CREATING VALUE IN ECOSYSTEMS:

CROSSING THE CHASM BETWEEN KNOWLEDGE AND BUSINESS ECOSYSTEMS

Bart Clarysse
Mike Wright
Johan Bruneel
Aarti Mahajan

Enterprise Research Centre
Imperial College London
Business School
Tanaka Building, South Kensington Campus
London, United Kingdom

Ghent University
Faculty of Economics and Business Administration
Hoveniersberg 4
Gent, Belgium

ABSTRACT

Policy makers take initiatives to stimulate knowledge ecosystems in technology hotspots. It is implicitly assumed that these ecosystems will lead to value networks through which the participating companies can realize a competitive advantage. Value networks refer to business ecosystems where the value proposition is offered by a group of companies which are mutually complementary. The strategy literature suggests that business ecosystems lead to competitive advantages for each of the partners in the ecosystem. Based on a unique hand-collected database of 138 innovative start-ups in the region of Flanders, we analyze the knowledge and business ecosystem and the financial support network. We find that the knowledge ecosystem is well structured and concentrated around a number of central actors while the business ecosystem is almost non-existent at the local level. Further, we find that the financial support network is almost 100% publicly backed and fails to bridge the knowledge and business ecosystem. The implications for policy makers who tend to focus on the development of local ecosystems are discussed.

Keywords: Ecosystems, value networks, innovation systems

1. Introduction

The literature has long recognized the advantages for innovative start-ups to be localized in geographical hotspots, usually centered around leading universities and public research organizations (Link and Scott, 2003; Van der Borgh et al., 2012; van Looy et al., 2003; Löfsten and Lindelöf, 2001; Pouder and St. John, 1996; Saxenian, 1996; 2006; Zucker and Darby, 2001). The flow of tacit knowledge between companies and the mobility of personnel (Saxenian, 1996; 2006) have been advanced as the main advantages of geographic co-location which characterize these hotspots. Such hotspots have been characterized as knowledge ecosystems where local universities and public research organizations play a central role in advancing technological innovation within the system.

In contrast, the strategic management literature focuses on business ecosystems as sources of competitive advantage for individual companies (Iansiti and Levien, 2004). A business ecosystem finds its roots in the idea of value networks (Normann and Ramirez, 1993) and can be seen as a group of companies, which simultaneously create value by combining their skills and assets (Eisenhardt and Galunic, 2000). Business ecosystems create value for an individual participant only when the participant is not capable of commercializing a product or service relying on its own competences (Lin et al., 2010). Such ecosystems are organized as complex networks of firms whose integrated efforts are focused on addressing the needs of the end customer. There is a growing consensus that business ecosystems provide entrepreneurial firms with resources and information to navigate in a constantly changing competitive environment (Zahra and Nambisan, 2012). Quite often, it is implicitly assumed that business ecosystems are the automatic consequence of setting up a knowledge ecosystem. However, to date, it is not clear whether the success factors that lead to knowledge ecosystems are similar to those for business ecosystems. Companies participating in a knowledge ecosystem which can make use of knowledge available in the region may not necessarily mean that these companies will also participate in the same business ecosystem. Hence, in this paper we explore the question of existence of a relation between knowledge and business ecosystems.

This question is of particular interest from a policy perspective as policy makers increasingly invest in regional innovation systems, which foster the creation of innovative start-ups around so-called knowledge hubs, using successful examples such as Silicon Valley as a benchmark (Engel and DelPalacio, 2011). We focus on whether such a knowledge ecosystem translates into a business ecosystem and draw conclusions for innovation policies aimed at fostering business ecosystems.

We make use of a unique hand collected database of 138 innovative start-ups in the region of Flanders, founded between 2005 and 2011. The companies were those which agreed to collaborate from a total database of 178 companies identified through public innovation advisors as start-ups in this region which could apply for a business plan development grant because they were developing a product or service based on or contingent on novel technologies that did not exist yet in Flanders. Since these innovation advisors receive incentives to identify innovative start-ups and guide them towards channels of public support, we are confident that these companies approximate the total population of innovative start-ups in that period. For each company we constructed the knowledge ecosystem they were embedded in, the business network they participated in, and the financial support network they made use of.

We find that the density of the knowledge ecosystem was much higher than the business ecosystem and was dominated by those knowledge institutes which had developed incubator/accelerator facilities and formal tech transfer offices. The business ecosystem's density was extremely sparse with only dyadic relations and a high amount of international partners, indicating that there is no overlap. Also the density of the financial support network was rather sparse, with only 40% of the start-ups participating in that network. It was dominated by public funds which took a central role while the private sector was almost completely absent. We found that working together with the top central actors in the knowledge network has a positive impact on the innovation output of innovative start-ups, but collaborations with average technology partners typically has a negative impact. Further, our findings show that receiving financial support from public funds, typically associated with these knowledge actors, does not help the knowledge production function of these companies at all. Since neither the knowledge ecosystem nor the financial support network directly contributes to short term survival of innovative start-ups, the lack of a business ecosystem has severe policy implications.

The paper unfolds as follows. First, we review the literature on knowledge and business ecosystems. We subsequently describe the method we used to collect and analyze the data. Finally, we discuss the results and their implications for our understanding of knowledge and business ecosystems and the innovation policies developed to support them.

2. Literature review

2.1. Knowledge ecosystems

The knowledge ecosystems literature has explored the mechanisms by which geographically clustered organizations benefit from their locations (Jaffe, 1986; Almeida and Kogut, 1999). This research stream has identified the reduced costs of moving people and ideas as the primary sources of advantage from being located in technological clusters (Clark et al., 2000). In addition to external economies of scale which allow firms in these ecosystems to benefit from collective resources, local spillovers make their technology development efforts more fertile than those of their isolated competitors (Agrawal and Cockburn, 2002). Both linkages among firms and with universities and public research organizations as well as intense labor mobility across different players facilitate collective learning and increase the speed of innovation diffusion (Baptista, 1998). As a result, physical proximity to knowledge generators such as public research organizations (PROs), universities and large firms with established R&D departments typically have a positive influence on the focal firm’s innovative output (Phelps et al., 2012).

Contemporary literature on knowledge ecosystems has analyzed the extent to which a focal company’s centrality in a global research network can substitute for not being part of a local technology hotspot (Owen-Smith and Powell, 2004; Whittington et al., 2009). The main findings show that in a biotech environment, participating in a global research network can partly substitute the lack of geographical proximity to a technology hub in terms of its impact on the innovative output of the focal firm. However, being part of a dense knowledge ecosystem such as the Boston, San Diego and San Francisco Bay areas remains the most important predictor of innovative output of a biotech company (Whittington et al., 2009). In other words, from a policy perspective, creating such a dense knowledge ecosystem remains the best guarantee to spur a high degree of innovation in the area.

Powell et al. (2010) analyzed the critical success factors in developing biotech knowledge ecosystems in the San Francisco Bay area, the Boston and Cambridge, MA area, and Northern San Diego County. They consider two features and one mechanism to be central to the development of knowledge ecosystems: 1) a diversity of organizational forms and 2) the presence of an anchor tenant, and 3) the mechanism of cross-realm transposition. First, a diversity of organizational forms generates divergent standards and multiple kinds of rules, resulting in competing criteria for gauging success (Boltanski and Thévenot, 2006). Including groups of organizations in the different parts of the value chain increases the adaptive capacity of the ecosystems more than if the system is dominated in only one area (Baptista, 1998). The availability of different actors such as universities and public research organizations, entrepreneurial firms, established companies, and venture capital firms has also been described in contemporary works on regional clusters (Saxenian, 1996). A second crucial feature is the presence of an anchor tenant. Anchor tenants assist in providing access to subsequent connections and field formation and hence actively spur economic growth (Agrawal and Cockburn, 2003). The anchor tenant is not disinterested, in the sense of being neutral, but does not directly compete with the other types of organizations that inhabit the community. Local universities or PROs can fulfill the role of anchor organizations in the knowledge generation process (Agrawal and Cockburn, 2002). These institutions produce basic and applied research and act as catalysts of technological innovation by transferring this to local industry through R&D collaborations. In turn, firms utilize this knowledge for industrial and commercial purposes (Friedman and Silberman, 2003). Diversity and anchor tenants alone are usually not sufficient to spur the emergence of an ecosystem, however. Some form of cross-network alignment is needed in which ideas and models are transposed from one network of organizational forms to another, for instance when the venture capital logic spills-over into the academic community in the context of spin-off ventures (Wright et al., 2006). This mechanism is called cross-realm transposition.

