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WORKING PAPER

Transferring Technology by Spinning off Ventures:

Towards an empirically based understanding of the spin off process

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Abstract

Although the commercialization of research has become an increasingly important issue for academics as well as policy makers, much less is known about spinning off firms as a tool for technology transfer from universities and research organizations, especially from a process perspective. Drawing on case study as well as a European wide survey, this paper arrives at an empirically grounded conceptual framework of the spin off process. Providing a life cycle model, we analyzed which financial and knowledge resources are most prevalent during different distinct phases of the spin off process. Policy implications for facilitating the spin off process are formulated.

Key words: technology transfer; spin-off process; life cycle model

1 Introduction

Since the mid-nineties, several authors emphasized the strength of Europe's educational and science base on one hand and Europe's inability to convert this advantage into strong technological and especially economic performance on the other. This phenomenon has become known as the "European Paradox" (European Report on S&T Indicators, 1994; Caracostas and Muldur, 1997). Ever since, the commercialization of science and technology has become a prominent issue in the European policy agenda. Despite the relatively new interest from a policy point of view, it has been the subject of academic interest long before. In a comprehensive review of research and theory regarding technology transfer, Bozeman (Bozeman 2000: p 627) reports: "in the study of how to commercialize research, the neophyte and the veteran are easily distinguished. The neophyte is the one who is not confused….".

Much of the academic work has been focusing on "technology transfer" from research organizations or universities to the incumbent industry. In the period 1990-1999, over 1000 articles have been published on the subject and since 1975 no less than 579 books and monographs tackled the problem (Bozeman 2000). Conversely, much less is known about "creating new ventures" as a way to commercialize research and technology. This does not mean, however, that creating spin offs for technology transfer purposes, is an entirely new phenomenon. Already in the nineteenth century, scientists such as Werner von Siemens and Gerard Philips set up spin-offs, which would later develop into multinational players (Mustar 1995). Nevertheless, the creation of spin-offs in Europe has long been epi-phenomena developed in the indifference if not opposition of European Universities (Nlemvo, Pirnay et al. 2000).

It is only since the mid-nineties that academics and policy makers have been showing an increased interest in the phenomenon, attracted by the US based success stories which emerged from the high tech clusters Silicon Valley and Route 128, associated with Stanford University and the MIT/Boston area respectively. As a result, a number of articles have been published, in which new-technology-based firms (NTBFs) and a subcategory thereof – the academic spin-offs – are the central topic of interest (Autio and Yli-Renko 1998; Stankiewicz, 1994; Downes and Eady, 1997; Storey & Tether, 1998; Chiesa and Piccaluga, 2000; Debackere, 2000; Mustar, 1995, 1997; Surlemont and Pirnay, 2001; Degroof, 2001; Clarysse et al., 2001; OECD, 1999; European Commission, 2000). Most of these authors reported that spin-offs in their countries were very different from the US based success stories that policy makers have in mind. More specifically, European spin offs are reported to be mostly one-man SMEs with a limited

ambition to grow and without a clear commercial strategy. Additionally, publications regarding the importance of spin-offs in different European regions are very diverse. For example, in the small region around the University of Twente (The Netherlands) (OECD, 1999) 72 spin offs were officially reported, whereas in the probably most technologically advanced high tech cluster in Europe -- Cambridge UK – it is surprising that only slightly more than 300 spin-offs were estimated (Segal Quince Wicksted, 2000).

The counter-intuitive finding that spin-offs in Europe are very different from and less growth oriented than their US counterparts, combined with a lack of consistent data about the importance of spin-offs in Europe might indicate that we actually do not use a homogeneous definition of "spin-off", nor that we have a good insight in the "spin-off process". Without a good understanding of the nature of these companies and the process through which they are created, it is not possible to interpret the statistics that are collected to analyze their economic importance. This paper wants to fill this gap and analyses the spin-off process and determinants facilitating the commercialization of research through spin-offs.

This paper unfolds along the following lines. First, we explain the methodology that guided our data collection and analysis, in order to gain insight into the as yet incomplete documented phenomenon. Second, we position spin-offs as one potential mechanism to commercialize the research and technology. Third, we explore the spin-off process in order to gain insight into the as yet incomplete documented phenomenon. Fourth, we provide a discussion of the "financial resources" and the "knowledge resources" which impact this spin-off process. We conclude with the practical implications of our understanding on the use of spin-offs as indicators and draw some policy conclusions.

2 Methodology

This study is based upon previous work performed by our research team. A summary of the methodology used in this previous work will be presented in this section. A first research input we drew upon was the qualitative work by Clarysse and Moray (2001). Given the lack of insights in the spin-off process, they adopted an inductive research design (Ancona & Caldwell, 1992 ; Brown & Eisenhardt, 1995 ; Eisenhardt, 1989) to improve their understanding of the spin-off process. In short, they gathered qualitative and quantitative data from multiple sources of evidence. Over a twenty-month period, an in depth case study of a particular spin-off process was conducted using participant observation (Clarysse and Moray, 2001). This research provided real time longitudinal data from which theory on the spin-off process was built from the ground up. In parallel, Clarysse, Heirman and Degroof (2001) performed an in depth study of the Belgian context. Herein, the evolution of the entrepreneurial climate in terms of financial

resources and knowledge resources since the mid-eighties till present was explored. The aim of this study was to improve the insights in the contextual resources, which shape the spin-off process. We use also this study as input. In this paper, we validate and enrich the qualitative insights coming from these two in depth cases in a sample of spin-offs, which is representative for Europe's leading regions in terms of R&D activity. To do so, we draw upon the data collection effort undertaken by our research team in a European study on the growth path of new technology based firms (Clarysse, Heirman and Degroof, forthcoming). Clarysse et al. (forthcoming) used science and technology indicators that are available at a regional level, namely patents/head and GERD/GDP[1] to select one or more of the most technology-intensive regions in each country. The interview notes provide us with information on 88 spin-offs and 34 intermediary institutes (investors, incubators, public agencies and research organizations), which were located in 13 regions throughout Europe[2]. A checklist was used to talk about the start-up configuration (technology, capital, personnel, shareholders,…), the problems at start-up, the growth path after founding and the growth expectations of the company. The first question in each interview was 'how did the company came into existence?' Therefore, most interview notes contain information on the spin-off process. However, since the interviews were conducted for a different study objective, only 37 interview notes were consistent enough to be used in a quantitative manner (eg. to calculate the length of the different phases in the spin-off process). Especially, when the original founders had left the firm accurate information was lacking. In each of the selected regions, interviews were conducted with managers of financial institutes, incubators, government agencies, public research institutes and technology transfer units at universities. These interview transcripts provided detailed information on the different financial and knowledge resources available to research-based spin-offs in the different European regions. We used this information to validate and enrich the spin-off process, which Clarysse and Moray (2001) deducted from one intensive case study. Further, the interviews at regional level were used to generate a more complete image of the financial and knowledge resources which are necessary to facilitate the spin-off process, using the Belgian case (Clarysse et al., 2001) as a point of departure.

[1] GERD: Gross Expenditure in Research and Development; GDP: Gross Domestic Product

[2] Leuven, Gent (Flanders, Belgium); Liège, Louvain-la-Neuve (Wallonia, Belgium) and Brussels (Belgium); Aachen (Germany); Rheinecker Triangle (Mannheim/Heidelberg/ Ludwigshafen – Baden-Württemberg, Germany); Pisa (Northern Italy), Milan (Northern Italy); Stockholm (Sweden); Twente (The Netherlands); Munich (Germany); Cambridge (UK); Amsterdam (The Netherlands); Ile de France (France).

