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WORKING PAPER

SPINNING OUT NEW VENTURES: A TYPOLOGY OF INCUBATION STRATEGIES FROM EUROPEAN RESEARCH INSTITUTIONS

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ABSTRACT

This paper explores the different incubation strategies for spinning-out companies employed by European Research Institutions. More specifically we focus on two central questions: (i) What differences or similarities are there in the goals and objectives of the Research Institutions for creating new spinout ventures? (ii) What different incubation strategies are employed to achieve these goals in terms of the resources utilized and activities undertaken? The study uses a two-stage approach. In the first stage, 7 spin-out services in five European countries were selected for analysis. Based upon an in-depth analysis of these seven cases, we identified three distinct incubation models of managing the spin-out process: Low selective, Supportive, and Incubator. The different incubation models have very different resource implications in managing the process. In particular, we identify resource and competence differences relating to finance, organization, human resources, technology, network and infrastructure. In the second stage, 43 cases were used to validate these incubation models in terms of resources and activities. This process identified two categories that departed from the normative models, namely the resource deficient group and the competence deficient group.

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EXECUTIVE SUMMARY

This paper explores the different incubation strategies of spinning-out companies employed by European Research Institutions. More specifically we focus on two central research questions: (i) What differences or similarities are there in the goals and objectives of a limited number of leading European Research Institutions for creating new spinout ventures? (ii) What different incubation strategies are employed to achieve these goals in terms of the resources utilized and activities undertaken?

The study uses a two-stage approach to investigate these questions. In the first stage, spin-out services in five European countries were selected for analysis. These spin-out services had to match the following criteria: they needed to have realized a number of spin-outs, they had to exist at least five years as a spin-out support unit and they needed to be considered successful by local experts. Only seven initiatives matched those criteria in the regions under study.

Based on an in-depth analysis of the seven cases, we identified three distinct incubation models of managing the spin-out process: Low selective, Supportive and Incubator. Each of these models serves different goals and objectives. In terms of objectives, the Low Selective model has a mission oriented towards maximizing the number of entrepreneurial ventures in line with the entrepreneurial mission of the Research Institute(s) to which the unit is attached. Usually these ventures tend to be self-employment oriented start-ups which only rarely grow beyond a critical size of employees. The Supportive model is oriented towards generating spin-outs as an alternative to licensing out its IP. The spin-out support service is embedded in the technology transfer unit of the Research Institute. Because a trade off has to be made with licensing as an option to commercialize research, the economic profitability of the potential spin-out is key. Hence, this model tends to generate "profit oriented" spin-outs with potential growth opportunity. Finally, the Incubator model makes a trade-off between the use of a body of research to generate contract research versus spinning-off this research in a separate company. The latter is only done if the financial opportunity is larger than in the case of contract research. We term the spin-outs resulting from this Incubator model "exit oriented" since the exit possibilities provide the financial opportunity.

The different models have very different resource implications for managing the process. In particular, we identify resource differences relating to finance, organization, human resources, technology, network and infrastructure. The Low Selective model needs the lowest number of resources in terms of quantity. The critical size is only a few persons and no organizational structure has to be created separate from the university. However, ideally some public money and incubation facilities should be available to support the new start-ups.

The Supportive model is probably the most demanding in terms of human, organizational and financial resources. Since spin-outs are an alternative to licensing out the technology, a well-functioning IP department and contract research unit tend to be key. Contract research is often the first (and most flexible) way to stimulate academics to commercialize their research results. The technology transfer unit can

only use this leverage if it manages the contract research performed at the research institute and if it is able to support it in such a way that academics feel they are helped in organizing this activity. The IP and spin-out activity are then the next step in the tech transfer process. To organize all this, a minimum critical mass of at least twenty persons is needed. In addition, the spin-outs tend to need external capital at a very early stage (when no venture capital fund is interested). Therefore, public private partnerships are set up to invest in these seed or even pre-seed ventures.