Powell et al.'s. (2010) analysis focuses on the development of knowledge ecosystems in the particular setting of biotechnology. In the biotech industry, the mere presence of innovation output creates immediate economic value. Organizational growth in this industry results mainly from building an IP portfolio which ultimately gets sold to an incumbent company on the market for technology or firms (Clarysse et al., 2011). R&D alliances between biotech firms and other research active organizations dominate in this environment and are good predictors of exploitative alliances which determine the commercial potential of the biotech company (Rothaermel and Deeds, 2004). As a result, biotech start-ups with a central position in the knowledge creation network of R&D alliances also tend to be successful in setting up exploitative alliances with large pharmaceutical companies to capture the value of their technology.

The implicit assumption made by research in the area of knowledge ecosystems is that they quasi-automatically evolve into business ecosystems. This means that creating a successful knowledge ecosystem is considered to be sufficient to create areas of true economic growth. We focus on a) whether knowledge ecosystems are developed and b) whether they lead to business ecosystems.

2.2. Business ecosystems

Industries such as biotech are organized as value chains characterized by a linear knowledge creation – knowledge commercialization process (Gans and Stern, 2003). There is a clear division of innovative labor where entrepreneurial firms are specialized in knowledge creation and large, established firms are specialized in knowledge commercialization. However, business ecosystems do not follow a linear value creation process and many of the players in such ecosystems fall outside the traditional value chain (Iansiti and Levien, 2004). Instead, different companies cooperate to jointly deliver a product or service to a customer. As a result, the value chain is not a linear process with upstream and downstream players, but is a network of companies with many horizontal relations (Moore, 1996). The members of such an ecosystem deliver value to end customers as an interrelated system of interdependent companies rather than as individual companies. Business ecosystems are nested commercial systems where each player contributes a specific component of an overarching solution (Christensen and Roosenbloom, 1995). In a business ecosystem, inter-organizational networks consist of both collaborative and competitive relationships which results in a "coopetition" structure (Moore, 1993). As a result, it is the competition among ecosystems, not individual companies, that largely fuels the next round of innovations. Innovation in business ecosystems goes beyond the focus on technological activity alone which is characteristic of knowledge ecosystems. Business ecosystems introduce the customer (demand) side which is mainly absent in innovation ecosystems (Wright, 2013). Companies collaborate to create and deliver solutions that meet the full package of value to customers (Moore, 1993). In other words, business ecosystems allow firms to create value which no single firm could create by itself (Adner, 2006). It also involves the creation of new markets and often entails the pursuit of relatively small and poorly defined commercial opportunities. For example, Kahney (2004) describes how Apple leveraged its business ecosystem to develop an easy-to-use MP3 player and music management and purchase software, which resulted in the iPod.

Iansiti and Levien (2004) have described how companies such as Walmart and Microsoft developed competitive advantages by having a strategy to build a business ecosystem around their value proposition. Along the same lines, Gawer and Cusumano (2002) refer to multinationals in the digital economy which are able to manage innovation through their business ecosystem as ‘platform leaders’. Birkinshaw and Hill (2005) refer to ecosystem venturing as a strategy used by large companies to build a business ecosystem around the company by incubating and accelerating start-up activities related to the company’s innovation strategy.

Through collaboration in a value network, firms exploit their interdependencies and have a competitive advantage over isolated companies which internalize all components of a value chain (Iansiti and Levien, 2004). For start-ups it is therefore important to participate in such a business ecosystem (Zahra and Nambisan, 2012). Companies in a business ecosystem co-evolve their capabilities and roles, and tend to align themselves with the directions set by one or more central companies. Hence, start-ups which can participate in such an ecosystem align their innovation function to the expectation of the leaders and move towards a shared vision (Moore, 1996). Numerous examples describe how start-ups in business ecosystems prosper from investments made by industry leaders to maintain the network (Birkinshaw and Hill, 2005; Kaminsky, 2000).

Iansiti and Levien (2004) put forward two important ingredients that contribute to the success of business ecosystems. First, business ecosystems are characterized by a large number of loosely interconnected participants dependent on each other for their mutual performance. Each participant is specialized in a specific activity and it is the collective efforts of many participants that constitute value, while efforts individually have no value outside the collective effort. Rich networks sharing elements of both cooperation and competition emerge that link companies across products, services, and technologies. A second vital element is the need for a “keystone” company whose role is to ensure that each member of the ecosystem remains in good health. They consistently invest in and integrate new technological innovations of other participants and encourage the creation of new markets by developing new fundamental infrastructures (Moore, 1993). Keystone companies also create “platforms” such as services, tools, or technologies, which are open for other players in the ecosystems to enhance their own performance (Iansiti and Levien, 2004). Consequently, keystone players are involved with the creation of value within the ecosystems as well as sharing the value with the other participants.

Taken together, we observe three important factors in which knowledge and business ecosystems differ. First, the primary activity in knowledge ecosystems is the generation of new knowledge whereas the focus in business ecosystems is on value for customers. Second, players in a knowledge ecosystem are typically connected in a dense, geographically clustered network while business ecosystems are represented by value networks which can be globally dispersed. Third, knowledge ecosystems are centered around a university or PRO whereas large companies are the leaders of business ecosystems. Table 1 below provides an overview of these factors.

**** insert table 1 about here ****

Policy makers world-wide have sought out the most effective mechanisms to stimulate ecosystem development. Adopting a knowledge ecosystem philosophy, they have established policies giving a crucial role to universities and public research organizations as engines of regional economic development and drivers of technological innovation (Florida and Cohen, 1999). Universities and public research organizations are catalysts of innovation, stimulating the production and diffusion of knowledge across regions (Finegold, 1999). Facilitating knowledge transfer via different mechanisms such as contract research and spin-offs became the third mission of these organizations after teaching and research, and they received structural support from governments to fulfill this role (Debackere and Veugelers, 2005). In addition, governments have also implemented several initiatives specifically geared towards fostering innovative start-ups in the ecosystem, most notably stimulating access to external capital (Wright et al., 2006).

Despite these policy initiatives, there is no guarantee that these knowledge ecosystems will evolve into business ecosystems as the dynamics in both are fundamentally different (Iansiti and Levien, 2004). Still, policy makers expect that the development of a knowledge ecosystem will facilitate the companies embedded in this ecosystem to become part of a larger business ecosystem. This is a strong hypothesis as both ecosystems are considerably different in terms of drivers and characteristics (see table 1). We will further investigate this hypothesis in the remainder of the paper.