3 Research-based spin-offs as a potential vehicle for commercializing research and technology

A first step in the analysis of the spin-off process is to position "research-based spin-offs" both among other types of high tech start-ups and among other vehicles for technology transfer.

The literature on high tech firms offers an interesting insight regarding the role of technical uncertainty: Tether and Storey (1998) argue that high tech start-ups can be classified on a continuum ranging from pure innovators (developing their own technology[3]) to pure imitators (using technologies). Second, the innovation literature (Teece, 1986) points to the importance of the complementary assets – manufacturing, distribution, complementary technologies, sales and service, etc.-- or the situation on the downstream market as a predictor of the chances which a start-up versus an incumbent firm has to commercialize an invention. In other words, Teece (1986) argues that innovators need a number of specialized complementary assets in order to capture value from the technology. When a totally new market has to be created, market uncertainty is very high and incumbent firms are unlikely to monopolize the downstream value chain needed to penetrate the market. Hence, at this end of the continuum start-ups make a good chance to realize economic profits. At the other end of the continuum, where market uncertainty is quite low, the value chain is normally controlled by a number of incumbents, which make it impossible for new start-ups to realize economic profits. **Figure 1** structures these insights into a two-dimensional figure in which four quadrants can be distinguished. Each quadrant represents a "pure type", pointing to typical characteristics regarding market and technical uncertainty.

INSERT **Figure 1** ABOUT HERE

In the upper left quadrant, we find the so-called imitators or technology contingent start-ups. These start-ups use new technologies to enter new markets or to launch new ways of doing business (Hellman and Puri, 2000), but do not really invest in R&D. They might perform some engineering work to adapt the technology to a commercial product, but there is no technical uncertainty involved. The so-called dot-coms are a recent example of this kind of companies. Because in this upper left quadrant existing (but most likely rather new) technology is used to create or enter new markets, it is likely that the complementary assets needed to penetrate the downstream market are not yet tightly held by incumbent firms. Therefore, the first firm that captures the complementary assets makes a good chance to dominate the market in the long run. Hence, the first mover advantage is the core competence of these start-ups (Coviello and McAuley, 1999). Interestingly, we find in this category quite a number of "spin-ins", i.e.

companies created by entrepreneurs who have a business idea and search for the appropriate technology in universities or research organizations to support this idea.

In the lower left quadrant of **Figure 1**, we find those companies that face both little technical and market uncertainty. We call them the non-high tech or non-innovative start-ups. A typical example of this kind of start-up in a university environment is a service company testing the pollution in water or a small auditing company. The market is certain, but also settled. This means that this kind of company has either a local or a person-related customer base and economic profits are quite small. In a non-university or research environment, this is the typical SME-type start-up such as a grocery store.

Third, we distinguish the lower right quadrant, which is characterized by high technical uncertainty and low market uncertainty. In this quadrant, not an entrepreneurial venture seems to be the way to commercialize research and technology in the most efficient way, though contract research or some form of licensing with the existing incumbent industry seems to be preferred. The reason is straightforward: in existing markets, incumbents are interested to improve their competitive position either through the introduction of process innovations, which let them produce cheaper than their competitors or through product innovations, which can replace existing products and give them a first mover advantage in comparison to their direct competitors. In contrast to the case where market uncertainty is involved, these product innovations do not require a change in value chain or customer attitude. A typical example is the introduction of the broad screen TV players, replacing the existing ones. Technical uncertainty is involved, but a start-up would not be able to realize the economic returns because the downstream production and especially distribution channels are monopolized by a small number of incumbents.

Thus, in the upper right quadrant we find the research based spin-off. This quadrant encompasses science-based discoveries that have the potential to open up new markets. As a result, this quadrant is characterized by high technical and high market uncertainty. The creation of new firms, namely research based spin-offs, is an often chosen approach to commercialize such inventions. Following Smilor, Gibson and Dietrich (1990): an academic spin-off is an enterprise of which (1) the entrepreneur is an academic, a research worker or a student who left the university to start a company or who started a company while he or she was still attached to the university and/or of which (2) the business activity is founded on a technological development or innovative concept developed at the university. The main difference with the

[3] In fact, technology can comprise both knowledge and technology in the classic sense. Especially in the service

technological contingent firm lies in the amount of technical uncertainty involved. Typically, the research based spin-off has a technology platform as its core competence, but this platform needs to be adapted to specific market applications. Often the start-up still has to develop a prototype. The core competence is not so much its first mover advantage on the market but its technological novelty. We believe that a transfer of technology is a conditio sine qua non for defining a particular company as an academic spin-off. However, whether or not this transfer takes place at the time the company was established or only later on, is a matter we will leave out of account. In most cases there is also a transfer of researchers. However, we do not consider this a prerequisite for the definition of an academic spin-off. It is also possible that the parent organization invests capital and provides additional services for the spin-off (physical incubation, management consulting,…). The investment of capital and the provision of additional services may strengthen the ties between the spin-off and the parent organization, but these are no prerequisites for considering the company in question as a spin-off. Although empirical data regarding this remains scarce and has not been systematically collected so far, some studies indicate that for each research based spin-off, three technology contingent start-ups are created (Segal Quince Wicksted, 2000).

At a European level, few empirical evidence exists that allow us to compare at which levels Europe lags behind its main Triad partners in the commercialization of research. Progressively realizing the key role they could play in managing more proactively the commercial exploitation of research, most European universities only recently adopted an active policy to patent and license inventions and to spin off companies.

Since the capacity of innovation and entrepreneurship in a region is intimately bound to its capacity of creation and diffusion of knowledge, the low rates on entrepreneurial activity in different European countries can provide a part of the explanation for the lagging behind with regard to issues of technology transfer. GEM (2000), for example, reports entrepreneurial activity in 21 countries worldwide. The present level of entrepreneurship activity in Europe is only between 2 to 5%, whereas in the US this level amounts to over 12%. This suggests that much could be gained by improving the context in which individual initiatives can flourish, including entrepreneurship in academic institutions and public laboratories. Later in this paper, we will elaborate on some policy implications that are of particular relevance for spinning off firms as technology transfer mechanism.

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sectors, knowledge tends to be the basis for creating this kind of company.

4 The Spin-off Funnel: a Conceptual Framework

Based on an in depth longitudinal field study of a Belgian spin-off over a period of two years, using participant observation as a main data collection technique and following the Eisenhardt (1989) design to extract theory from the ground up, Clarysse and Moray (2001) suggested that the founding of a spin-off can be seen as a process in which three different stages can be distinguished: the invention phase, the transition phase and the innovation phase (see Figure 2). First, there is the phase of validation of the business idea. This phase was labeled the "invention phase". In the invention period, most research teams continue their activities within the parent organization such as the university, research institute or embedded laboratory. Second, there is a phase of validation of the growth expectations, which was called the "transition" phase and finally, there is the business development phase or "innovation" phase. This idea of dividing the spin-off funnel in different stages is in line with the organisational life cycle theory. In his study of new technology based firms Kazanijan (1988) found four phases through which high tech start-ups develop: conception and development; commercialization; growth and, finally, stability. Other scholars in this organizational life cycle tradition found three stages: Roberts (1991) studied the life cycle of MIT spin-offs and labeled the three stages in their growth path as: (1) start-up, (2) initial growth and (3) sustained growth. The start-up phase embodies both Kaznijan's conception/development and a part of the commercialization stage. In a recent review of the literature, Foh and Tan (2001) concluded that the literature converges on the idea that the life cycle of high tech firms includes three stages: (1) start-up; (2) growth and (3) maturity. The three stages in the spin-off process suggested by Clarysse and Moray (2001) are in fact a further elaboration of stage 1 – the start-up – which we find in the organizational life cycle models. Further, we represent the spin-off process as a funnel: from the relative large amount of business ideas during the invention phase only few will become validated. During the transition phase a further leveling off takes place. As a result, still fewer business ideas will exhibit growth expectations and enter the innovation or business development stage (Branscomb & Auerswald, 2001).

