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Spinning-off new ventures from academic institutions in areas with weak entrepreneurial infrastructure: Insights on the impact of spin-off processes on the growth-orientation of ventures

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ABSTRACT

We discuss the characteristics of academic "spin-off processes" in environments outside of high tech clusters and where technology transfer and entrepreneurship infrastructures have been weak. To identify their implications for venture formation, we studied the case of Belgium, gathering data from eight universities and forty-seven firms. We propose that spin-off processes in academic institutions affect the form and growth orientations of ventures.

1. INTRODUCTION

In the 1990s, spinning off new ventures from academic labs gained acceptance in Europe as a valid method of technology transfer. Entrepreneurship was also recognized as a key instrument of technology innovation (European Commission 1998, 2000). This was an important change in Europe, where academic institutions have traditionally considered that technology transfer

and commercialization were outside their mission (Owens-Smith et al., 2002) and entrepreneurship has not been as developed as in the USA (OECD, 1999).

Academic spin-off ventures in regions outside established high tech clusters tend to stay small (e.g. European Commission 1998, 2000). Explanations generally refer to macro-structural and cultural factors, but scholars have not extensively examined, the spin-off processes that generate these ventures as a possible source of the problems of lack of growth and growth orientation. This is the focus of this paper.

2. LITERATURE REVIEW

Despite changes in policies and new public resources, a recent OECD survey shows that, outside the USA, spinning off new ventures from research institutions has remained a process of technology transfer with minimal impact (Callan, 2001). The conclusions of this survey are summarized below.

- Most OECD countries outside the USA witness the creation of no more than a couple dozen spin-off firms each year.

- The firms' size, growth rates, revenues, and product generation are modest, at least in the first decade of their existence. While a small percentage of spin-offs do blossom into large high-technology firms, a large proportion survive without growing considerably.
- Their failure rate is significantly below national averages.
- Not all academic disciplines equally generate new firms. Academic spin-off ventures are mainly in the biomedical and information technology fields.
- Spin-off firms tend to come from a small number of top research institutions. The support structures on which public spin-offs rely are expensive and not worth developing if an institution does not generate enough intellectual property to justify a professional technology commercialization staff.
- Academic spin-off firms cover a large variety of types of firms and there is not a clear consensus on the definition of an academic spin-off firm

The OECD survey concludes that the impediments to spin-off formation are not yet well understood as data on financing, growth and life cycles are hard to come by. The characteristics

highlighted by the survey are consistent with earlier findings from academic research and policy studies (e.g. Capron and Meeusen, 2000; Chiesa and Piccaluga, 2000; European Commission, 1998; Mustar, 1995; Roberts, 1991; Roberts and Malone, 1996; Segal Quince Wicksteed, 1990, 1999).

Of particular concern is the fact that academic spin-off ventures in regions outside established high tech clusters tend to stay small "boutiques" (e.g. European Commission 1998, 2000). They fail to grow to become global leaders in their market, in contrast to some of the spin-off firms that have emerged in established USA high tech clusters, such as Boston and Silicon Valley (Lee et al., 2000; Kenney, 2000; Roberts, 1991; Saxenian, 1994). This is a problem that has been observed among European new technology-based firms in general (Storey and Tether, 1998).

Various explanations have been posited. Some refer to institutional factors, or what policy makers label "structural deficiencies" such as tax disincentives or regulations representing obstacles to entrepreneurship (Rowen, 2000). For instance, an important deficiency is the underdevelopment of capital markets in

Europe, particularly the lack of early stage venture capital (Bannock Associates, 1999; European Commission, 1998; 2000)

Others point out to the divide between academia and industry (Howells and McKinley, 1999). Outside the USA, and indeed within many US institutions as well, academic institutions have until recently considered that technology transfer and commercialization were outside their mission (Owens-Smith et al., 2002).

Some authors further point out that innovative high tech ventures seem to thrive especially in very particular ecologies of which Silicon Valley and the greater Boston area are the archetypes (Lee at al., 2000; Kenney, 2000; Saxenian, 1994). Such environments have, however, proved to be difficult to replicate.

Finally, is the argument that certain cultures are less entrepreneurial than others (OECD, 1999). For instance, in some cultures the stigma of failure is higher. In Europe, entrepreneurship takes primarily the form of creating small businesses, known as small and medium size enterprises (SMEs). They are job-substitutes for their founders, or an instrument to pursue other life style objectives, instead of incorporating growth targets (Timmons et al., 1990:9). The growth-oriented model of ventures

only diffused internationally in the late 1990s, during the technology boom, from America's high tech clusters. So, the issue is not only a lack of growth that most ventures exhibit, it is also a lack of growth orientation of most entrepreneurs. For instance, academic institutions in our sample had to confront the issue of how to raise the interest of academics in spin-off initiatives.

All these macro-factors clearly play a role in why European new technology-based firms and academic spin-off ventures fail to grow, a question that has been addressed by policy makers, especially since the late 1990s (e.g. Cincera et al., 2001a; 2001b; OECD, 1999). For instance, at the Lisbon summit in 2000, the European Commission set a new ambitious strategic objective for the next decade "to become the most dynamic and competitive knowledge-based economy" (European Commission, 1999). However, the factors mentioned above represent structural and cultural obstacles that will need multi-year efforts to overcome.

Surprisingly, besides these macro-factors, few have examined, the spin-off processes that generate these ventures as a possible source of explanation for the problems of lack of growth and growth orientation, although it is likely that they affect the firm

formation process directly. Indeed, new ventures are typically resource-poor and the academic institutions from which they originate, along with their sponsors, are major resource providers, whether it is early stage funding, space and facilities, intermediation with outside parties, or legitimacy. This dependence is particularly true in regions where there is a weak entrepreneurial community.

Our hypothesis that spin-off processes shape the ventures that they generate is consistent with Freeman's (1986: 33) conceptualization of entrepreneurship as an organizational product. He argues that the pieces necessary to create a new firm are generally outputs of other organizations and are provided by them. Academic spin-off firms are extreme examples of this interpretation of entrepreneurship. From the point of view of the growth potential of spin-off ventures, it is important to focus on the spin-off process and on the early phase of firms because venture development is path dependant and initial stages strongly "imprint" future developments (Boeker 1989). It is thus likely, as Roberts (1991) suggests, that early choices during the incubation phase impact the subsequent growth potential of ventures. If we want to improve the growth

prospects of academic spin-off firms, perhaps is there a more *immediate* opportunity for leverage than addressing structural and cultural obstacles.

Because of the weak researcher attention to spin-off processes of academic institutions as a possible explanation for the lack of growth-orientation in academic spin-off ventures, our research examined characteristics of academic spinning off processes in an environment outside high tech clusters, where technology transfer and entrepreneurship infrastructures have been weak. We approached this question by examining eight academic institutions in Belgium, a country that is new to academic technology transfer and to entrepreneurship. Belgium shares a number of characteristics with other "old economy" regions that are trying to adjust to newer technologies and to new modes of technology innovation (Capron, 2000: 32). As in the rest of Europe, in the 1990s, federal and regional governments in Belgium expanded their science, technology and innovation (STI) policies (Cincera et al., 2001a; 2001b). Perhaps even more so than in other European regions, Belgium is characterized by a low entrepreneurial culture (Reynolds et al., 2001).