Finally, the Incubator model might be the most demanding in terms of technology resources. Spin-outs are seen as an option where the technology is really cutting edge and a financial participation might generate more revenues for the research institute than future contract research. The spin-out formation usually takes a very long time (up to three years) since all assumptions are tested before valuable IP is given to a separate venture. In addition, the venture tends to be created with formal, usually specialized venture capital funds as shareholders at start. This means that the venture has to match the expectations of these funds in terms of freedom to operate (e.g. licensing possibilities); broadness, novelty and depth of the technology; management capacity; market size and attractiveness. The Incubator model will, therefore, carefully prepare this type of venture using a number of milestones before a final go decision is given.

In the second stage, 43 random cases in the same regions were selected to compare to these models in terms of resources and activities. This validation process identified two categories that departed from the reference models, namely the Resource Deficient group and the Competence Deficient group. By far the largest category are the Resource Deficient institutions. Many research institutes view spin-outs as an attractive way to commercialize research results and obtain revenues. Because of this, the spin-out service is usually seen as an extension of the current technology transfer unit. The latter usually manages the IP of the research institute. However, without control over contract research opportunity seeking becomes extremely difficult. Therefore, the spin-out unit tends to be seen as a short term investment to generate long term revenues and as a result tends to be understaffed. These problems are exacerbated by a lack of financial resources in the current economic climate that make it extremely difficult to attract external capital for spin-outs. Finally, the board of the research institute commonly expects that the spin-outs created to commercialize the institutions IP to be profitable and exit oriented in order to realize any financial gain. The Competence Deficient spin-out unit, therefore, faces an objective for which it lacks the necessary skills and competencies.

SPINNING OUT NEW VENTURES: A TYPOLOGY OF INCUBATION STRATEGIES FROM EUROPEAN RESEARCH INSTITUTIONS

INTRODUCTION

The spinning out of new ventures from public or university based Research Institutions (RIs) is a long established phenomenon (Mustar, 1995). Historically, spin-outs have not resulted from any structured process of research commercialization. Rather, spin-out companies have been formed by entrepreneurs despite the lack of clear guidance and involvement from the RI with which they were associated. Only recently have RIs previously lacking any entrepreneurial orientation devised "pro-active" policies to stimulate the commercial exploitation of public research through spin-outs (e.g. Callan 2001; European Commission 1998; Siegel et al., 2003). In parallel, changes in the institutional environment have facilitated such a policy. For example, laws have been changed to assign ownership of intellectual property to RIs. In addition, employment laws have been loosened to allow public sector researchers more contact with the private sector and various initiatives introduced to provide early stage spin-out capital.

Although the strategy of commercializing knowledge from RIs via spin-out companies has become increasingly popular our understanding of the phenomenon is still limited. First, there is a lack of clarity about the processes that RIs may employ in the spinning-out of companies. Although a number of studies explain the reasons for starting spin-out services (Smilor, Gibson and Dietrich, 1990; Mustar, 1997) or the difficulties in starting this kind of service in a university context (Steffenson, Rogers and Speakman, 1999), few have highlighted the processes through which these services are taking place. This issue is compounded by the fact that many RIs have traditionally operated in an environment where high tech entrepreneurship is relatively new. Roberts and Malone (1996) stress that the process of spinning-out ventures from RIs will be very different in this context when compared to more developed high tech entrepreneurial environments such as Boston or Silicon Valley (Roberts, 1991; Saxenian, 1994). In a developed environment, there is already a strong entrepreneurial community with the capability to select the best projects and allocate resources to them. Here the spin-out process can follow a “business pull”

strategy, one that is not (fully) dependent on the activities of the parent RI, but benefits from high levels of innovation or R&D within the surrounding regional environment. Here the region acts as an incubator for the spin-out companies. In contrast, in environments with less demand for innovation, characterized by a weak entrepreneurial community and a lack of other key resources, RIs may need to play a more pro-active incubation role. This strategy is best described as "technology push", where the RI exercises selection and provides venture creation and development support throughout the stages in the spin-out process.