INSERT Figure 2 ABOUT HERE

The model suggested by Clarysse and Moray (2001) based on the in depth analysis of one spin-off was further validated using the interview data of the Clarysse, Heirman and Degroof (2000a, b and forthcoming) study. This in depth analysis resulted in an empirically grounded conceptual framework of the spin off process. In the next section, we elaborate on this more.

Comparing the in depth case data (Clarysse and Moray, 2001) with the European interview data of 88 companies across 13 regions (Clarysse et al. 2001), a first interesting finding relates to the fact that formal legislation of a spin off is in fact not always taking place at the end of the invention phase. Indeed, a lot of RBSOs are formally legislated when the business idea is validated but before a target market is clearly defined or a market ready prototype is developed. Hence, those companies, which are most often originating from universities, are founded at the end of the invention phase and (try) to bridge the gap between a validated business idea and a validated growth expectation as an independent entity. However, some research institutes, which act as venture incubators or accelerators, prefer not to spin-off the research team before there is a validated growth expectation and hence real venture capital can be attracted. Instead of creating a new company when the business idea is validated, they provide the research team at this stage with a maximum budget that can be used over a limited period of time (usually one to two years). In this period, the business idea is validated in the market, with potential clients. The development of the venture enters "officially" a phase of incubation, which is similar to the transition period defined in the case studied in depth by Clarysse & Moray (2001). In this period it is not clear yet whether the technology platform developed in the spin-off can lead to a real growth oriented business. The spin-off remains very much technology oriented and looks for partners who want to share the risk of bringing the technology to the market. The period of validation of growth expectations is taking place within the parent organization to enable a venture capital injection further along the line. It is only after this period that the venture will be formally legislated and will spin off physically from the parent organization. Interestingly, this type of spin off is only officially legislated when business development can start. The period following the formal legislation, however, is conceptually similar to the innovation phase we described in the aforementioned in depth case study (Clarysse & Moray, 2001).

Although there is no general rule about the formal legislation of a spin off along the spin off process, our data show that actually a life cycle model of spinning off a research-based spin-off can be constructed. The phase of validation of the business opportunity (i.e. the invention phase), including business plan development and starting to assemble a founding team, stops abruptly after the business idea has passed a round of external validation by people that do not belong to the research team, most often including a round of financing. Next, during the phase of validation of growth expectations (i.e. the transition phase) the spin-offs have to look for potential clients and partners. Maybe, the entrepreneurial team decides that the model they want to follow is not a growth model at all because either of market reasons or personal reasons. Often those start-ups become "R&D boutiques" or "technical consulting" companies primarily targeting the local market. In previous research we labeled those companies, which have a low risk profile but also a limited economic potential, as technological SMEs (Clarysse et al, 2001).

53% of the companies in our sample of 88 RBSOs could be categorized as technological SMEs (see Figure 3). If the growth ambition is validated during the transition phase, the spin-off goes into the next stage. The company has come to a point where it can show formal contacts with future clients, who further validate its growth expectation concerning the future market it will be in. Hence, the company gets venture capital backing and switches its main focus from a technological development (and convincing that the technology works) towards business development. We used the interview data of 88 RBSOs of Clarysse, Heirman & Degroof (2001) to quantify the duration of the invention and transition phase. To calculate the length of the invention phase, we found information in 37 of the 88 interview reports. The lack of adequate information in the other reports was due to the *ex post facto* methodology: the interviewee did not remember when the project that resulted in the spin-off started or the original founders had left the firm. To calculate the duration of the transition phase, we found information in 22 of the 88 interview reports. In this case the low number can be explained by the fact that 53% of the companies in the sample were technological SMEs which do not encounter a phase to validate growth ambition. Furthermore, at the time of interview various prospector firms in the sample did not reach the innovation phase yet. The results of our analysis are depicted in fig. 4. We found that the invention phase varies between 1 and 7 years with an average of 3,2 years. The transition phase is quite similar in its duration, it varies between 1 and 8 years with an average of 3 years.

INSERT Figure 3 ABOUT HERE

INSERT Figure 4 ABOUT HERE

We also observed that sometimes during the phase of validation of the business opportunity an intermediary, separate legal entity is already established. That entity is incorporated at the time of formal legislation of the spin off. Our data suggest two main arguments for why establishing a separate legal entity can be useful at that time already. First, the researchers want to protect the technology developed (separate from the parent organization). Second, they want to create a mechanism to access revenues from present or future contract research or consulting. Mostly, the legal entities founded at this period in the process are so-called “sleeping companies”. In addition to the technical developments, the research team also starts with the development of a preliminary business plan. Although during this phase a “go decision” to spin off has been taken, that does not mean that all initiatives result into the creation of a new business. Further, of all validated business ideas relatively few will reach the stage of validated growth expectation. Therefore, we have constructed Figure 2 in the form of a funnel.

Next to elaborating on the organizational life cycle theory, the novelty of our model lies in the fact that we show that the "founding" of a spin-off is not a single moment in time. Before a spin-off reaches the innovation phase a number of different phase have been gone through. It is important to stress that from a legal point of view, spin-offs are created over this whole funnel. It is thus not very useful to compare growth and start-up rates based on these statistical data since they can imply a totally different kind of company.

5 Financial and knowledge resources as environmental determinants of successful spin-off activity

Previous research has shown that the availability of high level research universities, institutes and embedded laboratories is a necessary condition to enhance spin-off activity in a region (Saxenian, 1994; Segal Quince Wickstead, 2000). However, the sole presence of these technology labs is a necessary but not a sufficient condition to enhance the creation of growth oriented spin-offs, which make it to the business development phase and thus can show a validated growth ambition. Suchman (1995:62) argues that, for a entrepreneurial technology cluster to emerge, the diffusion of two types of resource flows are necessary: operational resources, such as financing; and knowledge resources, such as summary information on entrepreneurial competence. Research of high tech clusters indeed highlight the importance of efficient risk capital markets in supporting the entrepreneurial activity (e.g. Lerner & Gompers 1999; Sahlman 1990), but they also stress the key role of social networks and institutional forums in diffusing "best practices" (e.g. Hellman 2000; Saxenian 1994) and in selecting the best projects (Roberts & Malone 1996).

This distinction between financial and knowledge resources is important, because the second type is often overlooked, but is particularly important in an emerging entrepreneurial environment, where information is scarce and does not circulate well (Larsden 1984; Saxenian 1994). The complementarity of these "financial" and "knowledge view" is also key, because knowledge and competencies infuse financial resources. For instance, we observed that early stage venture financing is only efficient if it comes with the appropriate competencies about high tech entrepreneurship. In the remainder of this section, we analyse how these financial and knowledge resources can be defined along the spin-off funnel.

5.1 Financial resources along the spin-off funnel

To analyze which financial resources are available and used by spin-offs during the spin-off funnel, we visited 34 intermediaries active in spinning off companies in 13 different regions. The regions were selected because of the availability of a technology base in the region.

Although the initial selection was based upon the publication and patent intensity of regions at the NUTS 2 level, we soon concluded that this level was much too aggregated. Intra-regional differences at NUTS 2 level in spinning off companies were often larger than interregional differences at the NUTS 3 or even NUTS 4 levels. Spin-offs are thus a very local phenomenon, initially surrounding the university or research laboratories. Only in these regions such as Cambridge or Île de France, which have established a tradition in spinning off companies, we found that the phenomenon has become more widespread than the local environment.

