates that venture capitalists exert a significant influence on their target firms' relational embeddedness within the global VC network.

The paper is structured as follows: In the subsequent section, the evolution of agglomeration theories as well as different theoretical approaches are described. An emphasis is placed on dense networks as drivers of knowledge spillover and, consequently, regional economic growth. Consequently, the 'social' character of VC is elaborated on. Section 4 briefly introduces the applied methodology. Next, using Social Network Analysis, the network position of investors and target firms is assessed. The last section discusses the empirical results and provides some concluding remarks.

### **Theoretical concepts**

Economic geographers repeatedly stress that the location in an industrial cluster increases firm's economic and innovative performance (Hill & Naroff, 1984; Porter & Stern, 2001). Originally based on Alfred Marshall's theory of 'external economies of scale', firms embedded in 'industrial districts' are hypothesized to be more competitive than their counterparts outside of clusters. The underlying forces explaining these performance differences are the positive externalities or agglomeration economies emerging from the spatial concentration of interlinked firms such as knowledge spillovers, access to a specialized

labor market and infrastructure, and a decrease in other agency costs like transportation (Liefner & Schätzl, 2011). Simply put, agglomeration economies, which are external economies of scale, because they do not only occur to one firm but to all firms located in that area, imply that it becomes more beneficial for companies to locate in areas where other firms are already located (McCann, 2008; Stuart & Sorenson, 2003).

Despite the ongoing globalization of economic activity and decreases in telecommunication and transportation costs that were expected to diminish the importance of location, the contrary has happened. Firms are continuing to agglomerate and a firm's location choice remains an important issue with respect to its competitiveness (see also Audretsch, 1998; Porter, 2000). Although distance, and as a consequence transportation costs, are less important in location matters today, geography still remains important through the growing impact of the spatial dimension of other location factors such as labor costs, technical expertise and, most important, agglomeration effects.

Also in sectors that do not rely on immovable inputs, but on highly transportable resources such as scientific expertise, a high degree of firm concentration is observed (Audretsch & Feldman, 1996; Stuart & Sorenson, 2003). A prominent example of knowledge intensive firm agglomeration being the high tech valley around San Francisco. With respect to the agglomerating behavior of knowledge-intensive industries, it becomes obvious that the rationales behind agglomeration of economic activity have changed. Whereas the industrial district literature mainly emphasizes the cost advantages arising from firm agglomeration, more recent approaches like Porter's cluster model and the Regional Innovation Systems approach [RIS] tend to stress the importance of knowledge spillovers for innovation and learning processes (Liefner & Schätzl, 2011).

In essence, Porter's concept of 'industrial cluster' (Porter, 1998; 2000) can be regarded as an advancement of Marshall's industrial district approach. Generally, the cluster model reflects the increasing interest in 'knowledge' as production factor and basis for competitive advantage. Globalization, technological advances and reduced transportation costs have rendered traditional competitive advantages such as cost minimizations arising from the proximity to markets and inputs more and more unimportant. In the knowledge-based economy competitive advantages are instead achieved by combining existing inputs in new

and innovative ways. Those innovative processes increasingly require the participation of various actors (e.g. universities, firms, governmental institutions). Porter also assumes that capital is more abundant and easier accessible in clusters, because investors are well-acquainted with industry conditions. The availability of capital in turn stimulates entrepreneurship. In a nutshell, the cluster location plays an important role in that it brings together different actors and enables repeated interactions which in turn facilitate various information spillovers.

The idea that knowledge spillovers resulting from the interaction of different actors lead to innovation and by that increase firms' competitiveness is also taken on by the regional innovation systems approach [RIS] developed by Philip Cooke (1997; 1998). Similar to the cluster model of Porter, RIS anticipate the interaction between different economic and non-economic actors (e.g. firms, universities, research centers, governmental organizations, financial institutions, consultants, lawyers etc.). In that, regional innovation systems can be described as intersectoral networks. The underlying reasoning of the RIS approach being that regional specific characteristics such as regional institutions, the regional infrastructure as well as the financial and educational system etc. are abetting innovation. The performance of RIS is then also dependent on the existence of a vivid entrepreneurial culture, the availability of sufficient entrepreneurial financing and the degree of innovation and learning processes within the region. Especially the financial dimension plays a crucial role for RIS. It is argued that only a functioning financial infrastructure can ensure the development of innovative processes in that it boosts entrepreneurial activity (Cooke et al., 1997; Liefner & Schätzl, 2011). Given, those regional conditions are fulfilled, a regional system of innovation is established which furthers information exchange and knowledge creation and by that enhances a region's innovative capacity. By making specific regional institutional characteristics responsible for the innovative capacity of a region, the RIS approach follows an institutional economic geography logic.