An RI engaging in a strategy to commercialize its technology through spin-out companies can utilize a range of different support activities designed to provide the venture with the resources and capabilities it needs to develop through these stages. However, the ability to provide the necessary support activities and resources may vary between RIs. Furthermore, this variation in venturing support activities may be associated with the spinning-out of different types of ventures. This paper addresses two central research questions: (i) What differences or similarities are there in the goals and objectives of the Research Institutions for creating new spin-out ventures? (ii) What different incubation strategies are employed to achieve these goals in terms of the resources utilized and activities undertaken? These questions are addressed employing a grounded approach based on in-depth case studies of RIs. All of the cases employed in the paper were drawn from Europe and have a proven, and widely recognized, track record of spinning-out new ventures. These cases were used to identify three different models for spinning-out companies. The three models are: (1) Low Selective model, (2) Supportive model and (3) Incubator model.

The remainder of the paper is structured as follows. First, we explore the spin-out process in order to gain insight into this as yet incompletely documented phenomenon. Second, we explain the two-stage methodology that guided our data collection and analysis. Third, we identify the resources and activities associated with the resulting typology of three models of incubation strategies used by RIs to commercially exploit internal inventions and intellectual property. Fourth, we discuss the nature of these models in terms of their strategies and the performance outcomes of these strategies measured by the number and type of spinout ventures created. Fifth, we consider the interaction of the local environment with the three models. Sixth, we present the results of our validation exercise. The final section presents some conclusions for policy.

MANAGEMENT OF THE SPIN-OUT PROCESS

The evolution of new ventures is a complex phenomenon that has been portrayed in various stage models. Although there is no generally accepted stage model, all emphasize that the nature of a business changes as it grows (Miller and Friesen, 1984). Clarysse and Moray (2003) suggest that the founding of a spin-out can be seen as a process in which three different stages can be distinguished (see Figure 1). The first phase, labeled the "invention phase", is a period during which technical uncertainty prevails. In the second phase, called the "transition phase", technical uncertainty becomes more limited and the business idea is validated. Finally, we can distinguish the validation of growth expectation phase or "innovation" phase. The process is represented as a funnel since from the relatively large number of research ideas during the invention phase only a few will become validated as having an economic value for a spin-out. 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 1 HERE

Formal establishment of a spin-out may take place at any stage. Research based spin-outs may be legally registered when the business idea is validated but before a target market is clearly defined or a market-ready prototype is developed. Some centers of excellence, however, acting as venture incubators or accelerators, may not spin-out the research team before there is a validated growth expectation and venture capital can be attracted. Instead of creating a new company when the business idea is validated, the research team at this stage may be provided with a budget that can be used over a limited period of time to develop the idea. The period of validating growth expectations takes place within the parent organization, preparing the potential spin-out for a venture capital injection further along the line. It is only after this period that the venture will be legally registered and will physically spin off from the parent organization.

To enable spin-out companies to move through the different stages in the spin-out process there may be a need for support from the parent RIs, i.e. for the parent to

perform an incubation role. Although the term incubation has traditionally been narrowly focused on property-based initiatives such a definition is highly restrictive as it excludes what are arguably the most important elements of support that are required by spin-out companies (Lockett, Vohora and Wright, 2003).[6] This support may involve a range of activities that facilitate the process (Clarysse and Moray, 2003) and provide the venture with the range of requisite resources to develop. The different activities of a proactive spin-out management process have been defined by Degroof (2002) as follows. First, technology opportunity search consists of trying to identify technologies with a commercial potential. Second, intellectual property assessment, involves assessing if patents have already been filed for the specific technology and, if not, perhaps filing one or more patents. This step can involve examining the choice between options of commercialization, primarily the choice between licensing and commercializing through a spin-off venture. Third is selection of the spin-off projects based on their intrinsic potential and on the comparison with alternative projects. Fourth, once the project is selected and a team volunteers to carry it out, a phase of business plan development is necessary. Fifth, once a business plan exists and is accepted, RIs channel their spin-outs towards potential source(s) of funding. Sixth, once funding is obtained, the venture can formally be incorporated, at which point the RI or another party can provide spin-out coaching. Although in practice, the founding of spin-outs is not as linear as presented in this step model, it offers a good comparative framework against which to map the activities by the different RIs.