A starting point of this research project was an isolated source in the literature that had examined academic spin-off policies. Roberts and Malone (1996) propose that two dimensions are key in analyzing spin-off policies: level of selectivity and level of support of academic institutions. They argue that only two spin-off strategies work in terms of selectivity and support: either high selectivity and high support strategies or low selectivity and low support strategies. First, the low support-low selectivity policy consists of spinning off many ventures, but with little support. It reduces the cost of spinning off, but seeks safety in numbers. "Choice is left to external agencies (such as venture capital funds) who are generally felt to have greater experience and expertise in 'picking winners' and less potential for conflicting objectives than the R&D organization" (Roberts and Malone, 1996: 41). Second, the high support-high selectivity strategy consists of spinning off a few well-supported ventures. It relies on picking potential winners and supporting them to increase their chance as much as possible.

On the other hand, the policy providing low support-high selectivity runs the risk of under-investment in a narrow portfolio. The policy of high support-low selectivity is seen by the authors as

the most risky because most of the investment risks are then made with low potential ventures.

Further, Roberts and Malone argue that low support-low selectivity policies are more fitted to entrepreneurially developed environments, while high support-high selectivity policies are more efficient in entrepreneurially underdeveloped environments. In entrepreneurially developed contexts, such as Boston or Silicon Valley, a strong entrepreneurial community has the capability to select the best entrepreneurial projects and allocate resources to them. Thus, research institutions can adopt a fairly passive strategy. In contrast, in underdeveloped entrepreneurial contexts that lack a strong entrepreneurial community, research institutions need to be more proactive by being selective and providing incubation capabilities to their spin-off projects.

(Insert Figure 1.)

3. RESEARCH DESIGN

Since the phenomenon had not yet been explored much, we decided to adopt an inductive design, seeking to gather insights from the field with the aim of building hypotheses, rather than testing hypotheses drawn from theory. We adhered most closely to Eisenhardt's (1989) prescriptions for inductive research through multiple cases.

We collected primary, secondary, and archival data from government sources, academic institutions, and spin-of ventures. We interviewed twenty representatives of eight academic institutions, the originating organizations of all but a few spin-off ventures in Belgium. Of the identified population of 106 firms, we interviewed forty-one firms and gathered data on six firms via a questionnaire when interviews were not granted. We believe that the sample is representative, because we pursued data gathering until the information that we collected became repetitive and did no longer provided new insights.

With a few exceptions, two researchers were always present during interviews. One took notes during the interview and imme-

diately wrote a report after each interview session. Each document includes both factual data reported by the interviewee and comments linking the specifics of the interview with references to other interviews in an attempt to identify trends.

Research based on an inductive design is by nature recursive in that it includes iterations of data collection and data analysis (Eisenhardt, 1989: 542). In this case, the process of data collection lasted over the course of two years from early 1999 to December 2000 through four major iterations which were punctuated by data analysis.

A detailed description of the research design and methodology is available in Degroof (2002).

4. ARCHETYPES OF SPIN-OFF PROCESSES

The detailed analysis of eight academic institutions suggests that some of them share characteristics in their spin-off process: a few archetypes of spin-off processes emerge.

We found it useful to distinguish among three phases of proactive spin-off processes that we identified inductively: the origination phase, the concept testing phase, and the start up support

phase. The origination phase includes the genesis of the spin-off process. This phase highlights, for instance, how the opportunity was identified (by the individual initiative of an entrepreneurial scientist, or by a pro-active search for a technology opportunity within the research institution). At this point a first selection occurs. This is followed by the concept testing phase, during which the opportunity is tested from a technical, an intellectual property, and a business point of view. This phase stops when there is a confirmation of the business opportunity that is often materialized by a new round of funding. At this point, the start-up support phase starts and the business opportunity is exploited.

(Insert Figure 2.)

In starting from the less developed to the more developed process, we distinguish four archetypes of spin-off processes.
(Insert Table 1).

4.1 First archetype: Absence of proactive spin-off processes

This archetype characterized all but one of the academic institutions prior to 1995 and three out of eight academic institutions in the period 1996 to 2000.

Origination phase. In the absence of pro-active technology transfer policy in an academic institution, the spin-off process was driven only by entrepreneurial scientists. The creation of a spin-off project resulted from the work experience of one or a few scientists, who perceived a commercial opportunity derived from their research work. The opportunity was commonly identified by industry participants in the research project or clients for whom the scientist(s) performed R&D or technical consulting work from within their lab. The venture creation typically happened following an increase in demand for the service that could no longer be handled within the research lab.

Concept testing phase. The business project was, however, generally modest and often took the form of a direct extension of the contract-based work performed by the lab.

As we will see below, ventures that emerged from such process generally represented a substitute for a job for their founders

or a vehicle to pursue lifestyle objectives rather than entrepreneurial objectives incorporating growth.

(Insert Figure 3.)

4.2 Second archetype: Minimalist support and selectivity

Universities that initiated a technology transfer policy, having emerging capabilities in that area, in the late 1990s began developing a proactive spin-off process with minimum support and selectivity. This was the case of three universities in our sample and of two other smaller ones outside the sample that we did not study in detail.

Origination phase. The new technology transfer policy did not include proactive technology opportunity search: the identification of a potential spin-off opportunity relied on individual scientists. In the absence of this search capability, these universities relied more on internal public relations campaigns encouraging researchers to submit entrepreneurial projects and advertising the resources available, mainly in the form of newly available seed funding. In this early phase of implementation of a spin-off policy, the aca-

demic institutions more likely encouraged spin-off policy initiatives than acted selectively in choosing projects to support. Indeed at best no more than a couple entrepreneurial initiatives began each year. Consistent with a weak entrepreneurial environment, academics generally showed little interest in commercializing the findings of their research. Policies of these academic institutions and of government agencies consisted of encouraging scientists to become entrepreneurs, instead of attracting people from the business world to exploit the commercialization of technology.

Weak intellectual property assessment slowly emerged as an intrinsic part of the process, in part because academic institutions obtained ownership in 1999 of the intellectual property of publicly funded research. This followed the much earlier lead of the United States Bayh-Dole legislation (Owens-Smith, 2002). Thus, in the late 1990s universities were just beginning to acquire some intellectual property expertise. This generally translated into hiring one person with some background in that area or in subcontracting to an outside firm. Business assessment and selectivity of the opportunity by the academic institution was limited because of a lack of internal capabilities; the primary concern of universities during

these initial years of support for spin-off initiatives was to generate projects rather than being selective.

Concept testing phase. Academic institutions supported little concept testing before the ventures were founded. Assistance in writing a business plan was limited, sometimes consisting only of providing the potential founders with a template for a business plan. Resources for product development and market test were not available. Rarely did the academic institutions attempt to expand the founding team beyond the original scientists and the board beyond the founders and a representative of the university or its investment fund. The main form of support was the provision of seed funding.