3. Research setting

To address this issue, we focus on Flanders, a small region in northern Belgium, as an empirical context. Since the regionalization of science, technology and innovation policy in

Belgium in 1991, the region autonomously decides its innovation policy. The region committed to invest 3% of its GDP (38 billion Euros) on R&D. A wide range of actors and stakeholders are involved in the Flemish Science & Technology Innovation system (Belgian Report on Science, Technology and Innovation, 2010): public administrations and agencies, knowledge institutes and centers, universities and university colleges, scientific institutes, public research organizations, university hospitals, various collective research centers, incubation centers, private companies, etc. Among these actors, IWT[1] is the one-stop-shop financing industrial R&D and innovation in Flanders. They offer both direct funding for R&D and innovation and indirect funding through a network of innovation advisors (VIN). In total, 1374 people in 220 intermediary organizations such as knowledge centers, collective research centers and industry federations provide advice to the local industrial community about new technologies in their sector, new innovative applications, how to finance innovation and how to get subsidies.

Public sector financial support schemes are important for high tech firms (Wright et al., 2006). In addition to giving R&D grants, innovation support and indirect support through the network of innovation advisors, the government manages through PMV[2] a public risk capital fund (VINNOF), providing seed and early stage capital to innovative start-ups and is a shareholder in GIMV[3], which provides venture capital (early and later stage) to innovative start-ups. In addition, the government has invested €211m since 2005 in 12 funds through its ARKIMEDES program, a co-financing scheme for funds committed to invest in innovative start-ups.

In addition to the private sector, universities and public research organizations (PROs) play a key role in R&D in Flanders. Six major universities and four major PROs represent the majority of knowledge production (Wright et al., 2008). The universities represent 90% of all non-private scientific output. In 2007, total expenditure in R&D in higher education was € 739m, of which 15.6% was privately and 84.4% was publicly funded. KULeuven, the largest university in Flanders spent €300m in 2008 on R&D and has 85 active spinoffs today. Ghent University follows with €200m R&D spending in 2008 and 60 active spinoffs, while Brussels University (VUB) spent €70m on R&D. In addition to the universities, there are six major public research organizations, four of which were founded before 2009 (and are relevant for

[1] Agentschap voor aanmoediging van Innovatie door Wetenschap en Technology
[2] Participatiemaatschappij Vlaanderen
[3] Gewestelijke Investeringsmaatschappij Vlaanderen

our study). In 2009, these four centers collectively received an annual grant of €135m in total. We refer to table 2 for an overview of the PROs.

**** insert table 2 about here ****

To analyze the knowledge and business ecosystems, we examine the R&D and commercial alliances of innovative start-ups in Flanders founded between 2006-2011. 178 innovative start-ups were identified by the innovation advisors of the Flemish Innovation Network and assisted to get innovation support from IWT. 138 of these firms agreed to participate in our study resulting in a response rate of 78%. Non-response analysis did not reveal significant differences between the 40 which did not and those that did participate in terms of age, sector or revenues in 2012. The descriptive statistics of the participating companies are included in table 3. This database is unique as it involves most of the new ventures created in the region with the specific objective to develop products or services new to the region and that are either based on novel technologies or involve the development of novel technologies.

**** insert table 3 about here ****

3.1. The knowledge ecosystem

For each company studied, we calculated the alliances they have set up with the universities, PROs and R&D departments of established industrial firms based upon the projects they submitted to the IWT to get co-financing for these collaborations[4]. We used the annual reports of the IWT from 2005 to 2011 to collect information about the requests for support for R&D. These reports contain an overview of the partners involved and the subject of the project. The pre-condition to submit a proposal is that the project should have a technological component and there should be technological uncertainty involved in progressing the project. In other words, the partnerships were mainly R&D focused. Using the IWT database, we identified 177 dyads between 86 innovative start-ups on the one hand (out of 138) and 82 technology partners on the other hand, in the period 2005-2011. The information was used to calculate the symmetric dyad graphs included in figure 1.

3.2. The business ecosystem

[4] IWT co-finances between 15% and 50% of exploration alliances that are set up between companies or between companies and universities/PROs. Exploration means that the subject of the alliance should be the development of a new technology or a new product based upon a novel technology. New or novel means that it does not exist yet in Flanders

Further, we asked for information on the commercial cooperations established with other business partners. Commercial cooperations involve relationships with "key customers" with whom they had tested their prototype, further developed their prototype into a commercially viable product or leveraged their prototype into a scalable product and the key "business partners" with which they jointly had developed a business proposition for a common customer. In total, we identified 584 commercial alliances which represent dyads in our analysis between 80 innovative start-ups on the one hand and 547 industrial partners on the other. This information was used to calculate the business ecosystem in figures 2-4.

3.3. The financial support network

Finally, we also collected information about the financial support network of these innovative start-ups. Powell et al. (2010) argue that financial investors such as venture capitalists play a prominent role in bridging the gap between the production of new knowledge and the subsequent commercialization of that knowledge. To calculate the financial support network presented in figure 5, we asked each start-up whether they had received financial support and from which investor. We cross-checked these answers relating to financial support with the websites of the investors which list the portfolio companies they invest in. Only for the business angels involved in the companies was no further information found. In total, we identified 102 dyads between 41 (out of 138) innovative start-ups receiving financial support on the one hand and 54 financial investors.

4. Analysis of the business and knowledge ecosystems and the financial support network

To analyze the knowledge and business ecosystems and the financial support network in the region, we used Ucinet 6.461 as a software program (Borgatti et al., 2002). We calculate Freeman's (1979) degree and normalized degree as measures of centrality. Degree refers to the total number of direct ties the organization has, while normalized degree includes the number of direct ties divided by the total number of ties in the network. In addition we calculated the total network centralization as a measure of equality in the centralization of the total network and network density as an indicator of collaboration activity.

4.1. The knowledge ecosystem

Figure 1 provides a graphical representation of the knowledge ecosystem which has a network density of 0.007. This implies that a large number of dyads do not exist yet in the network. Two major universities in the region (KULeuven and UGent) and two of the four major PROs (IMEC and IBBT) play a leading role (see figure 1) together with Sirris, which is the knowledge center of the major ICT industry federation (Agoria). The two universities, two PROs and the industry specific knowledge center seem to be Anchor-tenants as defined in the Powell et al. (2010) framework. These are the central knowledge generators in the knowledge ecosystem with a normalized degree > 4%, each. KULeuven has the highest share, which reflects its status as the largest research university in the region. We label these five central partners in the knowledge network as “top knowledge partners”. Since almost two out of three innovative startups in the ecosystem participate in the knowledge ecosystem, we can conclude that there is a high degree of cooperation among the actors and we can talk of a dense local network, which reflects a technology hotspot.

**** insert figure 1 about here ****

4.2. The business ecosystem

Figure 2 shows the results and network statistics of the business ecosystem where local and international business partners form a value network in which the innovative start-ups participate.

**** insert figure 2 about here ****

It is clear that there are very few overlaps and that no organization takes the lead in the business ecosystem and hence fulfills the role of keystone player. The density of the network drops to 0.002 and the most central organizations only have a degree of 3, which means that they only collaborate with three innovative start-ups in total. Because the innovative start-ups included in figure 2 are spread over different technological domains and are collaborating with a variety of research organization we took a subsample of the knowledge ecosystem, namely those innovative start-ups that only collaborate with the top-5 central organizations in the knowledge ecosystem (KULeuven, UGent, IBBT, Sirris and IMEC). Among these organizations, we only selected the innovative start-ups in ICT of which we can reasonably expect that there would be similar industrial companies with which these organizations can form partnerships.