In case of biotech companies, information spillovers and the specialized local labor force pool constitute the main advantages arising from firm agglomeration. To be more precise, the specialized and often tacit biotech knowledge is transferred easier when firms are located in geographical proximity (Audretsch, 1998). In addition, the larger local availability of highly-skilled people facilitates the recruitment process by e.g. lowering recruiting costs and efforts.

The larger availability of expert positions within a cluster in turn increases inter-firm labor mobility which furthers innovation by ‘learning through hiring’ (Bunker Whittington et al., 2009).

Audretsch (2001) analyzes the development of US biotechnology clusters and concludes, in line with the regional innovation approach, that for the establishment of successful biotech clusters regions need to fulfill several preconditions. Among those are, most importantly, the proximity to world class research institutions, the availability of finance including VC, a distinct entrepreneurial culture and a favorable regulatory environment (p. 14). Traditional tools used to promote economic development such as low taxes, reduced labor-costs and governmental subsidies on the contrary have proven less effective in the case of biotechnology (p. 14).

To conclude, among the underlying factors that facilitate dynamic entrepreneurship, knowledge creation and regional economic growth are the degree of cooperation between firms, the relational embeddedness of actors within the cluster as well as the existence of linkages to leading firms located in innovative hubs elsewhere (Bathelt et al., 2004). Those drivers are by no means mutually exclusive. Rather, they are reinforcing each other. The following section highlights knowledge spillover accelerating factors in further detail.

### *Local Networks*

The density of cooperation between firms, but also non-economic actors such as governmental institutions and research institutes is deemed decisive for the intensity of knowledge spillovers and the innovative capacity of clusters. For Porter, clusters consist of “interconnected companies and institutions”. It is thus not the mere co-location of firms that lead to knowledge spillovers and other advantages, rather the existence of local networks with a high intensity of cooperation is important for the success of clusters (Giuliani, 2010). Networks are broadly defined as “an integrated and coordinated set of ongoing economic and non-economic relations embedded within, among and outside of business firms” (in Giuliani, 2010, p. 264).

Dense knowledge networks that are characterized by mutual trust and repeated face-to-face contacts offer more possibilities for tacit knowledge spillovers which increases the innovative

capacity of firms. Hotz-Hart (2000) states that “innovation is an interactive learning process that requires knowledge exchange, interaction and cooperation among various actors” (p. 433). Cooperation is therefore particularly important in innovative sectors in that it facilitates new product development. The intensity of inter-firm cooperation is again alleviated by the spatial and sectoral proximity existing in clusters that make unplanned and frequent interactions possible (Boschma, 2005).

### *Network Embeddedness*

Firms that maintain a large number of strong cooperative linkages are said to be relational well-embedded within the cluster. From a policy perspective, firms’ network embeddedness is not only desirable due to its positive effect on knowledge creation, but also because it reduces the willingness of firms to relocate. Embedding in a new location requires in turn additional time, costs and efforts to create the mutual trust inalienable for knowledge spillovers. Deeply embedded firms are therefore less likely to relocate even if from a cost perspective other locations appear more beneficial (Boschma & Frenken, 2007; Knobens & Oerlemans, 2008). Though, geographical proximity which is crucial for the transfer of tacit knowledge can partly be offset by organizational proximity, by relocating, firms risk the loss of their well-established local linkages (ibid.). Thus, from a policy perspective, well-established local knowledge networks with deeply embedded firms are envisaged as they are supposed to accelerate positive spillovers and to decrease the likelihood of firms to move to another region.

Despite obvious advantages of deep network embeddedness such as frequent knowledge spillovers, Cooke et al. (2005), examining relational embeddedness, put forward that overembeddedness in local networks has an adverse influence on innovative activity (Bathelt et al., 2004; Uzzi, 1997; 1996; Porter, 2000). Too much relational proximity may lead to a repetition of the same processes and subsequently act as a barrier to learning and innovation. Such ‘lock-in’ is often occurring when the network is too restricted both by social contacts and geographic scope. In other words, less local and more external contacts positively impact firm’s innovative output and turnover.