Deficiencies in the initial resource endowments of spin-outs constrain the new venture's development (Shane, 2001) and may be further exacerbated by an un-entrepreneurial environment. From a resource-based perspective, spin-outs need to develop their resources over time if they are to progress through the different phases of development and create significant wealth (Penrose, 1959; Barney, et al. 2001). Following Brush, Green and Hart (2001), six types of resources can be identified as key to the spin-out process: human (individual skills, knowledge), social (external relationships, networks), financial (working capital), physical, technology and

6 We employ the UK Business Incubator (UKBI <www.ukbi.co.uk>) definition of business incubation, being a dynamic business development process encompassing one or more of the following functions: (1) encouraging faster growth and greater survival rates of new companies, (2) helping to identify investment opportunities, (3) facilitating the commercialisation of university or corporate research and new ideas and (4) helping to create jobs and wealth and to tackle specific urban or rural economic development problems.

organizational (structure of the spin-out service).

Importantly, RIs may differ in their approach and ability to provide support activities and resources when incubating the spin-outs. In what follows, we use detailed case studies to identify a typology of the different incubation models that can be utilized to successfully promote spin-outs.

METHODOLOGY

The paper employs a two-stage methodology. The first stage was to pursue a qualitative approach to identify and explain different incubation models of the organization of university spin-out activity. The second stage involved the empirical validation of the different incubation models we develop using a larger sample of institutions across the EU.

Stage 1: Model Building

The qualitative approach adopted in the first stage was appropriate because the literature on the technology transfer function in Europe is limited and rather descriptive. Moreover much of the literature on organization theory and entrepreneurship is US-centered, which makes hypothesis formulation and testing premature for the questions of interest. Despite growing interest in the commercialization of research by academics as well as policy makers, very little is yet known about how technology transfer activities, and spin-out processes in particular, are organized from the perspective of the parent institution.

The research design employed an inductive approach in order to obtain a rich understanding of how USOs evolve from research activities into commercial organizations. The multiple case design permits a "replication" logic (Yin, 1984), allowing the case analyses to be treated as a series of independent experiments (Brown and Eisenhardt, 1997). This method allows for close correspondence between theory and data, a process whereby the emergent theory is grounded in the data (Eisenhardt, 1989). To make this inductive process explicit we adopted Degroof's (2002) roadmap of steps / activities to analyze spin off processes and Brush, Green and Hart's (2001) bundle of resources that seem to be crucial in organizing spin-out activities. Both these dimensions were outlined in the previous section.

We examine the organization of incubation spin-out services from the

perspective of the parent institute. This entails looking at two interrelated levels: the internal activities that are geared towards spinning-out ventures and the context in which resources are employed (internal and / or external to the parent institute). We identified 13 European regions from which we selected seven organizational cases for detailed analysis where the spin-out service appeared to be working well. As a basis for identifying the models, we examined and compared the activities and resources in each of these institutes. Comparison of the cases with regard to their activities and resources was important to understand the nature of these practices and how they are sustained within the RIs under study. At an aggregate level, comparison allowed us to construct three archetypes or reference models of spin-out services.

As our purpose is to identify different approaches to the process of spin-out activities, rather than explain the presence or not of spin-out activity, we started with an analysis of the regions where a science and technology base was present. We identified 13 regions at NUTS2[7] level, which – according to the European Report on Science and Technology Indicators (1994: p. 152, 1997) – contained 80% of all research laboratories and enterprises of the EU[8]: Île de France and Centre-Est (Rhône-Alpes) in France, Vlaams Gewest and Région Wallonne in Belgium, Eastern (East Anglia) and East Midlands in the UK, Oost-Nederland and Zuid-Nederland in the Netherlands, Bayern, Baden-Württemberg and Hessen in Germany, Northern Italy (Nord Ovest, Lombardia, Nord Est and Centro) in Italy and Southern and Eastern Ireland (see Table 1).

INSERT TABLE 1 NEAR HERE

Even the most R&D intensive region in the EU is not as intensive as comparable regions in the US. According to the European Report on Science and Technology Indicators (1997), the states of California and Massachusetts, which

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7 NUTS refers to the regional classification system adopted by Eurostat. NUTS1 is the country level, NUTS2 is the first level below that, which usually corresponds to the administrative organization.