**** insert figures 3 and 4 about here ****

Figure 3 shows the network of all the business partners around the top-5 central organizations. In figure 4, we show the specific business partnerships of one business network, namely the one around IBBT (iMinds). The results are surprising. We would expect that a number of central "industrial leaders" would take the role of keystone players like the PROs in the knowledge ecosystem. As described in the business ecosystem literature (Gawer and Cusumano, 2002; Iansiti and Levien, 2004), these industrial leaders are companies like Microsoft and Cisco that create ecosystems around their businesses by supporting innovative start-ups. These industry leaders act as lead users (Von Hippel, 1986) which facilitate innovative start-ups to upgrade their prototypes and make them compatible with the expectations of other companies. It is clear that no business ecosystem has developed in the region although a few innovative start-ups that take part in the knowledge ecosystem succeed in integrating into Microsoft's business ecosystem. However, overall, the innovative start-ups collaborate with different partners separately and try to develop an independent network but no industrial organization takes a central role. It is even surprising how scarce the relations are among the different independent start-ups themselves. In sum, our findings indicate that a business ecosystem is non-existent. This finding leads to hypothesize that, in contrast to policy maker expectations set out in section 2, a tight knowledge ecosystem does not automatically lead to the emergence of a business ecosystem.

4.3. The financial support network

Following the same logic as above, we map the financial network that supports these innovative start-ups (see figure 5). The overall network density is about the same as in the knowledge ecosystem. However, only 40% of the innovative start-ups received some form of investment. The network centralization index is higher, which means that centrality is less spread over a number of key actors. In fact, VINNOF (Flemish Innovation Fund) plays the most prominent role. This is the main public fund which targets seed and early stage financing. Also, the other actors in the financial support network are mainly public. LRM is a regional fund in the north of Flanders, which is 100% publicly financed and IBBT (iMinds), KULeuven and UGent are a PRO and two universities, which have their own incubation/university funds that are involved in their spin-offs. The only notable exception is the Allegro Investment Fund, a 100% private fund set up by a few serial entrepreneurs in the region. Similar to the top knowledge partners, we label the top five financial partners in the support network "top financial partners". The lack of private initiatives in the financial support network is remarkable.

**** insert figure 5 about here ****

Based on the network indices, we conclude that the private sector is only marginally involved in investing in innovative start-ups in Flanders since mostly public financiers play a role in supporting innovative start-ups. Moreover, the majority of the public investors are closely linked to the leading PROs and/or the university. This means that the financial agents in the ecosystem do not form a mechanism of cross realm transposition. This leads us to propose the hypothesis that for a knowledge network to evolve into a business ecosystem, private financial agents should take over the lead of public sector organizations and be the first mechanism of cross realm transposition.

5. The influence of the knowledge ecosystem and financial support network on the performance of innovative start-ups

5.1. Innovative output of innovative start-ups

The performance indicator in the knowledge ecosystem is the firm’s level of innovative output (Powell et al., 2010), measured by the count of patents with the EPO[5]. We analyze whether collaboration with more central research partners had a positive impact on the innovative output, measured by the number of patents, of the focal firm. The mean number of patents was 0.9, while the standard deviation was 2.46, which indicates that over-dispersion might distort the interpretation of other count models such as a Poisson regression (Cameron and Trivedi, 1986). A negative binomial estimation was therefore necessary. Table 4 shows the results of this analysis. In the first stage, we enter only the control variables (age, size, and sector). Firm size is positively associated with the number of patents.

**** insert table 4 about here ****

In model 2, consistent with the extant literature on knowledge ecosystems (Tallman et al., 2004; Boschma, 2005, Whittington et al., 2009), we find that being close to the most central organizations in the knowledge ecosystem has a positive impact on the innovative output of the focal firm. Having no technology partners at all, on the other hand, is better than working with non-central technology partners in the knowledge ecosystem. Hence, collaborating with local strong knowledge providers such as PROs or universities accelerates the innovative output of the

[5] As a sensitivity check, we also used more fine-grained measures of innovation output such as the citation weighted EPOs, but this had no impact on our results We therefore chose to use the simplest measure in the further analysis.

start-ups, but collaborating with technology institutes which have no central role in the knowledge ecosystem has a negative impact. The top institutes in Flanders play their role as anchor organizations in the knowledge ecosystem and have a positive impact on the innovative performance of the start-ups which collaborate with them.

Table 4 also shows the impact of working together with a central financial partner on the innovative output of the innovative start-ups. Surprisingly, we find that receiving finance from the more central financial players in the Flemish network (VINNOF, LRM, Allegro, UGent, Baekelandt) has a negative impact on the venture's innovative output. This indicates that these investors mainly want to exploit technology rather than further developing technology portfolios to target the market for firms or the market for technology (Clarysse et al., 2011). Those innovative ventures which do not attract financial investors have even lower levels of innovative output. However, working together with less embedded financial investors such as GIMV does have a positive impact on the level of innovative output. This suggests that start-ups with the most promising technology opportunities tend to look for investors that are not necessarily very well embedded or that do not necessarily target the local industrial community but are able to attract investors that only play a minor role in the local community. The result, however, is that the most embedded local investors play only a marginal role in helping to sustain the Flemish knowledge ecosystem.

This finding extends Powell et al.'s. (2010) view on how clusters develop as they do not distinguish between exogenous entry of agents such as investors into a network versus endogenous initiatives taken by local entrepreneurs or policy makers. In other words, to make a knowledge ecosystem sustainable in itself, a realm transposition needs to take place between the new network (e.g., the financial investors) and the old one (e.g., the knowledge network). The realm assumes that the new network introduces a new modus operandi which is then adopted by the actors in the old network. However, if the public funds are extensions of the knowledge actors in the old network, they do not bring new practices into the ecosystem, but extend the logic of the knowledge actors. This is exactly what we observe here. Most financial investors do not contribute to the start-ups' innovative output. This finding lends further support to the hypothesis proposed in section 4.3 that private financial agents play a central role in facilitating the transition from knowledge to business ecosystems.

5.2. Survival of innovative start-ups

The business ecosystem literature proposes firm survival as the main performance indicator (Iansiti and Levien, 2004), especially for innovative start-ups as they operate in markets not yet clearly developed (Santos and Eisenhardt, 2009). Survival is less industry sensitive than other measures such as revenues[6]. We operationalize firm survival as a dummy variable equaling 1 if the innovative start-up failed during the period under study and 0 otherwise. Failures included completed bankruptcies, completed liquidations, closures based on company request, and merger or acquisition of organizations at risk of bankruptcy (Hannan and Freeman, 1989). We first identified whether a start-up had failed using the Belgian Official Journal. Secondly, we used financial reports from GRAYDON to identify companies experiencing difficulties in fulfilling their financial obligations. The founders of these firms were contacted and coded "1" if the founder confirmed that the company was bankrupt, liquidated or closed. We use survival analysis to examine firm survival (e.g. Dencker et al., 2009; Geroski et al., 2010) and employ a Cox proportional hazard model. The results are presented in table 5.

**** insert table 5 about here ****

Interestingly, working together with central partners in the knowledge ecosystem does not impact the survival rate of the innovative start-ups. Even worse, working with centrally embedded financial investors does not improve survival rates. This is surprising as one would expect that if they do not add to the innovative output in the knowledge ecosystem (see table 4), they would at least add to the economic viability of the start-ups. But this is not the case. This result suggests that the financial investors locally embedded in the ecosystem do not improve the economic viability of that system. This finding lends further supports to the hypothesis proposed in section 4.2 which states that a knowledge ecosystem does not automatically lead to a business ecosystem.

6. Discussion and Conclusions

We have analyzed the tension between knowledge and business ecosystems. On the surface, the success factors for the two types of ecosystems look similar: diversity of organizations and

[6] In further sensitivity analysis, we checked with other performance measures we had at hand such as the degree to which the founders of these innovative start-ups perceived themselves to being ahead of or falling behind their initial plans in terms of performance. The use of this performance indicator did not impact our results. Hence, we chose to elaborate our analysis using survival.

anchor/keystone player. However, there are significant differences between the organization and dynamics in knowledge ecosystems versus those in business ecosystems. First, the anchor organizations in the former type of ecosystems are not directly competing within the ecosystem and are typically players such as universities and public research organizations. In contrast, keystone players in business ecosystems are large, established companies that provide key resources and commercial infrastructures to the different ecosystem niches. Second, knowledge ecosystems are based on value chains where value creation flows from upstream to downstream players. Business ecosystems, on the other hand, are characterized by a non-linear value creation process as groups of firms deliver integrated solutions to end users. Our findings have notable implications for policy which we elaborate below.