### *External Linkages*

Besides relying on local networks, successful dynamic clusters are dependent on external international linkages. Clusters that are characterized by both a multitude of local linkages and a large openness towards external markets are often showing a higher innovative capacity and are in general more competitive than loosely connected inward-looking clusters (Bathelt et al., 2004; Bathelt, 2002; Larsson & Malmberg, 1999). Bathelt et al. (2004) have coined the terms ‘local buzz’ and ‘global pipelines’ in this respect. Local buzz describes the agglomeration of firms that facilitates fortuitous face-to-face contacts and by that knowledge spillovers at the local level. On the contrary, global pipelines are consciously established linkages with innovative hot spots elsewhere. Those global contacts, the authors argue, are important in that they feed local clusters with new knowledge generated in innovative hubs elsewhere. By inducting ‘new knowledge’, global pipelines guard to some extent against lock-in and too rigid, innovation hampering networks. Only by combining local knowledge with external inputs, a cluster can remain competitive in the long run. Although the pipeline is often solely established between two firms, a local and a foreign one, the gained knowledge will get dispersed through the local buzz and eventually, depending on their absorptive capacity, all cluster participants will be able to benefit from it (ibid.).

A dominance of international linkages nevertheless entails the danger that a cluster becomes too internationally oriented and that it loses its local grip, potentially resulting in the relocation of firms and eventually in the diminishing of the cluster. Chances for this scenario are, though existing, relatively small. Due to the high costs and efforts related to the establishment and maintenance of global pipelines, Bathelt et al. (2004) hypothesize that a firm is only able to maintain a limited amount of ‘global pipelines’

Summing up, applying the insights obtained from the theoretical discourse to the analysis of industrial cluster, it is explicit that attention must be paid not only to the identification of firm agglomerations, but also to the analysis of underlying factors that facilitate knowledge spillovers and in that are important determinants of successful regional innovation systems. Both the RIS approach and Porter’s cluster model highlight the importance of a sufficient availability of VC for the development of entrepreneurship and consequently innovative processes. Less attention is however paid to the impact VC exerts on the establishment of

dense networks and firms' relational embeddedness. Thus, in order to fill the prevailing literature gap, in this paper we particularly concentrate on the latter.

### **Impact of Venture Capital on Knowledge Spillover and Embeddedness**

In economic literature, it is widely accepted that venture capital [VC] eases the creation of startups and therefore forms an important catalyst for the dynamic growth of clusters (Florida & Kenney, 1988; Martin et al., 2002). VC can be regarded as a special form or subset of private equity. Commonly, VC funds are employed to back embryonic high tech firms by offering various services in return for equity stakes. Their activities range from management support, personal and professional relations (networks) to, most importantly, the provision of monetary funds (Collewaert et al., 2010; Gupta & Sapienza, 1992; Zider, 1998). Due to the riskiness of their business, insufficient hard assets, and an unforeseeable rate of return, innovative startups are generally unable to get capitalized by more conventional sources of money i.e. public securities markets, bank lending and insurance companies (Zider, 1998).

Besides providing incumbent innovative firms with funds, venture capitalists, reverting to their vast sectoral knowledge and personal contacts, are frequently facilitating the entry of startups into existing industry networks (Zook, 2004). Especially in the early growth phase of a startup, close personal contact to the venture capitalist is of particular importance. During this phase, the young firm makes its first experiences in the market environment and subsequently strategy adaptations are often made. With respect to the reassessment of the business strategy and the provision of valuable business contacts, the abundant expertise of the venture capitalist is usually crucial (Devigne et al., 2011).

Zook (2002) introduces the term 'smart money' (in contrast to 'dumb money') in this context. 'Smart money' specifies the much valued combination of the provision of money and the possession of comprehensive industry expertise, an extended network of potential clients, and the competency to 'open the doors' at leading firms. With respect to the generation of these beneficial synergies, it is argued that the distance between the VC fund and the portfolio firm plays a crucial role (Florida & Kenney, 1988). More precisely, it is assumed that tapping non-monetary resources is eased by the co-location of investors and investees (Mason & Harrison, 1995; Powell et al., 2002; Sunley et al., 2005). Zook asserts that: "Getting the most from a venture capitalist or 'smart money' [...] is constrained by geography [...] Firms located near

sources of VC have better access to the funding, networks, and advice of venture capitalists” (Zook, 2002, pp. 163).

Resulting from the importance of spatial proximity for the occurrence of knowledge spillovers including the easier and cheaper transfer of tacit knowledge, several scholars emphasized that VC activity tends to conglomerate geographically in a few areas (Christensen, 2007; Florida & Kenney, 1988; Mason & Harrison, 2002; Powell et al., 2002; Zook, 2002). Noteworthy, this observation is in sharp contrast to the widely accepted neoclassical assumption of the free flow of capital. Furthermore, it stresses that even with the ongoing globalization of financial services and continuing advances in telecommunication technology geography still matters to VC.