In each of these regions and more specifically around each of the local research organizations, we analyzed which financial resources were available for (potential) spin offs and in which stage of the spin-off process these resources were used. In the invention phase, we find without exception, that research grants to the research organizations (universities, public research laboratories and embedded corporate laboratories) play a very important role. Especially those research grants that favor industry-science collaboration are often the basis for a start-up although regional differences exist about the source of the grants. In Italy for instance, most eventual spin-offs were based on a project sponsored by the CEC before being spun-off, in other regions, the source of funding was more balanced between EC, national and regional grants. These grants were always given to the research organization, not to the start-up.

In the second phase – the transition phase – funding becomes much more complex. As explained before, in this stage, the business idea is validated by externals. However, it is usually not clear at all whether a growth oriented business based on repetitive sales will be obtained so venture capitalists are usually not interested to invest in this stage[4]. In general, we see three kinds of funding emerging (see Figure 5): the pure public funding which consists of grants or deferred loans; the public/private partnerships which invest in the capital of the spin-off and finally, the informal forms of capital provision. The three forms of finance are discussed below.

INSERT Figure 5 ABOUT HERE

5.1.1 Public Forms of Capital For Spin-Offs in the Transition Phase

Public forms of capital are usually either stretched forms of research grants or stretched forms of development grants. An example of a stretched form of research grant are the FIRST spin-off scholarship which are available in Wallonia (Belgium). These grants are given to researchers at universities who want to create a spin-off. The grant covers two years of salary for the researcher. In turn, the researcher has to develop a business plan and create a spin-off. The

success of these grants is very dependent upon the willingness of the professor who leads the research laboratory to use the grant in the proper way. Often, we see that these grants are seen as research money.

Another form of public grants in this period are the development grants, which are stretched into the direction of start-ups. Development grants are R&D subsidies granted to industry to correct for the market failure due to spill-overs in R&D. Among others, one of the most important criterions to give such a grant was the technological uncertainty and novelty of the project. Most European countries have an independent institute which is responsible for the different grants given (eg. Senter in the Netherlands, Anvar in France, NUTEK (changed its name to Swedish Business Development Agency), IWT in Flanders and DG Research in the EU… Since the mid-nineties these grants have come under pressure since especially the large enterprises seemed to benefit from them. As a response, most countries have implemented SME friendly mechanisms aimed to increase the participation of SMEs in the grants. SMEs were not only given a higher percentage of subsidy, often the subsidy could also be partly used for non-technical aspects of the project such as market research or commercialization. This kind of stretching of the R&D definition into "innovation" makes the grants quite attractive for start-ups, which need market validation of their technological concept. The major drawback of these grants is that they are granted based on a project proposal while the spin-offs in the transition phase have mostly a business plan. Of course, innovation grants need always to be complemented with other kinds of finance or revenues since they only finance a limited percentage of the project. An analysis of the R&D grants received by Flemish spin-offs from the IWT has shown that these grants account for about one third of the cumulated capital of these spin-offs in the nineties. Usually, Flemish spin-offs are already between two and three years in the transition phase before they receive this kind of grant. In addition to the money, these grants have a second major value added: the R&D granting institutes have often developed a very efficient mechanism to screen project proposals for technological strength and novelty. It is exactly this competence in providing technological due diligences that most financial investors lack. Hence, a positive evaluation is often very much appreciated by the other investors in the start-up.

5.1.2 Public/Private Partnerships Providing Capital For Spin-Offs in the Transition Phase

In addition to the public grants, we find in most countries a public/private partnership that invests in the capital of the start-up. Again, the implementation of this partnership depends upon the organization of the science and technology base in the country. In the different regions of

[4] Of course, when the stock markets are extremely favorable such as in 2000, venture capitalists tend to take more risks and invest smaller amounts of money.

Belgium, in Munich and Cambridge, most research organizations, incubators or universities co-participate in a start capital fund, that has as specific objective to invest in spin-offs during the transition phase. For instance, in the UK, fifteen university challenge funds have been established through the University Challenge Competition. These funds have received between 650K € and 1 Mio € to bring university research discoveries to a point where their commercial usefulness can be demonstrated to a sufficient extent that successful approaches can be made to venture capitalists (Summary Report on the First Year of Operation of the Fifteen University Challenge Seed Funds, Office of Science and Technology, 2001). The aim is that these start capital funds increase their capital with private funds. In the first year of their existence, they succeeded in increasing their capital with about 3 Mio €. In Flanders, these university funds were mostly created as a partnership between the local financial institutes that wanted to identify earlier in the process the most interesting investments and the research university spinning off these companies. The research organizations use public money to invest in the fund. Usually they take a minority position (20%) so that it depends on informal factors what their weight is in the fund. The funds differ in size, ranging from 2.5 Mio € to 12.5 Mio € and invest between 250K and 750K €. The interesting characteristic of these funds is that they perform a financial due diligence of the business plan proposed by the researchers. Often, the research organizations complain that they cannot engage the competent persons to perform a financial evaluation of a preliminary business plan because the tariffs are too high to be paid by the start-up. Since the financial institutes co-participate in the funds they help by definition to perform the due diligence. In Munich, a similar financial fund is set up by its largest incubator Bio-M. This incubator for young biotech companies has been set up in 1997 as joint initiative of public authorities, scientists, industrial companies and numerous financiers, including banks. The start capital fund of Bio-M has a size of DM 12 Mio and is used for small investments during the transition phase. The upper limit of investments is DM 300,000. However, this start capital may be supplemented by subsidies. In most of the investments, Bio-M is the lead investor, which enables the start-ups to apply for further capital from 'Technologie-Beteiligungs-gesellschaft' (TBG) and 'Bayern Kapital' in the form of silent partnerships.

Start capital funds are usually bottom-up initiatives taken by the research organizations active in spinning off companies or taking part in a competition for public funds. In addition to these bottom-up initiatives, a number of regions (countries) have taken top-down initiatives to provide a public form of start capital. In Wallonia (Belgium), FIRD[5] was created to stimulate start-ups based upon research grants that were already financed by the Walloon Region. FIRD is a fund, which acts as an independent organization, making use of the due diligence capacities of the

[5] Fond Industrielle de Recherche et Développement

local private/public venture capitalist SRIW. The drawback of this kind of fund is that it is completely detached from the universities or research institutes which have to provide its deal flow. In Germany, a similar fund exists, namely TBG (Technologie-Beteiligungsgesellschaft) which is part of the Ausgleichsbank co-invests in high tech start-ups. TBG only takes minority positions in high tech start-ups, including spin-offs. Because it only takes minority positions, the spin-off still has to find a lead investor. This is no problem in a region like Munich, where lead investors are available in the form of the incubator seed capital funds (e.g. Bio-M). However, in less developed regions such as Aachen, these lead investors are much more difficult to find. In the Netherlands, in 1999, a TWINNING fund was created to participate in ICT start-ups. Although the fund has no formal links with the research universities, it is located at the campus of these universities. The fund is run by managers who had a career in the financial services. In Sweden, NUTEK used to be a public R&D granting agency. After a substantial restructuring last year, NUTEK remains the responsible agency for SME support measures and to support high tech start-ups. It has a yearly budget of 7,7 to 8,8 Mio € to support high tech start-ups. On average, the institute invests between 88k and 132k € per company in the form of conditional loans. In another study, Clarysse and Duchêne (2000) found that in Ireland, Enterprise Ireland participates in a number of funds together with private investors. Enterprise Ireland mostly invests only if also another venture capitalist wants to invest. They are mostly interested in tri-partite agreements. The ministry of Industry (Department of Enterprise and Employment) manages together with Enterprise Ireland a high tech entrepreneurship fund that had in 1996 a start capital of about 100 Mio € (Science, Technology and Innovation – The White Paper, 1996).