Ventures were financed with the help of a seed fund set up by academic institutions, generally with public and sometimes private financial partners. In one region the government also subsidized a two year leave of absence for researchers to conduct a feasibility study of spin-off projects. Besides the provision of seed funding, founders were largely left on their own, in spite of their lack of business experience. Ventures were founded at a very early stage when the entrepreneurial project of the founders was still

vague and its main asset consisted of scientific knowledge. Thus, the concept testing phase happened, for the most part, after founding without the involvement of universities.

Universities that initiated spin-off process with minimal selectivity and support typically had a view of entrepreneurship that was much more infused with the SME model of ventures than with the growth-oriented mode of ventures. They also exhibited a conservative approach to venturing and typically compelled founders to submit business plans showing rapid positive cash flow. In so doing, they pushed founders even more to adopt a contract-based business model, often consulting. Universities were understandably not very well equipped to provide support to spin–off ventures, but they also pressured founders not to seek support outside the university and thus contributed to their isolation and the fragmentation of a potential nascent entrepreneurial community.

Insert Figure 4.

4.3 The third archetype: Intermediate support and selectivity.

This process involves more selectivity and support. It appeared in one university after 1999, after it had experimented for a few years with little success with the prior model of a spin-off process of minimal support and selectivity. The new policy, initiated around 2000 – 2001, involved a more proactive technology transfer policy consisting of building up internal capabilities in intellectual property and in business opportunity assessment and testing. It also involved efforts at structuring the nascent local entrepreneurial community into a support network and at building bridges with a more advanced entrepreneurial cluster overseas.

Origination phase. The origination process is based on an original organization of research, which separates the organization and the budget of contract-based research under the responsibility of an office of technology transfer, apart from the organization and the budget of the university. This gave more independence and resources to the office of technology transfer than in other universities. The university experimented with two systems of proactive technology opportunity search but with mixed success. By the end of 2001, it still largely relied on individual initiatives. This example

may point to the difficulty of conducting proactive opportunity search in a university setting. By 2001, its technology transfer unit included five professionals involved in intellectual property management and business assessment. Its capability to assess business opportunities relied in part on this internal capability and on structuring the nascent local entrepreneurial community and seeking its support. This represented a departure from other universities, which did not benefit from a nascent entrepreneurial community, but did not reach out to local business either.

Concept testing phase. The major change in the spin-off process followed at this university after 1999 is that more support was provided for the concept testing phase before ventures were founded. This appears to be due to lessons drawn in the prior years from disappointing spin-off experiences with firms spun off after too little concept testing of their business idea and the university's realization of the importance of the concept testing phase in terms of support and selection. It also seems to be due to the need felt by this university to push founders to target more ambitious opportunities than the small businesses they were usually tempted to create. Finally, as the global internet – telecom technol-

ogy bubble collapsed, the financial partners in the university's investment fund required more proof of concept from spin-off projects seeking funding. The change thus translated not only into more support, but also in higher selectivity. It materialized into small financial support of EURO 30,000 to 50,000 from the university's technology transfer office for business concept testing, such as product development or market testing, while potential founders were still on the university's payroll.

Start-up support phase. The university indirectly got involved in providing support for the start-up support phase, primarily by creating, along with another local research institutions, a network among the nascent high tech community, including about thirty of its own spin-off ventures founded over two decades. It also initiated links of this network with a similar one in Cambridge (UK), a much more developed technology cluster. This nascent community further benefited from the proactive development by the university of a science park, soon to be complemented by two others.

Insert Figure 5.

This spin-off model is the first among Belgian universities to exhibit a wider range of support mechanisms and to exercise selectivity. It is also the first that opened up to outside supportive communities, both locally and internationally.

4.4 Fourth archetype: Comprehensive support and selectivity

A fourth model of proactive spin-off process was implemented outside universities by two specialized research institutes. In contrast to universities that were all at least one hundred years old, these institutes were established respectively in 1984 and 1995 by a regional government as part of its Science Technology and Innovation (STI) policy with a strong mandate for technology transfer. These research institutes are umbrella organizations for research in micro-electronics and biotechnology. The older of the two was the first academic institution to attempt to spin-off ventures proactively in the late 1980s and early 1990s, but had little success given its lack of experience and the absence of risk capital. A more systematic policy appeared in 1996, when risk capital became more available.

The origination phase. Both institutes put in place a particular organization of research with a strong emphasis on technology transfer. They developed procedures for a proactive technology opportunity search of research findings with commercial potential. This task turned out to be more effective than in universities, probably in part because the specialized research institutes were dealing in one scientific area in contrast with universities whose research spanned a large number of sectors.

With their strong endowment, the two research institutes could put in place strong intellectual property capabilities to evaluate the technical potential of opportunities. One had a staff of twenty people in its technology transfer unit by 1999, while the second had a team of seven intellectual property professionals in 1998. Thus their capability to assess the potential of a technology early on in terms of intellectual property was strong, in contrast to universities.

Their ability to assess the business potential of the technology was more difficult to evaluate. It probably relied in part on their extensive local and international network which extended beyond academia to industry and the venture capital community.

The teams in charge of technology transfer concluded this origination phase of the spin-off process by selecting technologies that they believed had a great business potential worth testing. If there was no existing local firm able to exploit the opportunity through licensing it, they considered transferring the technology by creating a spin-off venture, but only if the potential was high enough to be able to attract venture capital from the outset.

The concept testing phase. The concept testing phase translated into incubating the spin-off project during a period of twelve to eighteen months. It involved work on the defense of intellectual property by the institutes' technology transfer teams. The business side of the concept testing phase was generally delegated to one or two persons with industry or policy experience, who were hired in a consultant capacity with the prospect of becoming part of management of the future venture. It included, for instance, business plan development, product development, and market research, as well as assembling a potential management team and board. The concept testing phase also relied on the institutes' extensive international network in academia and industry.

The objective pursued in the concept testing phase was to create enough proof of concept for the project that it would be eligible for new available venture capital. Ventures were only founded at the end of this concept testing phase when they had a technology that was intellectually protected, a business plan that demonstrated its strong market potential, a convincing business model to exploit it, and, finally, a management team able to carry out this project. Because the institutes targeted venture capital as funding sources, the selection was very severe. Not only do venture capitalists invest only in the most promising firms, but the spin-off ventures of the institutes needed to compete internationally with others for the funding. Thus, in contrast to a university setting, funding was much more competitive. In 2001, after venture capitalists became more conservative, one of the institutes formed a seed stage fund with financial partners from the banking sector, to overcome this new financial gap and bring ventures to the higher level of proof of concept required by venture capitalists.

The start-up support phase. The start-up support phase was primarily carried over by the management team put in place with the help of its financial backers, as well as the firms' board mem-

bers and advisers. The institutes also contributed, however, primarily through their local and international network in academia and industry.

Insert Figure 6.