Not only are close contacts between venture capitalists and their target firms beneficial for the latter, but, the literature points out that also dense ties between investors offer possibilities for knowledge spillovers, which is hypothesized to increase their expertise (Sorenson & Stuart, 2001). There are several ways how venture capitalists exchange knowledge e.g. through industry associations, conferences and other meetings. In this paper, we will especially concentrate on syndicated deals as events to link investors.

One way for knowledge exchange to happen in syndicated VC deals is during board meetings. In exchange for their investment, VC funds are commonly receiving equity stakes in return e.g. in the form of board membership. At board meetings, both entrepreneurs and investment partners regularly gather, which offers vast opportunities for information exchange and knowledge spillover between all participants. Also from a startup perspective it is desirable to be supported by investors with an advantageous network position as this generally provides the young firm with valuable information and network contacts (Bygrave, 1987).

It is anticipated that the more ties a venture capitalist maintains towards portfolio firms and other VC funds, as in the case of syndicated investments, the more central or embedded his position within the network becomes and, consequently, the more opportunities he has for the exchange of tacit knowledge and thus, the more influential his position gets (Abell & Nisar, 2007). Based on the assumption that portfolio firms are able to gain access to and benefit from an investor’s local network, we contemplate that VC investors facilitate and influence

startups' network embeddedness. More precisely, we hypothesize that the lead venture capitalist's structural position within the global VC network i.e. the degree of local and global embeddedness, impacts the geographic spread of portfolio firms' linkages. In that, we assume that especially those startups that are funded by a local venture capitalist that sustains many global linkages show a higher degree of international connectivity in form of a larger number of international co-investors compared to those firms that are supported by a predominantly locally embedded fund.

### **Methodology and Data**

In order to get an indication of the degree of local and global relational embeddedness of Belgian biotech actors and the role played by venture capitalists in the process, this part is intended to quantitatively analyze firms' and investors' structural position in a network based on financing linkages. Such analysis also provides detailed information as to the social structure of the Belgian biotech VC network. It reveals whether the network is highly centralized or decentralized and whether there are dense local clusters of biotech VC activity existing.

To determine and assess the ties of and between Belgian-based startups and their VC investors, we use Social Network Analysis [SNA]. To measure relations between different actors and their embeddedness in a network, SNA is commonly employed in a wide range of fields including sociology, economics, geography and business studies. So far, however only few studies exist that apply network analyses to VC data (see Bygrave, 1987).

We perform a social network analysis for inward and outward VC investment in Belgium. For this purpose, we collected data with respect to all inward and outward VC flows in Belgium between 2004 and 2012. In addition, all syndication partners of deals involving Belgian-based investors are identified. Consequently, UCINET is used to calculate different network characteristics (Borgatti et al., 2002).

Biotech startups that received VC are identified by means of the Zephyr database provided by the Bureau van Dijk. The database includes information on investees and investors details (name, address, sector), deal values and sort of financing. Thanks to the broad sector classification option included in Zephyr, it was possible to filter all VC investments that have

taken place in the ‘biotech, life sciences and pharmaceutical sector’ and that involved at least one Belgian investor or startup. To have a relatively complete and up to date dataset, the period 2004 till 2012 is chosen for analysis. Besides obvious practical matters, this time span enables us to assess pre- and post-financial crisis performance of the VC markets.

For measuring network linkages between investors, the dataset is restricted to those actors that invested at least twice in cooperation with a Belgian investor. Funds that obviously belong to the same investment company are merged. In addition, for simplicity reasons, no details as to the number of investment rounds per portfolio firm an investor participated in are included. Instead, it is only determined whether an investor has been investing in a specific startup or not.

### **Financing of Biotechnological Innovation: Evidences from Belgium**

Before analyzing the impact VC funds exert on startups’ relational embeddedness in further detail, the following section introduces some key figures with respect to the Belgian biotech sector and VC investment in the latter. For reasons of comparison, Belgium’s performance in the VC market is benchmarked to that of the EU-15, Switzerland and the US. Those countries are chosen as they possess VC markets of a significant size or belong to the main trading partners of Belgium. Up front, it has to be said that the relatively imprecise definition of ‘biotechnology’ by the OECD as well as the lack of a specific industry classification code causes industry statistics concerning biotechnology to differ largely.