6.1. Policy implications

Our analysis suggests that policy has focused too much on bilateral links rather than on an ecosystem approach. Much policy emphasis has been on the commercialization of research on one hand and innovation support to SMEs on the other. We discuss the implications of our research on both of these policy foci.

First, to facilitate commercialization of research, universities have received funding to set up technology transfer offices (TTOs) and seed funds which support spin-offs. The literature on knowledge ecosystems (Powell et al., 2010; Whittington et al., 2009) has already shown that for such an ecosystem to evolve into a viable cluster of organizations there must be anchor organizations facilitating connections between different types of players. We observe in this study that the leading TTOs and PROs play these roles as anchor organizations. However, Powell et al. (2010) argue that there needs to be a transfer of logic between the different players in the ecosystem. They label this process of logic shift as cross-realm transposition. It is questionable whether these funds bring a new logic into the ecosystem or whether they are just used to finance companies which follow an academic rather than a commercial logic. If cross-realm transposition takes place in the ecosystem, private VCs should play a much more prominent role than is the case. This lack of cross-realm transposition is reflected in their negative impact on the level of innovation output of these start-ups and the absence of the impact of financial investors on their survival. Our results suggest that public funds, which tend to be very focused on the regional dimension, can add little value in building a complex network of relationships across different industrial players.

Second, innovation policy typically has focused on creating a network of technology intermediaries to support SMEs and innovative ventures which are not spun off from the large research institutes. We observe that these less central technology institutes do not cooperate with companies with a positive innovative output, nor do they contribute to the survival of these companies. Iansiti and Levien (2004) have shown that leading industrial incumbents play a major role in stimulating these companies thereby creating a business ecosystem which develops a joint value proposition to a common customer. We observe that the business ecosystem in Flanders is completely absent. This means that none of the leading companies in the region plays the role of keystone or anchor company. This is remarkable as it is these large companies which play a major role in the development of US business ecosystems. One could question why even large public companies such as the national (regional) television station and the telecom operator are not encouraged to play more of a leading role in nurturing innovative start-ups in the region. Public procurement policies, such as the SBIR[7] program in the US, may provide an important stimulus to the creation of a business ecosystem. SBIR program incentivizes large, established companies to invest part of their budgets in projects with local, innovative start-ups. In Europe, EU policy does not allow such programs and there is little support, even informally, to work with innovative start-ups at regional level. In contrast, subsidies are given to technology push intermediaries or sector federations, which typically support large, established players in the ecosystem. Alternatively, the question arises as to whether a region might benefit from a university-centered knowledge ecosystem without having a well-defined related business ecosystem or a keystone player. However, the challenges in linking universities and industries are well-known.

It is likely that if the innovation output of the knowledge ecosystem is commercializable through a more global business ecosystem, a business ecosystem in that same region is not required. If the knowledge is globally commercializable then in the absence of a local business ecosystem, the region needs to develop links to global business players. However, if policymakers see development of a knowledge ecosystem as a mechanism to create local employment, they may need to adopt policies to attract global firms. Overall, this raises questions about the extent to which an innovation policy towards the development of knowledge ecosystems in the absence of a business ecosystem makes sense. One could argue that value is created in the knowledge ecosystem but is captured by a few central players in the business ecosystem (Thomas, 2013). If a region wants to benefit from the value creation which happens

[7] Small Business Innovation Research Programme (SBIR)

within its knowledge ecosystem, it will have to find a way to attract the companies which also capture the value. This can be done either by providing an interesting environment to attract them or, more realistically, by making sure that the innovative start-ups in the knowledge ecosystem also co-capture that value in the business ecosystem. Co-creation does not automatically lead to co-capturing (Thomas, 2013) so facilitation is needed.

In light of these observations, policy may therefore need to develop incentives and mechanisms to enable ecosystem links to develop. There is a need for reconfiguration and reorientation of policy to link knowledge and business ecosystem elements. One key policy challenge is how to bring larger corporations into the ecosystem. Perhaps there is a need to develop boundary spanners who can make the bridge – and develop training mechanisms to enable this. The extant literature on tech hubs and knowledge ecosystems has shown that TTOs at universities and PROs are successful in developing local knowledge networks (Whittington et al., 2009). Policy makers should consider structurally supporting similar functions at large, established companies. Dedicated innovation managers in firms that are critical industry hubs should pay specific attention to their role in the business ecosystems and develop initiatives that promote collaborations with local, innovative start-ups. They should monitor the health of the network of innovative start-ups and stimulate large firms and incumbents to continue investments in technologies and commercial infrastructures which these start-ups can leverage. These managers have to guarantee that the terms of collaboration for innovative start-ups promote sustainable growth, avoiding that large, established players develop into dominators. As put forward by Iansiti and Levien (2004), a healthy business ecosystem requires a healthy keystone as well as healthy innovative start-ups.

The weakness of the financial support network in bridging the knowledge and business ecosystems suggests a need for policy to develop a financial network beyond public sector provision, which is lacking in both the amounts of finance and the specialized strategy support that can be provided. There may be a need for a more differentiated approach to developing financial support networks. Stimulation of business angel and accelerator activity may warrant attention. There may also be a need to stimulate cross-border venture capital provision, which may involve both cross-national and cross-regional borders. For example, a potentially fruitful avenue to address spatial mismatches in equity funding is to consider how to stimulate cross-regional mobility in such funding provision where angel financiers may find it difficult to identify enough sufficiently attractive targets in the regions where they are located (Harrison et al., 2010). Entrepreneurs in investment finance-deficient regions with ventures that may be potentially attractive to venture capital firms and business angels may therefore need to find ways to signal their quality to these financiers located outside their region (Mueller et al., 2012). Policy may therefore need to consider developing incentives and mechanisms to facilitate cross-regional access to angels.

A further option may be to try to attract interest of new financial entrants. For example, a growing trend in the provision of entrepreneurial finance is the development of 'family office' funds, where family firms with surplus cash balances are establishing funds to invest in private equity and venture capital. Perhaps more could be done to incentivize these operations to integrate more with the ecosystems. There may also be a need to explore whether the absence of a financial support network that bridges the gap between knowledge and business is related to demand side or supply side factors (Fraser et al., 2013). To the extent that some entrepreneurs are not interested in growing their firms, and/or maintaining control, they may be reduced demand for external finance. Other sources of finance may need to be stimulated such as supply chain finance, crowdfunding, etc. but may require policy initiatives to raise awareness, introduce appropriate regulation, etc.

6.2. Implications for further research

As all studies, our analysis has limitations that open opportunities for further research. First, our context related to one small region in one country, which may not be representative of all types of regions. As spatial context may have an important influence on entrepreneurial and innovation ecosystems (Zahra and Wright, 2011), further research is needed both to compare similar regions in other countries and also to compare our findings with different contexts. For example, future studies might consider matched pairs of research intensive regions in Europe (Clarysse et al., 2005) to revisit the ecosystem questions addressed in this paper. Further, from a national perspective, different geographical locations may involve different ecosystems some of which are localized while some have cross-regional and cross-country elements.

Second, although we analyzed the ecosystems of a cohort of start-ups over a particular period, further analysis is needed of how the different elements of an ecosystem co-evolve within a wider innovation ecosystem. For example, while we noted the distinction between exogenous entry of agents into a network versus endogenous initiatives taken by local entrepreneurs or policy makers, it was beyond the scope of our study to explore the factors driving these differences and the processes through which they occur.