Using Roberts and Malone's (1996) view of spin-off policies in terms of selectivity and support, we could represent the observed spin-off processes as follows.

Insert Figure 7.

5. IMPLICATIONS OF SPIN-OFF PROCESSES ON FIRM FORMATION

What are the implications of these academic spin-off processes for the formation of ventures?

5.1 High selectivity–high support spin-off processes generate ventures pursuing opportunities with the highest potential.

The first implication is that the data seem to confirm the prediction of Roberts and Malone (1996). The ventures spun-off by the specialized research institutes, following the spin-off processes with the highest selectivity and support, have the most growth potential at founding. They had the highest capitalization, the most complete and experienced founding team, the most experienced investors and board members, and pursued opportunities with the most potential.

In contrast to universities, the two institutes positioned spin-off ventures that adopted from the outset a high growth-orientation based on the model of technology ventures that is common in USA high tech clusters. They organized their comprehensive spin-off process to make their spin-off venture eligible for venture capital from the outset.

The example of the firm Fullsoft illustrates this case: [1] Fullsoft was founded in October 1996 based on a technology developed at one of the specialized research institutes. The firm provides tools for hardware and software co-design that cuts overall cost and integrated circuit design time in half, compared to traditional design

[1] The names of people and companies were altered in order to maintain anonymity

methods, and speeds new products to market. The institute estimated that the technology offered enough potential to justify a spin-off project that could attract venture capital. It offered the scientists the opportunity to further develop their technology and study their market for about a year. The research institute assisted the business process notably by providing external consultants from the USA, helping the founders to raise funds, providing their first client, and, overall, providing credibility.

Thanks to this incubation period, the firm started with a product that was ready for market and had a client. It was able to raise an initial round of capital of EUR 4 million from two local and one American venture capital firm. Early on, the firm established a presence in Silicon Valley, in a move to become a "born global" venture. Experienced managers were hired in the USA, notably with the help of the American venture capitalist. The firm adopted a product orientation right from the start. This did not rule out consulting, but consulting was conducted "in order to gain the trust of our clients."

In contrast to most founders of academic spin-off ventures, one founder said, "right from the beginning in 1996, we wanted to

become big, although this project of becoming big quickly ran against the Belgian culture." The founders explain this orientation because of the role models provided by firms in their sector and the need to have a critical size to deal with their clients, which were typically multinationals. Also, the research institute, which had disappointing experiences with early spin-off ventures with little ambition, was selective in supporting Fullsoft and pushed the founders to opt for an ambitious entrepreneurial project.

5.2 Implications for firms in case of spin-off process with minimal selectivity and support

There are also implications for firms in the case of an absence of proactive spin-off process or in the case of a process involving minimal support and selectivity. These two processes represent the majority of cases as illustrated in Figure 7. First, absence of or limited selectivity allows great variance in the types of ventures, notably in their level of ambition. However, in an environment with little entrepreneurial culture and infrastructure, the small business SME model is likely to dominate. This type of firm indeed represented thirty-two out of the forty-three sampled firms

that we could classify. They were generally characterized by minimal legal capitalization and the desire of their founders to keep the ownership of the firm closed. Their management team was composed of technicians who did not exhibit any growth orientation.

Second, with limited support, academic institutions spun off ventures at a very early stage of development, when their main asset was some form of scientific knowledge, but when founders had little concrete idea on how to commercialize it and turn it into a viable business model. As a result, the only option for founders was to adopt a very simple business model consisting of performing contract-based work, often in the form of consulting, which was a close extension of the work they had performed in their lab.

Third, such a spin-off process that involved little support, pushed most of the burden of the concept testing phase to after the founding of the venture. The founders complemented their scientific expertise with market knowledge by experimenting through their contract-based work. They needed to learn both basic business and management skills, as well as to find a viable business model. This presented the challenge of operating as a business,

while at the same time performing a great deal of development work.

Most ventures (thirty-two out of forty-three firms classified) never performed concept testing beyond the stage of contract-based work. This lack of concept testing happened because the drive of these ventures was primarily the personal lifestyle motivations of the founder(s). Growth orientation was either rejected by these founders because it conflicted with their lifestyle objectives or it was not considered because of the lack of information and concrete competencies to implement a growth-oriented project. Alternatively, this lack of concept testing of opportunities with more potential happened because founders fell in a "consulting trap" (Roberts, 1991; Segal Quince Wicksteed, 1990). They became comfortable with the contract-based model of firm and never explored further.

The example of the firm Streamco illustrates such as case. Streamco was founded in 1992 by a professor of microbiological ecology and technology at one of the Belgian universities and three of his research assistants. Based on its expertise in microbiologic processes, Streamco helps firms solve environmental problems,

such as water purification. In the mid-1980s, the lab was increasingly called upon by industry to help solve such problems. This new demand, combined with university budget restrictions which limited career opportunities for his researchers, led him and three of his researchers to set up a commercial structure to meet industry needs.

After considering the new venture for a year, the founding parties established Streamco in 1992 as an extension of the "commercial work" already performed within the university lab. The university did not have any involvement with the creation of Streamco. The founders formed their company with EUR 32,000, the minimum capital required by law in 1992. Choosing to incorporate with the minimum legal capital and trying to maintain this level is typical of founders of SMEs. Only the founders were shareholders and board members; they were opposed to outside capital, since independence was a key part of their project. This case thus illustrates the closed ownership structure of this type of firm and the minimal management structure. Initially, they operated out of the university lab, using its equipment. Later, they moved to the university's scientific park where there was an "incubation center."

This structure was limited to provision of space for start-up firms and did not provide business coaching. Nevertheless, Streamco remained there for eight years and thus kept strong connections and a strong identity link with the university.

The founders did not actively seek growth opportunities. They welcomed such opportunities only on the condition that independence from outside shareholders could still be maintained. They concentrated more on technical issues than on commercial ones. As one founder said, “Streamco’s main investment was in its laboratory, because that is the heart of the firm.” In 1999, Streamco, which started with three founders, had fifteen employees. Its original capital of EUR 31,250 grew to EUR 250,000 by internal financing. One founder commented that the reason for increasing the capital to this level was that it was the minimum required to be able to bid for certain governmental projects. This example illustrates the closed ownership mode of governance at the heart of this type of firm and the priority of independence over growth.

We also see a small but growing number of firms, which departed from the SME model. There were only seven such firms in

our sample founded after 1995. Following a similar spin-off process involving the founding of ventures at an early stage, as described above, some founders pushed concept testing further in order to find an opportunity with greater potential. When that happened, it often resulted from pressures from their academic institution to explore a more ambitious project, after the latter began a supportive policy towards spin-off initiatives. They needed to conduct concept testing by experimenting through their contract-based work as there were so few models or templates available locally, due to the weak entrepreneurial community and the weak incubating capabilities of their originating academic institutions. The founders needed to experiment by themselves, for instance, with refining their product, selecting a market niche, and finding a viable business model in general. It was a learning process that was characterized mainly by experimentation, which was thus slow.