8 EU refers only to EU12. The Northern European countries – Sweden, Finland and Denmark – joined the EU much later and were not included in the European Report due to lack of regional R&D statistics compiled by Eurostat.

include Silicon Valley and Route 128 spend on average 6.3% of their GDP on R&D (1994 figures). The top region in EU, Baden-Württemberg spends only 4.3% of its GDP on R&D, which is line with only the median state in the US. In contrast to US research, our analysis incorporates regions with a broader range of intensity of R&D, from Baden-Württemberg at the higher end and Northern Italy at the lower end with 1.4% of GDP. The regions we selected are therefore representative of large parts of Europe, not only the top high tech areas.

The research process involved the creation of a research network with local university researchers from each of the regions involved in the study. The network was financed by the European Commission. Each researcher was asked to identify, for their region, technology transfer units that were associated with universities or public research institutes according to the following criteria: (1) they needed to be founded at least before 1997; (2) they needed to have a documented record of spin-outs; (3) the local researchers had to consider them as examples of processes of spin-out activity that were successfully achieving their objectives. The selection of the technology transfer units of RIs was based on data collected through telephone interviews. In total seven cases were found to match the criteria: Scientific Generics and TTP in the UK; Leuven R&D and IMEC in Belgium; BioM in Germany; University of Twente in the Netherlands and, Crealys in France (see Table 2).

RIs may have different objectives and the outcomes of their activities may reflect these objectives. Respondents were therefore asked to rate the degree to which the outcomes were in line with their mission as an interface service. We asked representatives in each of the seven RIs to rank different outcomes in order of their importance.[9] Respondents were presented with nine conjoint sets of outcomes, which they had to evaluate using Likert scales. The outcomes were based on six categories of selection criteria, which we identified through our interviews: (1) degree to which the spin-outs/spin-out could receive (public/private) external capital at spin-out; (2) degree to which the technology on which the project was based was patented; (3) product orientation of the potential spin-outs (consulting, R&D contracts, product); (4) the target market (location, market size and market growth); and (5) the forecast of the financial characteristics (time to break even); (6) whether the spin-out received

9 We thank an anonymous reviewer for this suggestion.

venture capital.[10] Respondents were asked to rank the nine outcomes in terms of the TTO mission with respect to spin-outs.

On this basis, we categorized RIs as having a mission focused on stimulating *(a) self-employment oriented spin-outs* (i.e. the objective was to create employment and enhance development in a depressed region, without a focus on profitable growth or creating a realizable financial return for investors) if they rank those outcomes highest which contain many (>7) spin-outs and 1. None use external capital ; 2. only a few are based upon a proprietary technology developed at RI; 3. Most are consulting or service oriented ; 4. Most target a local market ; 5.Time to breakeven is less than one year ; 6. None received private VC money.

We identify their mission as stimulating *(b) economically profitable spin-outs* (i.e. the objective was to create economically profitable businesses but with no envisaged exit to generate a financial return for investors at time of creation) if they rank those outcomes highest in which there are some (3-7) spin-outs and 1. Most use external capital; 2. The majority is based upon a proprietary technology developed at RI; 3. Only half are consulting or service oriented; 4. 50% targets a global market; 5.Time to breakeven varies considerable among the different ventures; 6. few received private VC money at spin-out.

Finally, we identify their mission as stimulating (c) *exit-oriented spin-outs* (i.e. the objective was to create businesses that would generate realizable financial returns to investors) if they rank those outcomes highest where there are few (<3) spin-outs and 1. All use external capital; 2. all are based upon a proprietary technology developed at RI; 3. none are consulting or service oriented; 4. All target a global market; 5.Time to breakeven is for each of them > 1 year; 6. all received private VC money.

The results of this exercise are included in the objectives section of table 2.

INSERT TABLE 2 HERE

Data on each case was collected through a variety of techniques including personal interviews with several persons in the institutes and secondary data sources such as annual reports, web sites and descriptions of the institutes in the local press.