Third, social contexts for entrepreneurship and innovation are heterogeneous (Wright, 2013). The structure and dynamics of knowledge and business ecosystems may differ both across sectors and the phases of the life-cycle of development of innovative start-ups. Further, as these start-ups emerge, they may need to enter and disrupt pre-existing ecosystems. As yet, little is known about how these processes work.

Fourth, we use very simple measures of innovative output and economic performance. Future research might explore these into more depth by looking at a mix of short term and long term measures. Innovation outputs can be further refined by adding citation impact as a long term quality measure, while economic performance can be further developed into measures of long term success such as IPO, profitability and sustainable growth (de Saint-Georges and van Pottelsberghe, 2013; van Pottelsberghe, 2011). However, survival is the short term focus of most innovative start-ups and it is the most straightforward performance measure. By controlling for industry and the availability of venture capital, we overcome the most important cross-sectoral differences in survival rates. Hence, our analysis of the determinants becomes stronger.

Finally, we included universities as part of the knowledge ecosystem but further research might focus on examining the circumstances under which a university could be considered an ecosystem and how this interacts with knowledge and business ecosystems. The universities as research partners literature suggests an important role for universities in creating basic research awareness and challenges in public-private funded projects at the pre-commercial stage (Hall et al., 2003). The related academic engagement literature covers a wide-range of activities between academics and industry partners and tends to emphasize individual and department level engagement (Perkmann et al., 2013). The links between pre-commercialization engagement (knowledge) and subsequent commercialization (business), and the challenges in developing them to create an ecosystem have, however, been neglected. Studies could attempt to identify and analyze cases where universities operate as such ecosystems, and for example, develop a typology of the kinds of knowledge and commercialization that lend themselves to different types of ecosystems.

6.3. Conclusions

In conclusion, we show that there seems to be a disconnect between the development of knowledge and business ecosystems. Policy makers have primarily supported the creation of knowledge ecosystems assuming that these ecosystems will automatically trigger the development of business ecosystems. However, the value creation processes in knowledge and business ecosystems are fundamentally different, which implies that policies to support each type of ecosystem must be specifically tailored. Supporting large, established companies to fulfill their role as keystone players may be an important way forward. We hope that this paper will inspire further research and policy to develop our understanding of different types of ecosystems.

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Table 1: Overview of differences between knowledge and business ecosystems

Factor	Knowledge ecosystem	Business ecosystem
Focus of activity	Knowledge generation	Customer value
Connectivity of players	Geographically clustered	Value network
Key player	University or PRO	Large company

Table 2: Overview of PROs

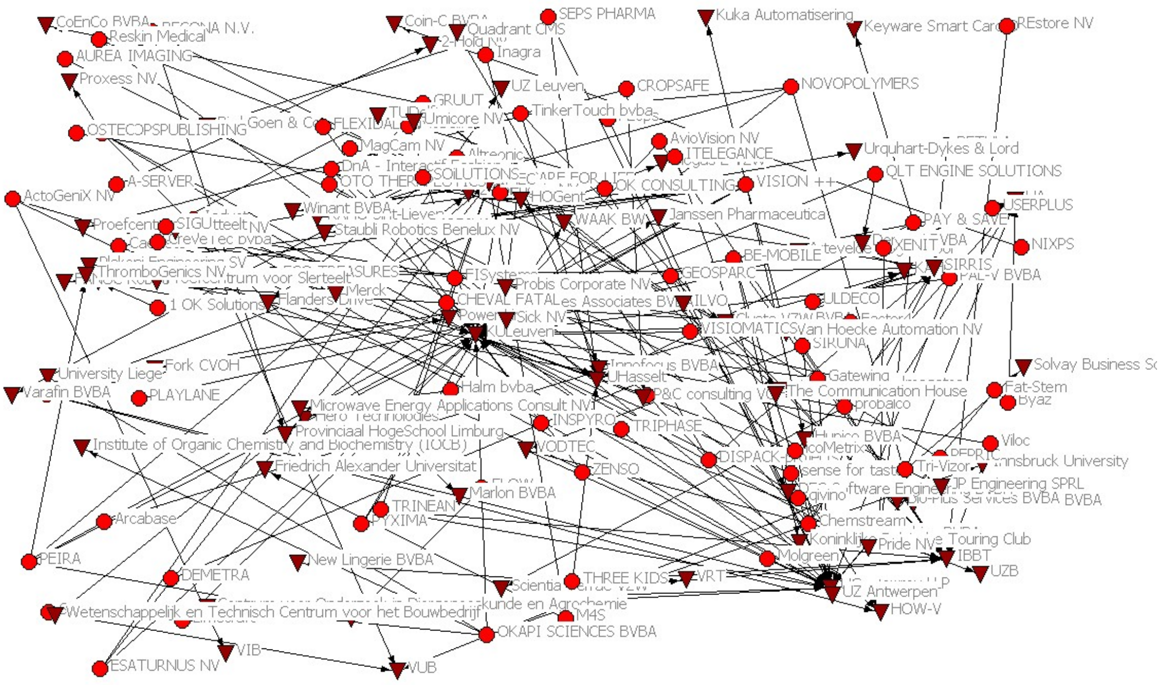
		Founded in	Operating budget 2008	# researchers	# spinoffs
IMEC	Micro-electronics (Research in nanotechnology and nano research)	1984	€270m	2000	26
VIB	Biotechnology	1995	€62.5m	1200	12
VITO	Technological Research (Environment, Energy, materials and remote sensing)	1991	€73.5m	600	
IBBT (iMinds)	Broadband Technology	2004	€26.4m	1000	13

Source: Belgian Report on Science, Technology and Innovation 2010

Table 3: Descriptive Statistics of the Sample

	Mean	s.d.	1	2	3	4	5	6	7	8	9
1. Number of patents (total number of EPO applications)	0.92	2.46	1								
2. Top technology partners (dummy; 1 if collaboration with top-5 central partner in knowledge network, 0 otherwise – centrality measured as degree centrality)	0.39	0.49	0.226**	1							
3. No technology partners (dummy; 1 if no collaboration with technology partner 0 otherwise))	0.38	0.49	-0,10	-0.62***	1						
4. Top financial partners (dummy; 1 if collaboration with top-5 central partner in financial network, 0 otherwise – centrality measured as degree centrality)	0.19	0.39	-0.04	0,11	-0.11	1					
5. No financial partners (dummy; 1 if no collaboration with financial partner 0 otherwise)	0.70	0.46	-0.3***	-0.26**	0.18*	-0.74***	1				
6. ICT (dummy)	0.34	0.48	-0.01	-0.04	0.01	0.04	-0.07	1			
7. Manufacturing & engineering (dummy)	0.15	0.36	-0.03	0.07	-0.08	0.16	-0.08	-0.26**	1		
8. Company age (months)	36.51	15.38	0.10	-0.12	-0.06	0.09	-0.13	-0.06	0,07	1	
9. Number of employees	5.67	7.14	0.25**	0,15	-0.11	0.03	-0.28***	0,03	-0.06	0.24**	1
10. Failure (dummy)	0.25	0.44	-0.1	-0.13	0.06	0.02	0.09	-0.07	0.26**	0,04	-0.15