The presence of these kind of start capital funds allow the spin-off thus to start-up in the transition phase as a legal entity and search for validation of the business on the market. In addition to the public/private partnership funds, also informal capital plays an important role.

5.1.3 Informal Forms of Capital For Spin-Offs in the Transition Phase

Most US books on entrepreneurship refer to 3F (fools, friends and family) money as *the* source of capital. Figure 6, which uses the GEM 2000 data as a source, shows that this kind of money is much less available in most European countries than in the US. Whereas in the US, about 7% of the population has invested in a start-up during the three years preceding the survey, in most European countries this percentage is much lower than 4. This means that informal capital in the form of 3F is to be found twice as high in the US – on average – than in the "better" European countries. Since the percentages are representative for the whole US, this means that in the high tech clusters such as Silicon Valley and Boston this will be much higher as well. About half of the 88 spin-offs visited were started with some personal funds of the entrepreneurs, but these

funds were usually only sufficient to deposit the minimum capital to establish a legal entity in their country (between 9K and 60K €). We can thus conclude that these amounts stay very small.

INSERT Figure 6 ABOUT HERE

A second form of informal capital is the so-called business angel capital. Unlike 3F's business angels do not tend to know the entrepreneurs personally. They invest in a business because they like the idea … (Ardichvilli 2000; Leleux and Surlemont, 2000). For the majority of 88 spin-offs in our survey, this kind of capital was of no importance at all. Only 5% of the spin offs were financed by B.A.'s during the transition phase and 18% during the innovation phase. Only in the denser high tech clusters such as Cambridge UK, BA investments in high tech start ups are more common as compared to other European regions. The reasons that were given for the low level of BA investment in continental Europe were that the available business angels in the area did not understand high tech and therefore were not likely to invest in this kind of business. Despite the major efforts which have been undertaken by the European Commission and the various national governments to organise business angels in networks and to make this form of capital accessible, it does not seem that this kind of capital is very useful to the growth oriented high tech firms unless former high tech entrepreneurs make part of the business angel network.

5.1.4 A cross-region comparison of different financing mechanisms available for spin-offs

Based on the model presented in Figure 5, we can map the availability of the different forms of capital in each of the regions that were visited by us. In the transition phase, we distinguish between three forms of capital: public forms of capital, public/private partnerships and informal forms of private capital. Public capital is available in the form of stretched research grants or stretched development grants. Both fall in the category of innovation grants. The region of Louvain-la-Neuve offers the most developed form of stretched research grants (FIRST spin-off). This grant is provided by the Walloon Region and the UCL promotes it actively among its university professors. It offers the researchers the possibility to spend time to set up a company. The grant is complementary to the public-private partnership funds in the region since it provides the researcher with money in the invention phase while the latter only can be used in the transition phase. Although no official evaluation exists of the mechanism, it seems to be very useful and it is probably the only form of capital available in this phase. The drawback of the mechanism is that only individuals can benefit from it while most high tech companies tend to be founded by a small team of entrepreneurs.

Each country/region has a tendency to stretch its development grants towards the commercialization end of the continuum, of course within the borders of the European Framework Agreement. Stretched development grants find their roots in the former US SBIR (Small Business Innovation Research Programme), which was adapted already in 1986 in the UK in the form of the SMART business award scheme (Dodgson and Bessant, 1996). The initial idea was to encourage the development and formation of innovative small firms in a non-interventionist way and to increase the attraction of private capital into high tech small firms. The SMART scheme might be considered a pioneering initiative in terms of stretched development grants towards high tech start-ups. Each year a limited amount of money (max. 50K €) was granted to a maximum of 180 proposals. Various evaluations (see Dodgson and Bessant for a summary) have shown that the scheme was greatly appreciated by the high tech start-ups, but that at the same time the scheme did not fulfill its initial objective: attracting private venture capital into technologically new ventures. The experience of the SMART scheme points to one of the biggest challenges between the different financial actors on the scene at this moment: how to integrate public, private and public/private initiatives? Dodgson and Bessant state that – in 1996 – UK private investors continued to evaluate business proposals as they always did: based upon the short term market opportunities and the quality of the management team. Apart from a small interim period driven by the 'hausse' on the stock markets, this is still the way that venture capitalists tend to evaluate high tech proposals. The difference in competencies between the R&D granting agencies, which tend to be specialized in carrying out technological evaluations and the venture capitalists, which are used to assess the market potential of business ideas and the quality of entrepreneurial teams is a complementarity that offers a number of opportunities. Unfortunately, the circles of financial specialists and public administrators seldom overlap. As a result, administrators keep refusing excellent business plans because the technical novelty is not challenging enough and venture capitalists refuse early stage technological ventures because they do not trust the technological opportunities. In France, ANVAR – the agency responsible for R&D grants – has set up informal collaborations with local venture capitalists. In other regions such as Wallonia and Munich, these collaborations have become formalized in equity participations or in formal agreements with venture capitalists to undertake a joint due diligence.

Since the amounts of capital needed in the transition period of the spin-off process are rather small (range of 250-750 K €), it is not only necessary to reduce the "risk" for venture capitalists, it is also necessary to increase the "efficiency" of the money invested. In general, it takes the venture capitalist the same amount of effort to follow up an investment of 1 mio € as one of 250 K €. Therefore, the small early stage investments are only looked at in times of intense competition between venture capitalist. However, when the stock market is in a 'baisse',

venture capitalists tend to wait longer and increase their portfolio efficiency. Therefore, we rarely find private venture capitalists who invest directly in these spin-offs. Usually, they tend to invest indirectly through setting up incubators, venture accelerators or through a joint effort with the public research institutes. A particularly interesting example, are these related to university start capital funds such as in Belgium and the UK. In these funds, universities or research organizations bring in the technological and the financial institutes the financial expertise. Only in Munich, where the incubator takes over the role of the university, these public private partnerships collaborate closely with the public R&D granting institute to leverage the capital invested with stretched development and research grants.

Since in most European countries 3F money is very scarce *and* the cost of setting up a high tech company (including salaries) is much higher than in the US high tech regions such as Boston and Silicon Valley, the public money and public/private partnership funds are an absolute necessity to close the financial gap in the spin-off process. However, it is a necessary but not a sufficient condition to foster spin-offs. In addition, different forms of "incubation" or "venture nurturing" are needed to stimulate and manage this process. This is the subject covered in the next section.

5.2 Venture Nurturing as a necessary complement to a finance and science/technology base

As aforementioned, Suchman (1995) suggested that next to the financial resources the knowledge resources surrounding a new start-up play an extremely important role to foster growth oriented spin-offs. In his study of high tech start-up located in Silicon Valley, he highlighted the important role which lawyers played as carriers of knowledge between different companies in the area. In Europe, the role of knowledge brokers seems to be fulfilled by intermediary organizations and research institutes setting up spin-off activities. Clarysse, Heirman and Degroof (2001) have analyzed the different services that were offered by different forms of intermediary organizations to spin-offs during the spin-off process. They divided the different support activities into three distinct categories: technological nurturing, business nurturing and facility management (see Figure 7). Each of them is discussed below.

INSERT Figure 7 ABOUT HERE

5.2.1 Technological Nurturing

The first activity was labeled technological nurturing. It includes the process of searching for ideas that can be commercialized in a research organization or university, creating a fertile ground for spin-off activity in this environment and protecting the technology base. We

distinguished three different activities in the technological nurturing process: technology opportunity search, project management and knowledge protection activities.