During the last years, the biotechnology sector has gained more and more attention by policy makers across the EU. Biotechnology is regarded as one of the key technologies that potentially enable the transition to a more sustainable low carbon economy in the future. By improving the exploitation of natural resources and making many industrial processes more resource-efficient, the biotech industry importantly contributes towards the restructuring of production processes and industrial change (EU Commission, 2013).

Taking into account its interdisciplinary nature, the Organization for Economic Co-operation and Development [OECD] offers a relatively broad definition of biotechnology: “The application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods

and services” (OECD, 2013). In other words, the goal of biotechnology is to increase the efficiency of or, respectively, develop new (chemical) compounds used in a number of industrial and non-industrial fields (Rosiello & Orsenigo, 2008). Although, strictly defined, biotechnology is only one part of the broad field of ‘life sciences’, we use the terms ‘biotechnology’, ‘biotech’ and ‘life sciences’ industry interchangeably in this part.

Biotech startups are in most cases emerging as academic spin-offs. Only few firms are spin-outs of leading companies in the sector. In the beginning, academic spin-offs generally rely on financing from university or governmental seed capital funds and business angels, spin-outs in contrast often remain financially dependent of the parent company. At later stages, when the business idea gets more mature, higher amounts of capital are required and startups regularly seek out for VC investment.

Due to the necessity of long-standing clinical trials, biotech startups are characterized by longer development phases than startups in other knowledge-intensive sectors. After having secured seed capital at first in order to grow further and to finance expensive clinical trials, it becomes important, particularly for pharmaceutical biotech startups, to look for subsequent rounds of financing. Due to the extent and costs of clinical studies, firms require disproportionately more capital in this stage than at the early business formation and research phase. In general, single university and government funds in Belgium are too small to carry such expenses (Verbeke, 2011; Vlaams Infocentrum land- en tuinbouw, 2012). Going public in order to gain money is also often no possibility at the pre-clinical stage as the new product is still in its infancy and not yet fully tested and approved and therefore regarded as highly risky. In general, VC is the only available private source of capital for aspiring firms in the life sciences sector to cover the high costs arising at the testing stage.

In Belgium the biotech sector is still relatively young compared to e.g. the US, few firms have therefore reached the expensive trial stages so far. However, given the rapid development in the sector, it is expected that in the coming years several firms will start testing their products and require additional financing. Given the relatively small size of the VC industry in Belgium and Europe in general, this will inevitably lead to a bottleneck in the biotech sector. To secure financing, Belgian biotech startups might be forced to look for funds abroad too (Vandenbussche, 2011).

Between 2004 and 2012, 17 VC deals were closed with 11 Belgian-based biotech portfolio firms of which the majority was arranged with companies located in Flanders. Thus, the VC market in Belgium is still small with respect to its total size. However, compared to the EU-15, Switzerland and the US, in proportion to its economy, the Belgian VC market is in the mid-range. Considering VC investment as percentage of GDP, Belgium scores 4th and ranks higher than most of the benchmark economies. However, when looking at deal numbers, it turns out that Belgium is lagging behind other European countries, including the population-wise similar states Denmark and Sweden. Questions like whether the small number of VC deals is ascribed to an insufficient availability of local VC or rather to a low degree of regional entrepreneurial activity are therefore suggested to be analyzed in more depth in the future. Given that by virtue of their relatively restricted capitalization the majority of Belgian funds is focusing on financing biotech startups in their seed and early growth phases, prospectively, it also has to be figured out if there possibly exists a misdistribution of funding regarding certain stages in the life-cycle of startups. A regional liquidity gap might e.g. potentially be present with respect to medium and later stage funding.

In line with the existing literature stressing the geographical-wise relatively ‘sticky’ character of VC (Zook, 2002; Harrisson et al., 2003), it was indeed observed that inward VC investment in Belgium mainly originated from neighboring countries, particularly France and the Netherlands. Though geographically proximate, only one investor from Germany and none from Denmark participated in VC deals with Belgian Biotech startups in the investigated period. In opposition to that, Belgian venture capitalists preferred deals with, in comparison, relatively distant US firms.

On average, each VC deal that was concluded with a Belgian biotech startup consisted of 5.5 investors. Of them about 3.6 investors were of Belgian origin compared to 1.9 foreign investors. The large number of local investors per deal and the fact that there was no deal without at least one Belgian investor show that VC is still highly localized. To attract foreign investment a functioning local VC market seems indispensable.