In other words, these ventures needed to go through a "gestation period" of experimentation. Such a period could sometimes last several years. Although founders of these ventures hoped to build a firm that would grow beyond the SME model, growth was

not an immediate opportunity. Instead, their focus was on learning basic business skills and figuring out a viable business model. This is why we propose to label these ventures “growth oriented ventures in gestation.” This observation is similar to the “soft start” described by Segal Quince Wicksteed (1990) in their description of ventures in the high tech cluster of Cambridge in the 1980s. The main challenge of such ventures in their early stage was to succeed in their concept testing phase while operating as a business.

The example of the firm Magnes illustrates a case of growth-oriented firm in gestation. Magnes was founded in May 1998 by two researchers from a university lab which specializes in the generation and use of high magnetic fields for scientific experiments. Magnes built on this expertise to produce industrial magnetizers.

While the two founders were still researchers, people in industry regularly asked if they would sell equipment similar to that which they had created for their research work. They could not do this within the context of the university, but it triggered the idea that they might be able to do it in the context of a firm, especially since their employment contract at the university was about to ex-

pire. Around the same time, they learned about the university's new supportive policy towards spin-off initiatives.

Once the founders started exploring the idea of forming a company in 1997, they met with the technology transfer office of their university which reacted positively, but encouraged them do more "homework" and provided a template for a business plan. They went back to the technology transfer office in October 1997 and were given useful support which, they acknowledge, helped them elaborate upon and consolidate their business plan. This assistance forced the founders to enlarge their focus beyond the scientific lab market and into the industrial market.

Magnes was founded with EUR 200,000, a higher capitalization than the typical EUR 62,500 of SME firms. The founders each invested EUR 12,500, which represented an important financial effort on their part, while the balance, 75%, was provided by the university and an investment fund set up in the late 1990s by the university in partnership with financial partners. The board of the company was composed of the founders, a marketing professor from the university, a banker representing the investment fund,

and a professor of management of technology representing the industrial liaison office and thus the university.

The firm was composed of the two founding scientists. Thus, like SMEs the management structure was quite weak. However, their culture was completely different from that which we described in founders of technology SMEs. These founders were aware of their lack of experience and were eager to learn from outsiders. They did not exclude outside capital. At the time of the interviews, when the firm was two years old, they were still primarily in a phase of learning basic business skills and concept testing. Indeed, they were engaged mostly in market exploration and product development, trying to define clearly what their product line needed to be. They felt that their shareholders realized that they needed time to refine the concept of their business and acquire the necessary skills. According to the founders, the shareholders gave them from 1998 until early 2000 to go through this stage of concept testing.

In terms of business model, Magnes' founders, like so many academics turned entrepreneurs, initially wanted to create a consulting firm. However, their early explorations made them change

their mind. They realized that firms which have problems with magnetic issues want a piece of equipment to solve them; consulting alone is inadequate to meet their needs. The founders said they also realized that consulting, with training and follow-up on problems, grows as a by-product of selling equipment. Clients who order equipment want consulting along with their purchase.

The founders' initial model was one of a small firm with a couple of employees. Initially, they also targeted the academic market because "this is the one we knew the best." While working on their business plan, however, the people from the university's technology transfer office and the investment fund pointed out that this market was too small and pushed them into targeting the industrial market instead.

The academic market thus became no longer an end in itself, but a step towards gaining entry into the industrial market. One way they tried to penetrate the industrial market was by talking to lead users and learning about their needs. This was an idea that the professor of marketing sitting on the Magnes board suggested.

Until the time of the interview, they had been doing either consulting or they had produced tailor-made equipment, but they

realized that they needed to start producing small batches of equipment in order to gain economies of scale. They envisioned that they would reach this stage within one to two years perhaps. Ultimately, their aim was to produce a large series of small equipment.

At founding and during the early phase of business, traditional SMEs and growth-oriented ventures in gestation did not appear very different to an outside observer. The difference lay primarily in the attitude of the founders and/or of their sponsors. Founders of ventures that were trying to overcome the small business, contract-based work model, and have growth orientation, treated the contract-based business model as a transitory state and a learning opportunity to incorporate market insights into their scientific knowledge base. For founders who did not have the ambition to move beyond the small contracting business, consulting was primarily a source of revenue and an end in itself. Therefore, SMEs and growth-oriented firms in gestation may not be easy to distinguish, especially at their early stage, without rich qualitative data collection and analysis.

6. DISCUSSION

The analysis of spin-off processes in these eight academic institutions suggests that the processes impact the form academic spin-off ventures adopt and their growth orientation, independent of macro structural and cultural obstacles to entrepreneurship. Specifically, spin-off processes that involve high selectivity and support and are practiced by academic institutions that have a strong exposure to the American model of growth-oriented entrepreneurship, generated ventures that pursued opportunities with the highest potential. This result confirms Roberts and Malone's (1996) prediction.

On the other hand, academic institutions that had either no spin-off policies, or followed a policy of low selectivity and low support, which was the case of a majority of academic institutions in the sample, appeared to generate a majority of SME types of spin-off ventures without growth orientation. They also generated a minority of ventures that needed a long gestation period before growth could become a priority.

What mechanism links spin-off processes characterized by weak selectivity and support with the types of firms they generate?

Roberts and Malone (1996) argue that low selectivity implies a low potential quality of the ventures being spun off. This paper proposes that low support also implies that ventures were spun-off at an early stage in which they could only adopt a basic business model of contract-based work. A weak selectivity and support spin-off process pushes the burden of most concept testing on ventures after they were founded. In an environment dominated by the SME model of venture, most founders never consider growing beyond a business model based on contract-based work.

For owners who want to move beyond the small business model, contract-based work serves as their method of conducting concept-testing and learning basic business skills. This presents the challenge of operating on a dual mode: conducting concept testing while functioning as a business. Learning, thus, follows a process of isolated experimentation, since ventures evolved in environments where there was little entrepreneurial community and the academic institutions from which they originated had little incubating and coaching capabilities.

At the firm level, experimenting is a slow process that could last several years before growth became a priority. During this gestation period, the risk is high of falling into a "consulting trap," with founders never trying to move beyond the model of contract-based work because at the venture population level, there was little knowledge circulation and little cumulative learning occurred at the local venture population level, given the weak entrepreneurial community, few service providers playing the role of "pollinators" (Suchman, 2000).

It thus seems reasonable to propose that spin-off processes involving minimal selectivity and support contribute to the low quality and weak growth orientation of spin-off ventures, in addition to the macro structural and cultural obstacles to growth that these ventures face. This impact may be significant as such low selectivity and low support spin-off processes seem to dominate in environments with weak entrepreneurial infrastructure, as this example illustrates and evidence from other regions indicates (Clarysse et al., 2001).

The slow start of most growth-oriented ventures may be compounded further by the particularities of research-based ven-

tures. Innovative technologies sometimes require long development and often do not have clear product applications and/or identified markets right away. Some even create entirely new markets. This involves, for instance, convincing customers to use the new technology instead of the incumbent one or to change the way they operate.