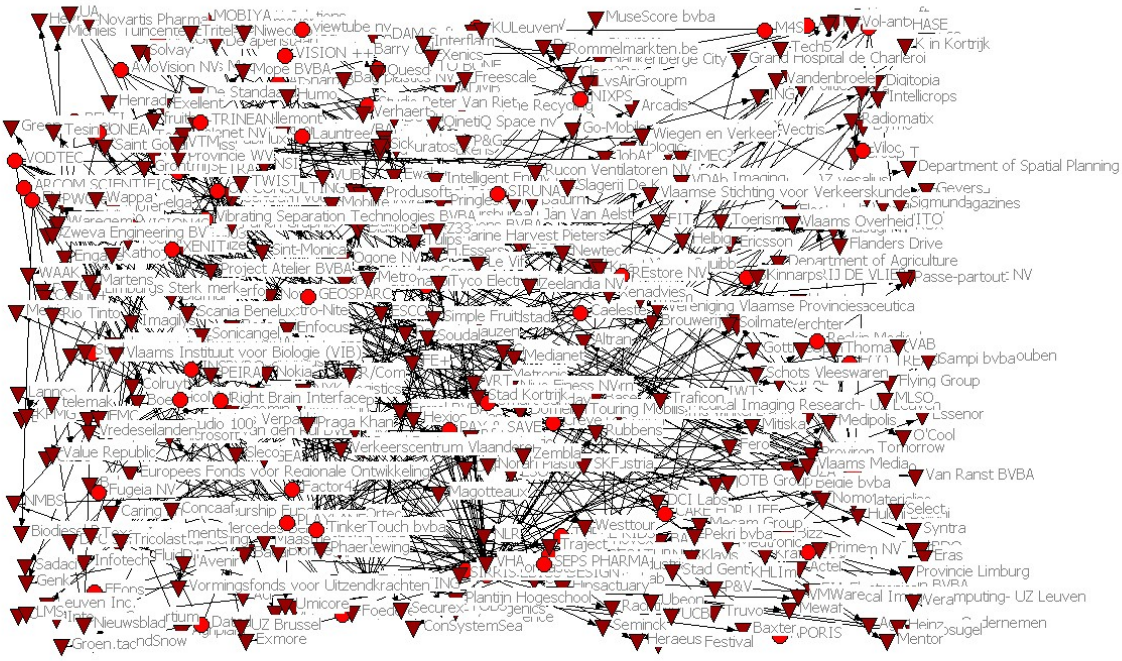
Figure 1 : Knowledge ecosystem in Flanders



Network	Type	Degree (centrality)	Norm. Degree (centrality)	Network Centralization	Network Density
				11,75%	0,007
KULeuven	University	27	16.265		
UGent	University	20	12.048		
IBBT (iMinds)	PRO	11	6.627		
SIRRIS	PRO	8	4.819		
IMEC	PRO	8	4.819		
UA	University	5	3.012		
UHasselt	University	5	3.012		
HOGent	University	4	2.410		
KAHO Sint-Lieven	University	4	2.410		

Degree (centrality) = number of direct links
Norm. Degree (centrality)= (number of direct links/total number of links)*100
Network Centralization = Centralization= 100* Σ(C*-Ci) / Max Σ(C*-Ci) , where C* is the centrality of the most central actor and Ci, the centrality of all the other I actors
Network Density= Sum of existing ties divided by the number of all possible ties

Figure 2 : Business ecosystem in Flanders



	Degree	Norm. Degree	Network Centralization	Network Density
Total Network			8,88%	0,002
Microsoft	3	0.482		
Nieuwsblad	3	0.482		
Deloitte	3	0.482		
VRT	3	0.482		
NMBS	3	0.482		

Degree (centrality) = number of direct links
Norm. Degree (centrality)= (number of direct links/total number of links)*100
Network Centralization = Centralization= 100* Σ(C*-Ci) / Max Σ(C*-Ci) , where C* is the centrality of the most central actor and Ci, the centrality of all the other I actors
Network Density= Sum of existing ties divided by the number of all possible ties

Figure 3 : Business ecosystem in ICT with IBBT, UGent, KULeuven, Sirris and IMEC as central knowledge hubs