A first step to fill the pipeline with ideas that can be commercialised is to search for research results in the organisation that can be commercialised either through licensing with large enterprises or through spin-off activity. This search activity is often seen as a "missionary" activity to convince professors and researchers. Few systematic models are used to complete the task.

A second step in the technology nurturing process is the establishment of a professional project management structure for applied research activities. One of the main problems identified in European research universities is the fact that they want to create spin-offs out of basic research activities. However, empirical research has shown that in the US, spin-offs in research based universities do not emerge from the basic research performed in the faculties. Instead, start-ups are often spun off from the research centres associated with the universities (Steffensen et al. 1999). This intermediary structure is normally used to manage a portfolio of contract research with industry or government. The difference with the fundamental research laboratories is that the latter is usually run as a profit center. In other words, the professor who is active in the research center is not only evaluated based upon his scientific results but also upon his ability to make money with this research center. In addition, the research center offers the professor the opportunity to recruit senior researchers in a structure, which is much more flexible than the classic university (Debackere, 2000). It are exactly those senior researchers and not the professors who seem to have the profile of the technical entrepreneurs who start-up the spin-off. Of course, when this management structure is absent, it becomes extremely difficult to encourage spin-off activity. Of the 35 research universities/research organizations we visited, we only found a few which had this intermediary structure. Universities, which did not have it, mostly complained about the gap between the mentality of the professors to perform basic research and their aptitude towards commercialisation. In countries such as Germany, where contract research activities are centered in large national organisations such as the Fraunhofer Institut and to a lesser extent, the Max Planck Institut, we found that not the universities, but these institutes were the most important sources of spin-off activity.

A third set of activities are the knowledge protection activities, both in a proactive and reactive way. It has been shown that one out of two research projects initiated at universities concern research that has already been patented or even published by others. A proactive way of knowledge protection means that before a research project is even financed, at least a patent scan is performed. Although this activity has become standard in certain European projects,

most universities do not apply it at all. Second, once the research activities are started, a knowledge protection strategy is needed. Universities and research organisations must be very careful about how they will protect and valorise the results of their research activities. Only when the research organisation itself has a well formulated and healthy knowledge protection strategy, different commercialisation options can be considered.

5.2.2 Business coaching

Once the potential spin-off project reaches the transition phase, technological nurturing makes place for business coaching. Business coaching encompasses a number of activities that we classified into three groups: business plan development; start-up coaching and specialised advice or consulting.

The first activity, the business plan development, is probably the best known. In order to convince investors of pre-seed capital and to structure the ideas around the potential business, a business plan is needed. Unlike the business plans in ventures of the old economy, business plans for spin-offs are extremely difficult to standardise. A business plan is more an estimation of the way the technology will be developed and the investment needed to complete this development than a real forecast of the marketing, strategy and finance of the eventual company. Often, there is no market, so a strategic positioning is not possible. Without revenues, also a financial plan makes little sense. In fact, we see that in Europe there is a big need for assistance in business plan development for high tech ventures.

Once the spin-off is founded, there is need for specialised consulting and coaching of the business process. Coaching of the business process implies the strategic management of the commercial, financial and legal aspects of a technology venture. In large companies, a CEO or a director's committee fulfils these tasks but in a technology start-up it is in general impossible to recruit this person or team of persons. Therefore entrepreneurial teams need coaching in the management of the business process (Clarysse and Moray, 2001).

Finally, a high tech start-up has specific needs which are not to be found in businesses of the old economy: spin-offs need to form a knowledge protection strategy, they are involved in complex co-development contracts with multinationals, they have to recruit high level engineers and scientists and set up a specific human resource and incentive system, they need to operate with an external board of directors…. In highly developed environments such as the Cambridge UK environment, Segal Quince Wickstead (2000) reports that one out of three companies in the high tech valley are specialised service providers. It is of crucial importance in entrepreneurial

poor environments to attract the expertise of these specialised consultants inside the local environment.

5.2.3 Facility Management

The need for incubation facilities – affordable housing adapted to the needs of high tech start-ups – is probably one of the most elaborated knowledge resources in Europe, at least at the beginning of the spin-off funnel. The European Commission has already initiated the Business Incubation Centers in 1984 through the structural funds. However, the facility management function is only one dimension of the venture nurturing process, which in itself is only one of the three contingencies identified (science/technology base; financial environment and knowledge resources) necessary to create an environment which is supportive for high tech start-ups and research based spin-offs in particular. Since most BICs were created in environments where the other contingencies were not fulfilled, one should not be surprised that the demand for incubation facilities in these regions was coming from non-research based spin-off companies or was simply absent.

The nature of facility management also tends to evolve along the spin-off process. Whereas start-ups in the transition phase need relatively small space but with facility services such as reception, cleaning, informatics… included, the growing companies in the innovation phase need larger spaces in science parks. Since most high tech regions are quite densely populated, space for these science parks has become very scarce. Several incubators in our study reported space problems in Flanders, Munich, …..

6 Summary and Policy Implications

6.1 Summary and discussion

The first argument which was put forward in this paper is that “research based spin-offs” are a specific way of commercializing research results in an environment where both market and technological uncertainty are dominating. However, when the downstream market is developed – which is mostly the case – research based spin-offs have little chances to succeed. Instead, universities or research organizations might choose to license out pieces of technology to the incumbent industry. The situation in the downstream market is thus an important indicator of the spin-off opportunities. Research based spin-offs seem to have the most chances in markets that need to be created and thus require a substantial change in organizational structure and/or economic approach from the incumbents. Scattered evidence suggests that for each research-based spin-off, three high tech start-ups are created which use a technology that has become standard but apply it to a new market niche. Sometimes, these companies are considered to be

spin-ins. The growth and start-up process of the latter seems to be quite different from the former. In general, the first mover advantage is the most important competitive advantage of spin-in companies. Finally, we consider a forth category which fall under the non-high tech start-ups. Also these companies are found in the environment of research organizations and universities. In general they are consulting companies set up by professors to fulfill a market demand. In Cambridge, one out of three "spin-offs" seems to be this kind of company. Since each of these companies has a very different growth path and has a certain place in the commercialization of research results, their heterogeneity should be taken into account in any study on spin-offs. It is useless to compare research based spin-offs with non- high tech start-ups created by professors or graduates.

Even if we limit the scope towards research based spin-offs, the formal incorporation seems to differ substantially from the actual start-up of the company. Spinning off a company is not a single moment in time but is a process during which we identified three distinct phases: an invention phase during which the business ideas are validated; a transition phase during which the growth expectations are validated and, finally, an innovation phase during which growth is realized. Any time along this process, the company can be formally legislated as a start-up for a variety of reasons. Thus, since the process can take several years, comparing growth rates of research based spin-offs based upon the legal founding of these companies as a starting point is a tricky thing. Moreover, the spin-off process seems to take the form of a funnel, which means that only a few business ideas will reach the stage of realizing growth. This does not imply that the other ventures go bankrupt or fail, it means that only a few will realize their objective through a growth oriented venture. Other ideas might never be incorporated and end up as licensing agreements between the parent institute and incumbent industry. Still others will end up as economically very attractive consulting businesses, which are not adaptive to explosive growth looked for by financial investors. In order to stimulate research based spin-offs, an insight in this spin-off process is necessary.

We identified three conditions which are necessary to create an environment that is fertile for spin-off activity: first, there is a sound science/technology base needed, including research universities, public research organizations and embedded corporate laboratories. Second, financial resources are needed to support the spin-offs along the spin-off process. Third, knowledge resources should be developed to support the spin-offs. The first condition is straightforward. The paper focuses on the need for financial *and* knowledge resources both to enable and accelerate the spin-off process.