Though US and UK based VC funds’ interest in the Belgian biotech market has been limited, three Belgian-based investors became partners in several syndicated investment deals

concluded with biotech startups in both countries. Between 2004 and 2012, 16 deals have been closed with American biotech startups and 14 with UK-based firms. Thereby, startups located in those two countries form the preferred foreign investment targets of Belgian-based VC funds searching for opportunities in the biotech field. Far behind are the Scandinavian and Southern European countries that did not attract many Belgian investors. In the case of the Southern European countries the little interest of investors is mainly ascribed to an underdeveloped biotech sector providing few investment opportunities. With respect to the Scandinavian countries the results are however striking. Though relatively proximately located and possessing a vivid biotech sector, Belgian investors are less inclined to invest in the latter. This suggests that besides spatial distance also other factors like the size of the target economy play a role in predicting VC flows.

Contrary to the general downwards trend in VC investments in many of the benchmark economies from 2008 on, Belgium noted a peak in VC deals in 2009. However, besides an exceptional increase in deals in 2006 and 2009, the number of VC deals arranged by Belgian startups remained more or less at the same low level over the investigated period.

Consequently, we assess the relational ties of investors that either invested in Belgian biotech startups or were of Belgian-origin and funded biotech firms elsewhere. Such analysis gives an indication as to the spread of venture capitalists' local and international financial contacts. It is hypothesized that those portfolio firms that are supported by local venture capitalists that maintain a large number of international linkages are possessing a more central position in the global VC network than their counterparts funded by local investors with few internal and external contacts.

## **Results**

It appears that all Belgian biotech startups are loosely connected with each other through mainly their Belgian investors. Assessing the relations between Belgian biotech startups and their local as well as foreign investors, it becomes apparent that particularly the university linked funds of KU Leuven and the University of Ghent, the Flemish Innovation Fund (Vlaams Innovatiefund), KBC, Life Science Research Partners and GIMV are investing in not only one but several Belgian biotech startups. By that they function as important bridges between firms.



In order to measure the relational embeddedness of investors in the Belgian biotech network more precisely, the degree of centrality of each actor has been calculated. Generally speaking, degree of centrality can be understood as the connectedness of actors within the network. The more ties a venture capitalist is maintaining to other partners through, in our case, syndicated investment deals, the more central he appears in the network and the higher his 'degree'. Furthermore, it is anticipated that the more central an ego is positioned within a network, the more information he is able to obtain and, subsequently, the more influential his position becomes (Hanneman & Riddle, 2011).

Figure 1 visually depicts all ties between Belgian VC investors and their syndication partners. In Table 1, the centrality of VC funds has been calculated by means of Freeman's Degree Centrality measure. Results are restricted to deals in which Belgian investors participated. Thus, they have to be interpreted carefully with respect to the total degree of foreign funds which is likely to be underestimated.

Only few Belgian-based VC funds (with the exception of GIMV and KBC) are both internationally and locally well-embedded. Among Belgian investors, GIMV is the most central player, maintaining ties with 170 investors which equates to 11.8% of all linkages. GIMV is largely injecting money into foreign biotech firms with a preference for US targets. Those investments are generally taking place in cooperation with a substantial number of other local and foreign investors. GIMV is followed by Quest and KBC which invested together with 49 and, respectively, 46 different national and international VC funds in the period 2004-2012. The majority of Belgian investors so far however still focuses on local investments, mainly in syndication with other local partners. Given their lower capitalization compared to GIMV, they were also involved in fewer deals. This consequently leads to a lower number of ties which is expressed by a smaller degree.

Due to their predominantly local focus, most of the Belgian funds are nevertheless not strongly connected to the global VC network that emerged around GIMV and Quest. In that, they partly appear secluded from the 'global' VC playing field. Visually, this is indicated in Figure 1 by an agglomeration of Belgian VC funds in the upper left corner of the network.

These funds appear well-connected among each other, but distant from the more international ‘center’ of the network.

It is strikingly that US investors (Alta, Merlin and Forward Ventures) sustain more investment linkages within the ‘Belgian biotech cluster’ than most Belgian investors. Besides US investors, also British, Danish and Dutch funds seem to obtain relatively central position in the network. Ties between US, British and Danish funds on the one side and Belgian investors on the other are mostly established via deals including non-Belgian-based portfolio firms.

Venture capitalists’ network embeddedness is also observed to affect startups’ structural position in the network. Portfolio firms that were supported by a central player e.g. GIMV, sustained a more central position within the ‘Belgian biotech network’.

On a more aggregate level, the results of SNA suggest that, from a financial perspective restricted to VC, there are broadly two biotech clusters or networks co-existing in Belgium. One consisting of firms that possess both local and international linkages and the other entailing those firms that are largely locally embedded and only dispose, if at all, a small number of ‘global investment pipelines’. Though, they are overlapping and neither is detached from the other. Ties between the two groups exist in form of investors that participated in deals with firms from both groups.