The spin-off processes that we observed were not static. Some grew in sophistication over time, as some academic institutions learn from experience, suggesting that these archetypes may represent a learning or development path, which academic institutions follow. Some academic institutions at least seem to move up a learning curve as they learn lessons from their early experiences. Does this mean that academic institutions, which follow a low selectivity and support policy will evolve with time towards higher selectivity and higher support policies, as the case of university No 4 illustrates? Not necessarily. The detailed examination of spin-off processes, indeed, highlights that such a policy requires considerable resources to which individual academic institutions seldom have access. In the cases that we studied, and probably in many instances of weak entrepreneurial regions, Roberts and Malone's

(1996) recommendation represents an ideal to achieve rather than an immediate accessible policy. The question for academic institutions and policy makers is what steps can they take to achieve a high selectivity – high support spin-off process and what policies they can adopt in the meantime?

The framework in three stages proposed above to represent a proactive spin-off process could possibly help answer these questions. By identifying the three stages and the functions that need to be fulfilled at each stage, our framework can be used as a diagnostic tool to assess the extensiveness, or lack thereof, of an existing spin-off process. The framework can also be used as a management tool by linking each stage with the resources necessary to fulfill each of its functions.

Insert Figure 8.

The framework can serve as a management and policy making tool. It can highlight resources that are missing at each stage. In turn, this points out to steps to take in order to remedy this gap. For instance, it may highlight that an academic institution has suf-

ficient financial resources, but lacks relevant social networks in the scientific and / or business communities. Alternatively, it may have social networks that are appropriate for the origination phase, but not for the concept testing phase.

In addition, if academic institutions experience resource constraints and cannot fill in these gaps in resources, the framework can help determine what policies are possible to implement given these limited means. For instance, if an academic institution has no means to exercise selectivity and conduct concept testing in the form of market test or product development, its immediate options in terms of spin-off policies are probably limited to encourage the emergence of a vibrant SME population.

Also, overcoming resource constraints may force decision makers to consider alternative strategies, such as partnerships with other actors in certain phases of the process. For instance, it seems that scale is a problem for a number of universities. Putting in place an infrastructure supporting technology transfer and spin-off initiatives is costly and justified only if there is enough of a "deal flow" that most universities do not have. For instance, since 2000, two smaller Belgian universities have closed the investment

fund they had set up without having made a single investment. This issue of scale advocates for partnerships and pooling of resources among academic institutions. Creating supportive structures somewhat distant from universities may also alleviate another problem: the conflict of interest in which academic institutions often find themselves involved when they play various roles, such as licensors and shareholder of spin-off firms. Overcoming resource constraints may also lead to using substitutes, such as coaching after firm founding, instead of incubation prior to founding.

Our framework highlights that academic institutions cannot and should not assume all parts of the spin-off process alone, contrary to what most universities in this sample tried to do. Supportive spin-off processes, like any entrepreneurial process, involve reaching out to access complementary resources by establishing informal and formal links both locally and internationally (Bresnahan et al., 2001; Nohria, 1992). In established entrepreneurial regions, a high level of embeddedness of local firms in dense networks facilitates supporting interactions and knowledge sharing, and institutions help build trust and encourage relationships

among the actors (Breshi and Malerba, 2001). In contrast, regions with weak entrepreneurial infrastructure have weak and more fragmented support networks (Suchman, 2000). Academic institutions in those regions are likely to have a greater impact by facilitating contacts and building bridges than by conducting spin-off policies in a directive way and in relative isolation. Given their traditional insulation from industry and their internal culture, academic institutions are not the best equipped to play this intermediary role, which represents a clear challenge for them.

The above analysis can also serve as basis for discussion beyond the model proposed by Roberts and Malone. Their recommendation in favor of spin-off policies involving high selectivity and high support in weak entrepreneurial environments aims at spinning off ventures capable of pursuing opportunities with high growth potential. These ventures are the driving force of successful high tech clusters; the model policy makers would like to be able to emulate. They are, in fact, the types of firms that are missing the most in Europe (e.g. European Commission, 1998). However, promoting the creation of high potential spin-off ventures may also be complementary to the promotion of more modest ventures. SMEs

and growth oriented firms targeting smaller business niches indeed play a key role in high tech clusters as suppliers and service providers that support high tech growth firms (Saxenian, 1994). Smaller firms contribute greatly to the ecology of a cluster not only economically, but also as conduits of knowledge (Saxenian, 1994; Mustar, 2001). Therefore, people in charge of spin-off policies should probably try to promote a portfolio of spin-off ventures with different profiles and, thus, support them with policies adapted to their individual profiles. This, again, calls for academic institutions to join forces in such effort.

Although it is beyond the scope of this paper, the last point introduces the important idea that academic spin-off policies should fit within broader local innovation policies.

7. CONCLUSIONS

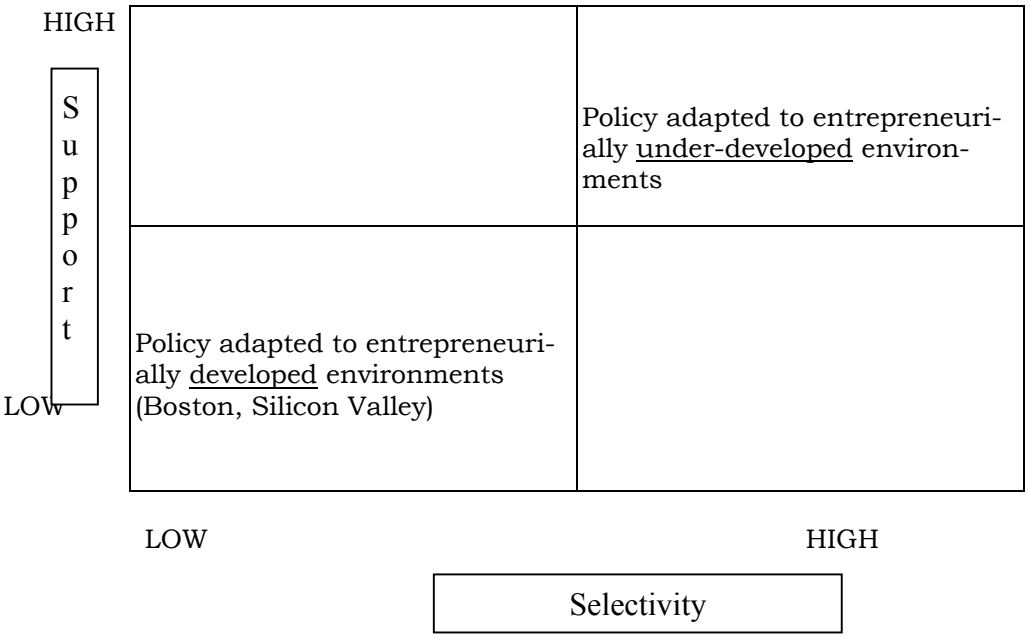
Our research examined whether spin-off processes affected the potential and growth orientation of academic spin-off ventures in environments with weak entrepreneurial culture and infrastructure. Data indicates that these spin-off processes may indeed have

an impact beyond macro structural and cultural obstacles to entrepreneurship, influencing the growth orientation of the ventures. Specifically, as predicted by Roberts and Malone (1996), spin-off process involving high selectivity and high support seem better able to generate ventures capable of exploiting opportunities with high potential. Secondly, spin-off processes with low selectivity and low support predispose ventures to adopt an SME format. Under the circumstances, founders who want to build a firm that goes beyond the small business model may need to go first through a long transitory gestation period of experimentation, during which they are prone to fall into the consulting trap.