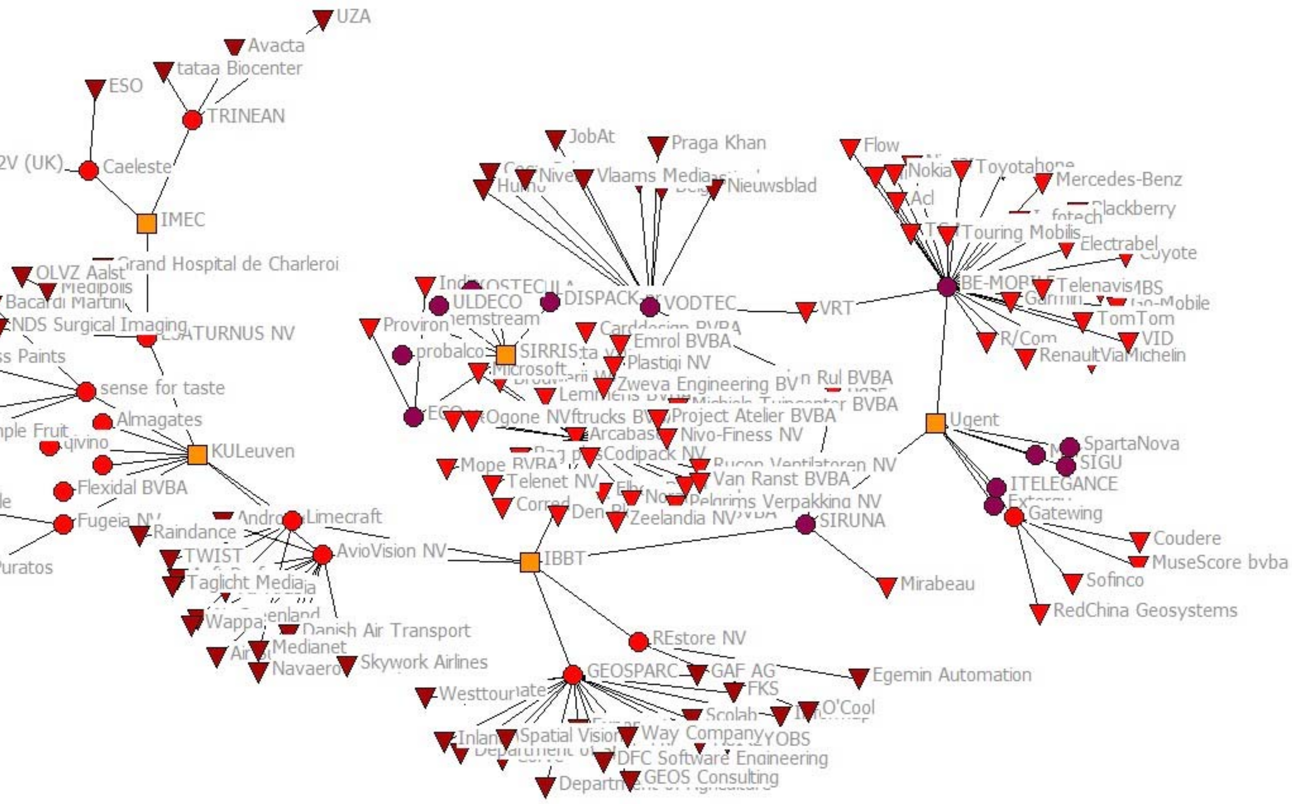


Figure 4: Business ecosystem in ICT with IBBT, iMinds, as central knowledge hub

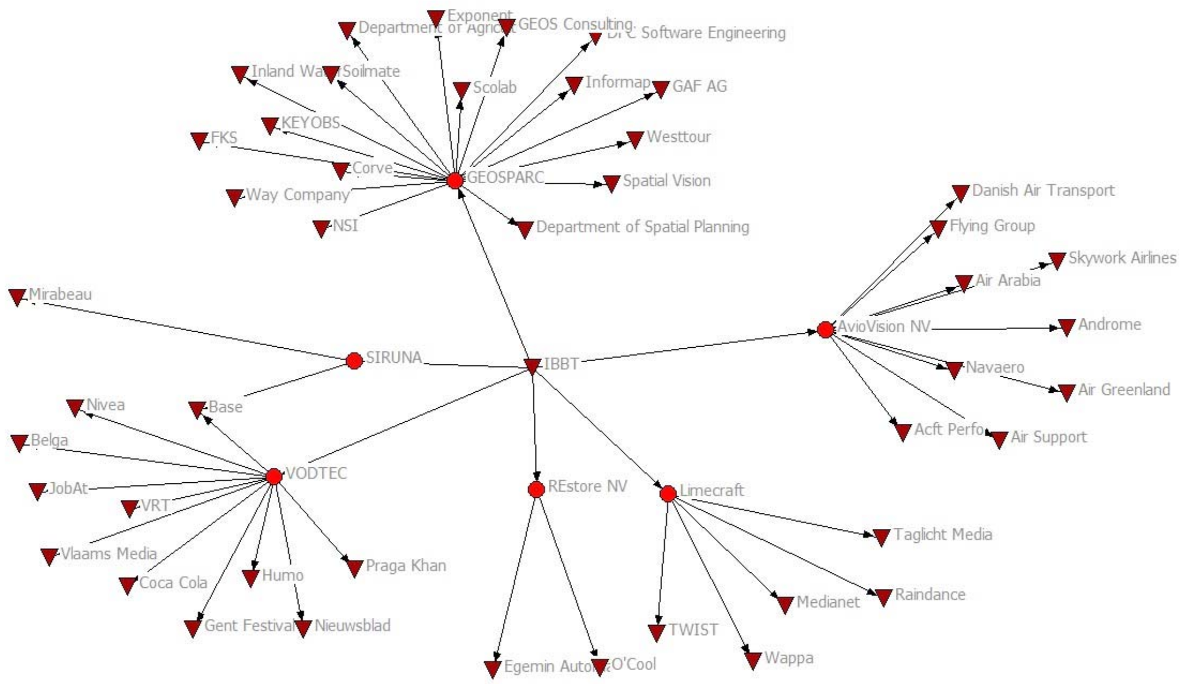
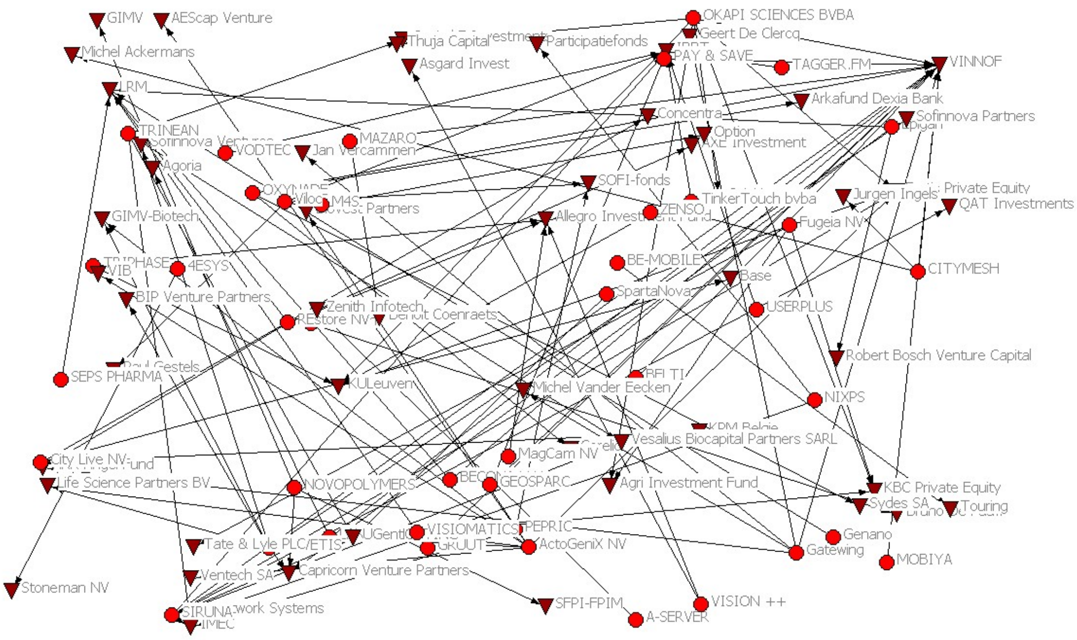


Figure 5 : Financial Support Network in Flanders



	Type	Degree (centrality)	Norm. Degree (centrality)	Network Centralization	Network Density
Total Network				8,72%	0,006
VINNOF	Public	13	13.83		
IBBT	Incubator	7	7.447		
LRM	Public	6	6.383		
Allegro Investment Fund	Private	5	5.319		
KULeuven/Gemma Frisius Fund	University	4	4.255		
UGent/Baekelandt Fund	University	4	4.255		

Degree (centrality) = number of direct links
Norm. Degree (centrality)= (number of direct links/total number of links)*100
Network Centralization = Centralization= 100* Σ(C*-Ci) / Max Σ(C*-Ci) , where C* is the centrality of the most central actor and Ci, the centrality of all the other I actors
Network Density= Sum of existing ties divided by the number of all possible ties

Table 4: Innovation Output (Negative Binomial Regression)

	Model 1	Model 2	Model 3	Model 4	Model 5
Controls					
ICT (dummy)	-0.014	-0.003	0,07	0,046	0,152
	(0.35)	(0.336)	(0.32)	(0.315)	(0.318)
Manufacturing & engineering (dummy)	-0.1	-0.031	0.347	0,301	0,415
	(0.466)	(0.46)	(0.428)	(0.423)	(0.422)
Number of employees (log)	0.835***	0.695***	0.439*	0.398*	0.421*
	(0.249)	(0.241)	(0.233)	(0.229)	(0.233)
Company age	-0.005	-0.000	-0.005	-0.000	-0.003
	(0.011)	(0.011)	(0.01)	(0.01)	(0.01)
Predictors					
Top technology partners		1.657***		1.052**	1.065**
		(0.494)		(0.479)	(0.474)
No technology partners		0.884*		0.805*	0.848*
		(0.524)		(0.485)	(0.479)
Top financial partners			-1.696***	-1.482***	-0.893
			(0.494)	(0.491)	(0.584)
No financial partners			-1.999$	-1.717$	-1.193**
			(0.403)	(0.42)	(0.509)
Top technology partners * Top financial partners					-1.747*
					(1.058)
Top technology partners * No financial partners					-1.293
					(0.893)
R^2	0.04	0.078	0.11	0.125	0.133
Chi^2	14.04**	27.04$	38.12$	43.21$	45.97$
N	138	138	138	138	138

* p<0.10, ** p<0.05, *** p<0.01, $ p<0.001

Table 5: Cox Proportional Hazard Model

	Model 1	Model 2	Model 3	Model 4
Predictors				
Top technology partners		1,042		0,982
		(0.491)		(0.460)
No technology partners		1,257		1,093
		(0.521)		(0.462)
Top financial partners			2,313	2,293
			(2.526)	(2.512)
No financial partners			3,653	3,541
			(3.919)	(3.831)
Controls				
Number of patents	0,894	0,898	0,974	0,974
	(0.141)	(0.144)	(0.153)	(0.155)
ICT (dummy)	1,421	1,451	1,478	1,488
	(0.597)	(0.613)	(0.629)	(0.635)
Manufacturing & engineering (dummy)	2.956***	3.059***	3.427***	3.446***
	(1.218)	(1.282)	(1.496)	(1.511)
Number of employees (log)	0.566***	0.572***	0.571**	0.576**
	(0.119)	(0.123)	(0.124)	(0.127)
Chi^2	14.61***	14.96**	17.23***	17.31**
N	138	138	138	138

* p<0.10, ** p<0.05, *** p<0.01, $ p<0.001