Along the spin-off process, the financial resources needed by the new venture change both in nature and size. In the invention phase, some form of stretched research grants which give the researcher some time and budget to validate his business idea might be sufficient. In the transition phase, small amounts of capital (250K € - 500K €) are needed complemented with subsidies to develop the prototype and to validate the growth expectation of the business. It is only at the time that the growth expectations are validated that formal venture capitalists come into the picture. Especially in the transition phase during which these growth expectations need validation, financial resources have been lacking and continue to fall short despite several efforts which were undertaken in the recent past. In Europe, three groups of financial resources can be distinguished in this phase: public forms of subsidies, private/public partnerships and informal, private capital. In the group of public capital, we observe that especially the R&D granting agents are active and have developed stretched R&D grants or conditional loans to support high tech start-ups. Their main strength lays in their ability to evaluate the technology. In the group of public/private partnerships, universities and incubators have created pre-seed or start capital funds to support early stage ventures. Since the private partners tend to be financial institutes, the main strength of these funds lies in the financial evaluation of the proposals. Finally, the market of informal capital tends to be very heterogeneous in Europe and much smaller than in the US. There is a lack of business angel support for high tech start-ups.

Also the knowledge resources change along the spin-off process. On average, knowledge resources are much less developed than the financial resources. Three categories of knowledge resources were distinguished: technological venture activities; facility management and support and, finally, venture coaching. Technological venturing implies that universities and research organizations create methods to search proactively for research results that can be commercialized. A necessary element which is often overlooked in this technological venturing process is the need for a professional project management structure for applied research. Research based spin-offs, also in the US, seldom emerge out of basic research departments but tend to be generated by the intermediary structures between these departments and the market. In the US, the top 10 research universities, have attracted numerous corporate research labs of large enterprises on their campuses which play this role. Smaller research universities tend to form research centers. In Europe, we find this structure is generally lacking, but crucial to retain the middle management needed in research. Second, different forms of business coaching are needed to shorten the transition period as much as possible. An often heard complaint by European high tech entrepreneurs is that they were the first on the market when they started to validate their growth expectation but by the time they really entered the market they were already leapfrogged by some US start-ups. In the US, scientific research has shown that the business coaching activity in Silicon Valley was performed by the large lawyer companies that

guided the start-ups. Finally, facility management is needed both in the form of research laboratories in the invention phase, incubation facilities in the transition phase and science parks during the innovation phase. Especially the transition from incubation facility to science park needs further attention.

6.2 Policy Implications and Recommendations

Research based spin-offs are only one vehicle to commercialise research results. It is dependent upon the technological uncertainty involved and upon the situation on the downstream market whether this vehicle is the most efficient and effective or not. This means that any public policy that wants to stimulate spin-off activity should bear in mind that these companies are only interesting in very specific circumstances. In mature research domains it might be very difficult to set up this kind of companies from within the research organisation or university. If spin-off activity is included as a criterion to measure performance of these research organisation or universities, it can only be a sub-criterion among others such as licensing activity, start-up rate by students, spin in rate, ...

High tech clusters have become a popular objective for regional innovation policy. It was argued in the paper that spin-offs, which are often referred to as the driving forces behind these clusters, are very dependent upon the local science/technology base. At least the partly presence of research universities, public research laboratories and embedded corporate labs is a prerequisite to initiate a policy to develop a knowledge based economy. If this science/technology base is not already present, it will be very difficult if not impossible to develop this kind of knowledge cluster out of scratch. It is therefore not easy to understand why structural funds are used to stimulate high tech or at least knowledge based entrepreneurship in underdeveloped regions.

Even if the science/technology base is present, it is no guarantee for a fertile spin-off environment. Financial and knowledge resources are needed as well. Financial resources have since the mid-nineties been recognised as being very important for high tech start-ups. Unfortunately, most policy initiatives have been oriented towards the stimulation of formal venture capital and the creation of business angel networks. However, both are relatively unimportant in the transition phase of the spin-off process. The relatively low amounts of capital needed by these spin-offs in this phase and the inexperience to evaluate new technologies make them an inefficient and risky investment for most venture capitalists. Both European and national actions are needed to correct for this market shortcoming. One correction, as initiated in a number of countries, is the use of the experience to perform technical evaluation in the R&D granting public agencies and stretch their development grants into the transition phase of

the spin-offs. This already decreases the risk on the site of the private investor since he can trust the technical evaluation made by a third party. In addition, public/private partnerships might be needed to increase the efficiency of the invested amounts. Universities and research organisations can create with the help of private and public investors' funds that invest in companies.

Of course, in order to be credible towards these private partners, the universities and research organisations have to guarantee a "deal flow", which often means they have to set up a technological venturing activity as well. Again government initiatives might be needed to encourage the universities to set up these kind of services. This can be done by taking these initiatives into account when the financial funds are divided among the universities (instead of only taking students or publications as an indicator to divide budgets). It is clear that interface services need to be supported to set up technology venturing activities. This means that also the regulatory framework with for instance a clear intellectual property law and fiscal policy towards royalties and extra earnings of researchers and professors at universities is needed. Next to opportunity seeking activities, these venturing activities also include the creation of professional management structures for applied and contract research. In Europe, very little experience is available with these structures. In different countries, the regulatory framework is lacking, while Europe might play a proactive role in the exchange of experiences.

Finally, any effective policy to encourage the commercialisation of research will need to integrate both different public departments and different networks of actors. First, the need to integrate different public departments is reflected in the fact that along the spin-off process different public agents with a very different cultural background are implicated. At the very start, the ministries of education and research have to take actions to encourage universities to engage into technology venturing activities and to stretch research grants. The remuneration of researchers can in the same phase be related to the fiscal policy in the country. In a later phase, the ministry of economics will be involved to organise the financial conditions and maybe to subsidise the need for venture coaching. Technology policy will be implied to stretch development grants into the transition phase of start-ups. Second, an effective policy will have to bring very different networks into contact with each other: the network of government officials who evaluate technological subsidy projects is very complementary to the one of the financial investors who are specialised in a financial/commercial due diligence of a business plan. One problem, both networks seldom overlap, they do not know each other. The network of university professors and researchers has to be related to the network of the business managers. Again, both are complementary, but seldom overlap. Finally, the different networks grouping the financial resources has to be brought into contact with the network knowledge resources.

There are only a few examples in the world where this mixture of networks is accomplished of which Silicon Valley is probably the most well-known. It has taken Silicon Valley over 25 years to develop, we wish Europe more success….

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Figure 1: market and technical uncertainty as determinants of commercialization vehicles