Summing up, by means of SNA we show that all Belgian biotech startups are interconnected via their Belgian investors. In addition, we revealed that those target firms that are supported by primarily locally embedded VC funds possess a less centered position in the Belgian biotech cluster and a lower number of ties than their counterparts that are funded by both locally and globally well-embedded investors. This finding suggests that investors are indeed to some degree able to affect portfolio firms’ embeddedness. Nevertheless, it is not precluded that besides investors’ ties, other factors such as the age and size of a portfolio firm play a significant role too (Fritsch & Schilder, 2008). The more mature a startup, the more likely it is to have received several investment injections as well as financing from funds located further away. Consequently, the more globally embedded it will appear.

One of the shortcomings of our analysis is that, for reasons of simplicity, we did not introduce any time-related variable. For future research an inclusion is however strongly advised. Only in this way, it is possible to assess whether outward investment is predating inward VC flows or vice versa. In other words, a time variable is needed in order to investigate whether Belgian investors that frequently infuse capital in target firms abroad are actuating foreign investment in Belgian startups.

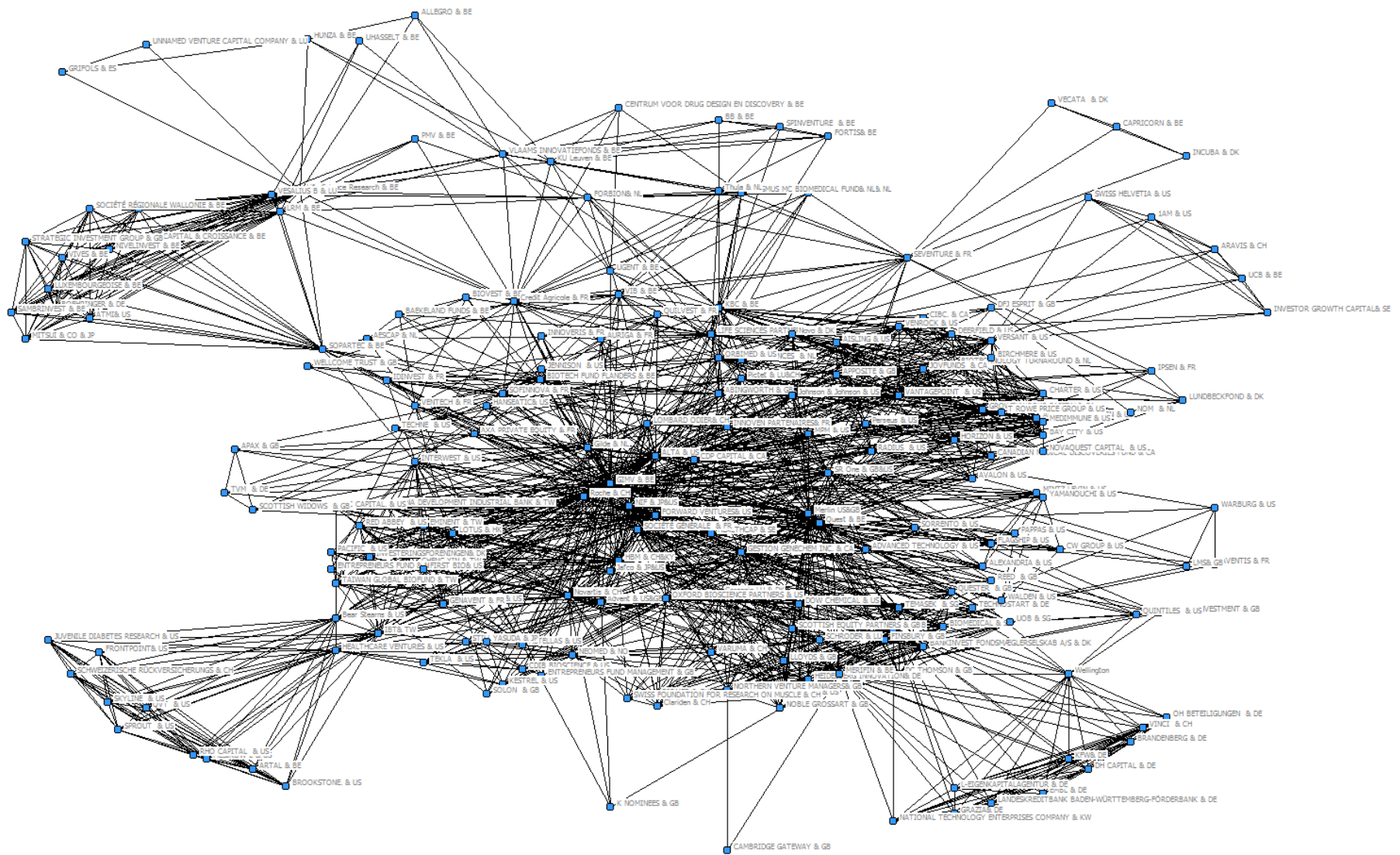


Figure 1. Network of Belgian VC Funds and their Syndication Partners (2004-2012)

**Table 1.** Freeman’s Degree Centrality for Belgian VC Fund Network (Top 20)

VC Fund	Degree	NrmDegree	Share
GIMV (BE)	170.000	11.789	0.047
Alta (US)	93.000	6.449	0.025
NIF (JP, US)	64.000	4.438	0.018
Merlin (US, GB)	59.000	4.092	0.016
HBM (CH, KY)	57.000	3.953	0.016
Novartis (CH)	55.000	3.814	0.015
Forward Ventures (US)	54.000	3.745	0.015
1I (GB)	50.000	3.467	0.014
Quest (BE)	49.000	3.398	0.013
KBC (BE)	46.000	3.190	0.013
Merifin (BE)	44.000	3.051	0.012
Gestion Genechem Inc. (CA)	44.000	3.051	0.012
Carnegie (LU, DK)	40.000	2.774	0.011
Oxford Bioscience Partners (US)	40.000	2.774	0.011
SR One (GB, US)	38.000	2.635	0.010
Johnson & Johnson (US)	37.000	2.566	0.010
Sofinnova (FR)	37.000	2.566	0.010
Life Sciences Partners BV (NL)	36.000	2.497	0.010
Gilde (NL)	35.000	2.427	0.010
Novo (DK)	34.000	2.358	0.009
	Degree	NrmDegree	Share
Mean	17.633	1.223	0.005
Std Dev	16.545	1.147	0.005
Sum	3.650.000	253.121	1.000
Variance	273.740	1.316	0.000
SSQ	121.024.000	582.024	0.009
MCSSQ	56.664.098	272.507	0.004
Euc Norm	347.885	24.125	0.095
Minimum	2.000	0.139	0.001
Maximum	170.000	11.789	0.047
N of Obs	207.000	207.000	207.000
Network Centrality	10.67%		