Managing spin-off processes should assist in overcoming this problem. The framework proposed to conceptualize the spin-off process helps first by proposing a typology of spin-off processes allowing an assessment of existing processes and second, by identifying resources needed to improve the process. Finally, the framework encourages those in charge of spin-off policies to consider creative partnerships to overcome limitations faced by individual institutions.

The generalizability of these insights remains to be established by studying more cases in other regions. Such an endeavor would be worthwhile because common characteristics of regions outside high tech clusters suggest that generalization of the present observations might well be possible.

Figure 1. Academic spin-off policies and types of entrepreneurial environments



Source: Adapted from Roberts, E. and D. Malone (1996).

Figure 2. Proposed framework to analyze academic spin-off processes

ORIGINATION	CONCEPT TESTING	START-UP SUPPORT
• Opportunity identification • Opportunity selection	• IP protection testing • Business concept testing • Selection	• Internal advising capabilities • Network support

Table 1. Number of types of spin-off processes observed

Types of spin-off processes	Number of each processes observed
Absence of policies	3
Minimal selectivity / support	3
Intermediate selectivity / support	1
Comprehensive selectivity / support	2

Figure 3. Summary of first archetype: absence of proactive spin-off processes

ORIGINATION	CONCEPT TESTING
• Individual initiatives of researchers often resulting from interaction with industry • No institutional support	• Performed while conducting joint R&D for industry, or consulting • No institutional support

Figure 4. Second spin-off archetype: minimal support and selectivity

ORIGINATION	CONCEPT TESTING
• **Opportunity identification** o Individual initiatives + PR of university • **Opportunity selection** o Emerging IP capability o Limited capability for business opportunity selection o Focus on encouraging spin-offs rather than on selectivity	• **IP protection testing** o Emerging – not always relevant, because cases without IP transfer • **Business concept testing** o Minimal • **Selection** o Minimal

↓

Firm founding at early stage → Most concept testing occurs after founding

Figure 5. Third spin-off archetype: intermediate support and selectivity

ORIGINATION	CONCEPT TESTING	START-UP SUPPORT
• **Opportunity identification** o Attempts at proactive opportunity search • **Opportunity selection** o Growing IP capability o Pressure founders to submit more ambitious business projects	• **IP protection testing** o Growing IP capability • **Business concept testing** o Market research – product development within university structure • **Selection** o Emerging selectivity	• **Internal advising capabilities** o Primarily through financial partners • **Network support** o Growing support through nascent local entrepreneurial community and external links

↓

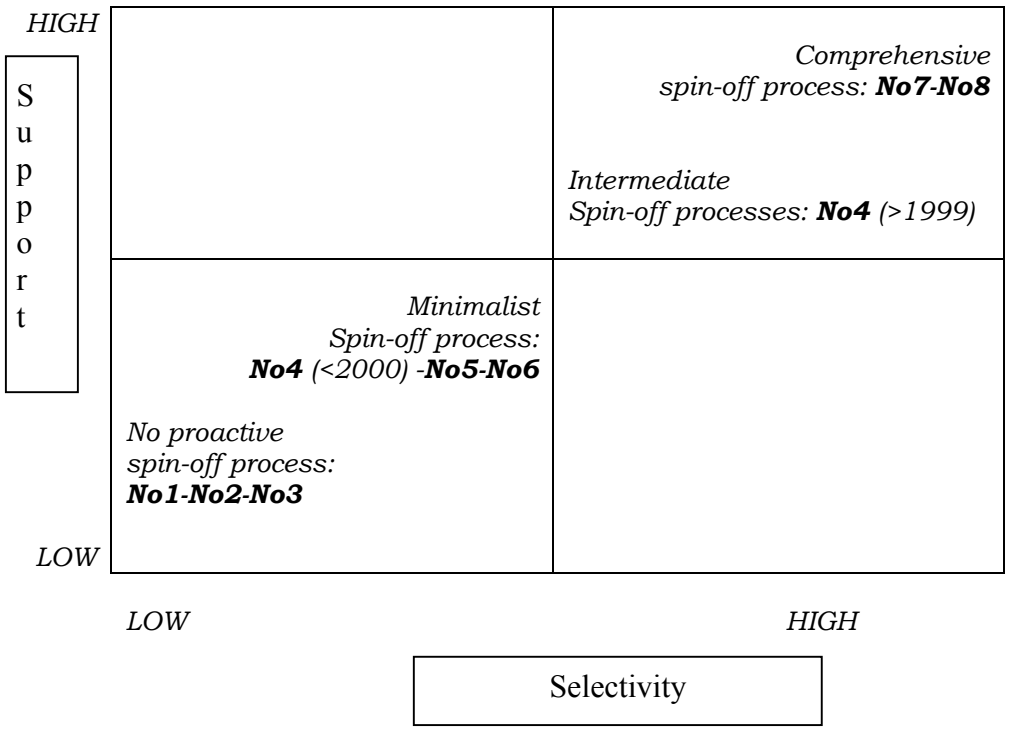
Firm founding after concept testing within the university

Figure 6. Fourth spin-off archetype: comprehensive support and selectivity

ORIGINATION	CONCEPT TESTING	START-UP SUPPORT
• **Opportunity identification** o Proactive opportunity search • **Opportunity selection** o Strong IP capability o Very selective – specific criteria for transfer of technology via spin-off strategy	• **IP protection testing** o Strong IP capability • **Business concept testing** o Market research - product development with help of outside consultants • **Selection** o Strong selectivity: target VC funding	• **Internal advising capabilities** • **Network support** o Local network + strong international network of the research institutions o Firm's Management team, board, advisors, shareholders

Firm founding after 12-18 months of concept testing within the academic institution

Figure 7 Rating of academic spin-off policies in terms of selectivity and support (*)



Source: Adapted from Roberts, E. and D. Malone (1996)

(*) Numbers in Figure refer to specific academic institutions in our study sample

Figure 8. Stages of the spin-off process and necessary resources

•	**ORIGINATION**	**CONCEPT TESTING**	**START-UP SUPPORT**
	• Opportunity identification • Opportunity selection	• IP protection testing • Business concept testing • Selection	• Internal advising capabilities • Network support
	RESOURCES		
Technical	Research capabilities; management of research; IP capabilities	R&D capabilities; IP capabilities Business due diligence and planning skills	R&D capabilities; business development and management skills
Financial	R&D financing; investment in TT	Innovation grants; seed financing; investment in TT	Early stage VC; growth-stage VC
Human	Scientists; TT specialists	TT specialists; business coaches	Scientists; management; board members; advisors
Social	Scientific network	Scientific network; network in industry and in the entrepreneurial community	Scientific network; local and international network in industry and in the entrepreneurial community.