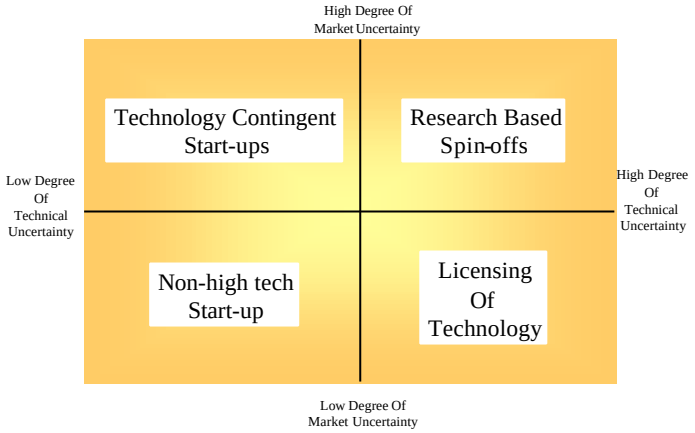


Figure 2: The spin-off funnel

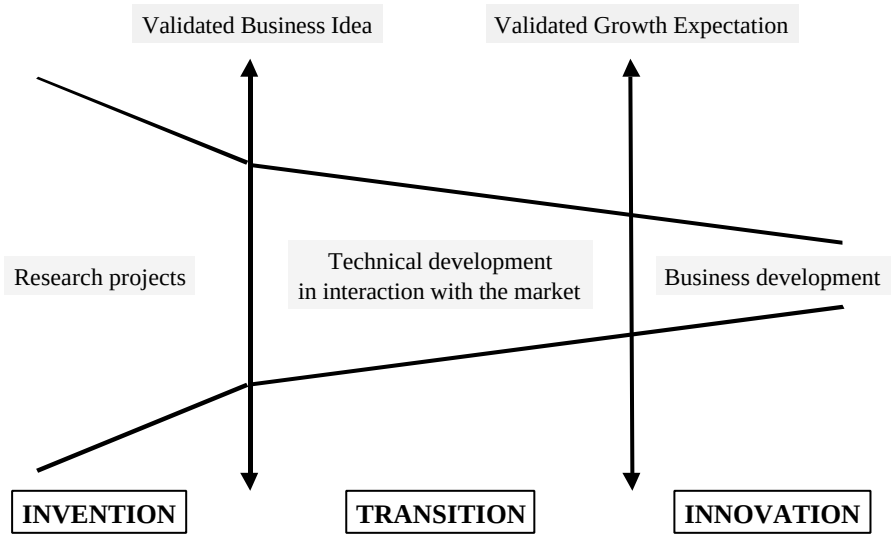


Figure 3: Different categories of spin-offs at time of formal legislation

	Technological SME's 7	Prospectors 8	VC backed type 9	Blank
Founded before 1995	64%	23%	10%	7%
Founded after 1995	41%	43%	13%	3%
All	53%	33%	12%	2%

Source: Clarysse, Heirman and Degroof (2001)

Figure 4: Duration (in years) of the invention and transition phase of European RBSOs

	Invention Phase	Transition Phase
Average (± SD)	3,2 (± 1,7)	3 (± 1,8)
Minimum	1	1
Maximum	7	8
N	37	22

Figure 5: financial resources along the spin-off funnel

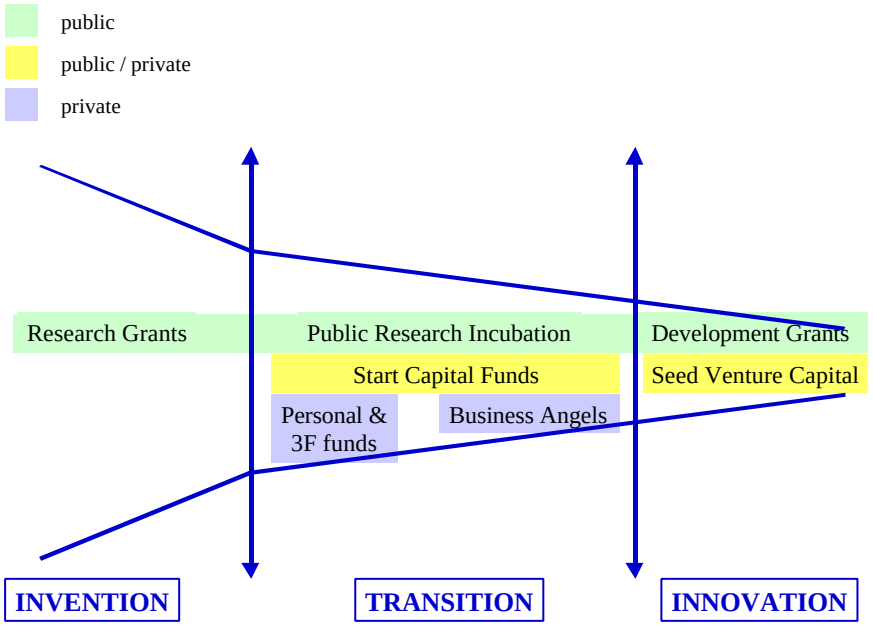


Figure 6: Fools Friends and Family in the US, Japan and different European countries

"% of the population that, during the last three years, invested in a transition company of which she/he was not the owner"

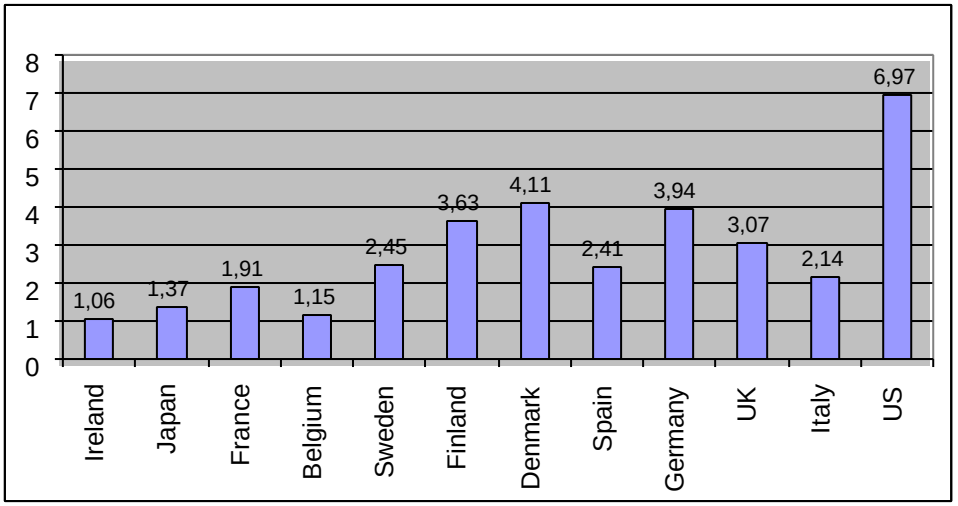
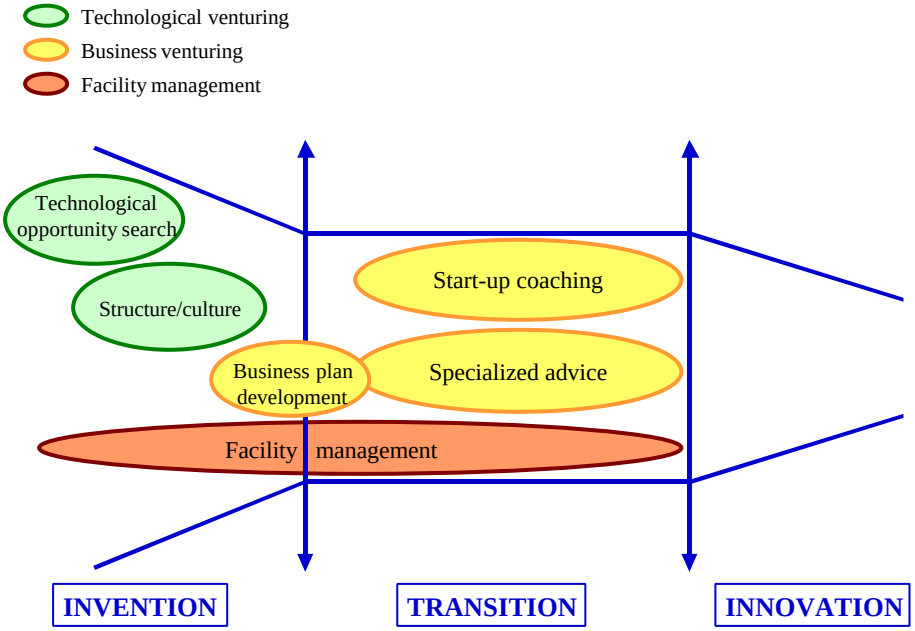


Figure 7: The Venture Nurturing Process



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