## Discussion and Conclusion

From a theoretical perspective, especially the Regional Innovation System approach emphasizes the importance of a functioning financial infrastructure for the emergence of regional entrepreneurship and the growth of regional clusters. In the case of innovative biotech startups, VC constitutes an important source of funding, because bank lending is mostly unattainable for these firms due to a lack of hard assets. Due to its ‘social’

characteristics, we hypothesized that VC is not only important for the development of entrepreneurship, but that it also exerts an impact on startups' relational embeddedness. The empirical results presented in this paper deliver first evidences that point to a confirmation of the latter.

A first indication of the impact of investors on their target firms' financial network position was provided in the empirical part. The results retrieved from SNA point out that those firms that were funded by internationally well embedded local investors maintained more ties towards foreign VC funds than those supported by local investors with a less centered position in the global VC network. Consequently, target firms funded by internationally well embedded local investors appeared more central in the extended Belgian biotech network. In that, the spread of local VC funds' financing linkages indeed seems to influence their portfolio firms' embeddedness.

Furthermore, our theoretical analysis indicates that a sufficient level of entrepreneurial financing is regarded as crucial driver for the stimulation of innovation and entrepreneurship. Several authors highlight that without a functioning regional financial system, firm foundation is seriously hampered. Nevertheless, what still needs some clarification is the question whether it is necessary for each region to possess a vibrant local VC cluster to boost local entrepreneurship or if a small number of local VC funds that attract international syndication partners is sufficient for the development of regional entrepreneurial activity. In this respect, despite the assumption that capital flows freely, our empirical results show that all Belgian startups were funded by at least one local VC investor. This hints at the importance of local investors to attract co-investors that are located further apart (see also Fritsch & Schilder, 2012). Thus, local investors' role in securing VC funding should not be underestimated. However, to thoroughly explore this question, further research is advised that measure the effect local investors exert on portfolio firms' financial relations and economic performance more accurately. Among others, it has to be figured out whether Belgian venture capitalists that frequently invest abroad are actuating foreign investors to support Belgian target firms.

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