REFERENCES

Bannock Associates. (1999). *EU innovation finance benchmarks*. London.

Bird Schoonhoven, C., Eisenhardt, K. M., & Lyman, K. (1990). Speeding product to market: waiting time to first product introductions in new firms. *ASQ, 35*, 177-207.

Breschi, S., & Malerba, F. (2001). The geography of innovation and economic clustering: some introductory notes. *Industrial and Corporate Changes, 20*(4).

Bresnahan, T., Gambardella, A., & Saxenian, A. (2001). 'Old economy' inputs for 'new economy' outcomes: cluster formation in the new Silicon Valleys. *Industrial and Corporate Changes, 20*(4).

Boeker, W. (1989). Strategic Change: the effects of founding and history. *Academy of Management Journal, 32*, 489-515.

Capron, H., & Cincerra, M. (2000a). R&D expenditures and the national innovation system. In H. Capron & W. Meeusen (Eds.), *The National Innovation System of Belgium* (pp. 73-10). Heidelberg: Physica-Verlag.

Capron, H., & Meeusen, W. (Eds.). (2000). *The National Innovation System of Belgium*. Heidelberg: Physica-Verlag.

Chiesa, V., & Piccaluga, A. (2000). Exploitation and diffusion of public research: the general framework and the case of academic spin-off companies. *R&D Management, 30*.

Cincera, M., Clarysse, B., Kalenga-Mpala, R., Monard, E., Nauwelaers, C., Spithoven, A., & Teirlink, P. (2001a). *Rapport belge en matière de science, technologie et innovation (Tome I)*. Brussels: Services Fédéraux des Affaires Scientifiques, Techniques et culturelles.

Cincera, M., Clarysse, B., Kalenga-Mpala, R., Monard, E., Nauwelaers, C., Spithoven, A., & Teirlink, P. (2001b). *Rapport belge en matière de science, technologie et innovation. Le système belge d'innovation: leçons et défis (Tome II)*. Brussels: Services Fédéraux des Affaires Scientifiques, Techniques et culturelles.

Clarysse, B., Degroof, J. J., & Heirman, A. (2001). *Analysis of the typical growth path of technology-based companies in life sciences and information technology, and the role of different sources of innovation financing*. Brussels: European Commission, Entreprise Directorate-General.

Debackere, K. (2000). Managing academic R&D as a business at KU Leuven: context, structure and process. *R&D Management, 30*(4), 323-328.

Degroof, J. J. (2002). *Spinning off new ventures from research institutions outside high tech entrepreneurial areas.* Unpublished Doctoral thesis, Massachusetts Institutitute of Technology, Cambridge, MA.Available at Web.mit.edu/jdegroof/www/index.htm

European Commission (1998). *Communication from the Commission to the Council and the European Parliament. Risk capital: a key to job creation in the European Union*. Brussels: Commission of the European Communities.

European Commission. (2000). *Communication from the Commission to the council and the European Parliament. Progress report on the risk capital action plan* (COM (2000) 658 final). Brussels: Commission of the European Communities.

Freeman, J. (1986) Freeman, J. (1986). Entrepreneurs as organizational products: semiconductor firms and venture capital firms. In G. Libecap (Ed.), *Advances in the study of entrepreneurship, innovation, and economic growth. A research annual. Entrepreneurship and innovation: the impact of venture capital on the development of new enterprise.* (Vol. 1, pp. 33-52). Greenwich, CT: JAI Press.

Howells, J., & McKinlay, C. (1999). *The commercialisation of university research in Europe*. Manchester: University of Manchester, PREST (Policy research in Engineering, Science and Technology).

Kenney, M. (Ed.). (2000). *Understanding Silicon Valley. The anatomy of an entrepreneurial region*. Stanford, CA: Stanford Business Books.

Lee, C. M., Miller, W. F., Hancock, M. G., & Rowen, H. S. (Ed.) (2000). *The Silicon Valley hedge. A habitat for innovation and entrepreneurship*. Stanford, CA: Stanford University Press.

Mustar, P. (1995). *The creation of enterprises by researchers: conditions for growth and the role of public authorities.* Paper presented at the High level workshop on SMEs: employment, innovation and growth, Washington, DC.

Mustar, P. (2001). Generating spin-offs from public research: trends and outlook. *Science Technology Industry Review. Special issue on fostering high tech spin-offs: a public strategy for innovation, 26*, 165-172.

Nohria, N. (1992). Informational and search in the creation of new business ventures: the case of the 128 venture group. In N. Nohria & R. Eccles (Eds.), *Networks and organizations: structure, forms, and action* (pp. 240-261). Boston: Harvard Business School Press.

OECD. (1999). *Fostering entrepreneurship*. Paris: OECD.

Owen-Smith, J., Riccaboni, M., Pammolli, F., & Powell, W. W. (2002). A Comparison of U.S. and European University-Industry Relations in the Life Sciences. *Management Science, 48*(1), 24-43.

Reynolds, P., Camp, S. M., Bygrave, W. D., Autio, E., & Hay, M. (2001). *Global Entrepreneurship Monitor*. Wellesley - London: Baboon College - London Business School.

Roberts, E. (1991). *Entrepreneurs in high technology. Lessons from MIT and beyond*. New York: Oxford University Press.

Roberts, E., & Malone, D. (1996). Policies and structures for spinning off new companies from research and development organizations. *R&D Management, 26*(1), 1996.

Rowen, H. S. (2000). Serendipity or strategy: how technology and markets came to favor Silicon Valley. In C. M. Lee & W. F. Miller & M. G. Hancock & H. S. Rowen (Eds.), *The Silicon Valley hedge. A habitat for innovation and entrepreneurship* (pp. 184-199). Stanford, CA: Stanford University Press.

Saxenian, A. (1994). *Regional advantage. Culture and competition in Silicon Valley and Route 128*. Cambridge, MA: Harvard University Press.

Segal Quince Wicksteed. (1990). *The Cambridge phenomenon. The growth of high technology industry in a university town* (2nd edition). Cambridge: UK, Market Street, Cambridge CB4 5 QG: Segal Quince Wicksteed.

Segal Quince Wicksteed. (1999). *The Cambridge phenomenon revisited*. Cambridge: UK, Market Street, Cambridge CB4 5 QG: Segal Quince Wicksteed.

Storey, D. J., & Tether, B. S. (1998). New technology-based firms in the European Union: an introduction. *Research Policy, 26*, 933-946.

Suchman, M. (2000). Dealmakers and counselors: law firms as intermediaries in the development of Silicon Valley. In M. Kenney (Ed.), *Understanding Silicon Valley. The anatomy of an entrepreneurial region* (pp. 218-240). Stanford, CA: Stanford Business Books

Timmons, J., Smollen, L., & Dingee, A. (1990). *New Venture creation. Entrepreneurship in the 1990s*. Boston: Irwin.