For each of the institutes, the way they organized the spin-out process was mapped using the different activities of spin-out management defined by Degroof (2002) and outlined above as a guideline. Using a structured questionnaire, we assessed to what extent and how each of the interviewed spin-out services was organized or was engaged in the particular activity. For instance in the case of technological opportunity search, we examined the degree to which different tasks such as 'informal visits to the research labs', 'organization of a business plan competition', 'structured brainstorming with research groups', 'mapping of the research activity' were carried out by the spin-out service.[11]

We also analyzed the resources that were developed to efficiently organize these activities (Brush et al., 2001). The resource-based theory of the firm was used as a theoretical framework to classify these resources: human (individual skills, knowledge), networking (external relationships, networks), financial (working capital), physical (infrastructure and space), organizational (structure of the spin-out service) and technical (focus on knowledge or technology) were distinguished. Concerning the seven cases, we analyzed to what extent the resources that were present were crucial to organize the activities described above.[12]

Stage 2: Validation of Model

The second stage involved the empirical validation of the model developed in Stage 1. We selected a range of different cases from the regions identified in Stage 1. First, we identified a sample frame of universities and RIs in the particular regions. Second, the universities and RIs were screened for the existence of a spin-out service. Third, a preliminary analysis of the effectiveness of the initiatives set up by the spin-out service took place. Based on this analysis, the most active spin-out services in each region were selected. This analysis produced a sample of 43 RIs. The selected cases were actively pursuing a spin-out strategy, but did not necessarily meet the three different criteria used as selection conditions in stage 1. Several selected cases were founded after 1997 and were not, as yet, able to be considered successes.

INSERT TABLE 3 HERE

11 Details relating to the activities undertaken by each case are available from the authors.

12 Details relating to the resources of each case are available from the authors.

Data were collected on each of the RIs as for the initial seven cases. On the basis of this data, an attempt was made to fit the cases into the models identified in stage 1 and to identify areas of resources and activities where they departed from the models (Table 3).

MODELS OF SPINOUT ACTIVITY

Based upon the data collected in each of the cases selected, three different models of spin-out activity were compiled: (a) Low selection model; (b) the Supportive model; and (c) the Incubator model. In the following section, we outline these different models. For each model, we distinguish in turn the activities undertaken and resources required, below.

Activities

In this section we analyze, for each model in turn, the activities involved in spinning-out ventures in terms of: opportunity search and awareness creation; intellectual property assessment and protection; strategic choice of how to commercialize R&D; (property-based) incubation and business plan development; the funding process; and control of the spin-out process after start-up of the spin-out company. The essential activities of each model are summarized in Table 4.

INSERT TABLE 4 HERE

The Low Selective mode

This model is based on the principle of "sow as many seeds as possible, some will become highly successful, some will not". In other words a natural selection process takes place rather than executives in the RI making decisions about each project and its viability. The University of Twente (TOP case) in the Netherlands and Crealys in France are prime examples of the "Low Selective" model. The University of Twente is located in the north-east of the Netherlands. In the mid 1980s, the region was confronted with relatively high levels of unemployment. At that time, the university deliberately chose to play a major role in the rejuvenation of the region. It tried to engender an entrepreneurial climate and promoted itself as the "entrepreneurial"

university. In this atmosphere, the TOP initiative was created with money from the European Regional Development Fund. In contrast, Crealys is located in the south west of France, near to Grenoble in the region "Rhône Alpes". Both initiatives are discussed in detail below.

A] Opportunity search and awareness creation. Although the spin-out service might undertake some activities such as providing entrepreneurship lectures, the "opportunity seeking" activity remains passive. In France, Crealys limits its opportunity seeking to regular visits by TTO- staff to departments of the universities and public research laboratories. Similarly in Twente, the bulk of opportunity generation appears to occur within the departments. In this model the onus for opportunity identification therefore remains with the individual researchers and research department members. Twente refers to the entrepreneurial mission of its parent university as a main driver of spin-out activity (Karnebeek, 2001). It is important to mention that the trigger to spin-out a company in this RI lies in the general acceptance by the researchers/professors and graduates that they work for an entrepreneurial university and that starting your own business is an attractive idea. As students have the least to lose, it is likely to be easier to incentivize them than a tenured professor to start up a business. As a result, many businesses are started by end-of-contract researchers and students who have just graduated. Hence, spin-outs present an alternative to employment at an established firm.

B] Strategic choice how to commercialize R&D. The selection criteria are limited and projects eligible for funding are at an extremely early stage in the spin-out funnel, e.g. when there is only a project proposal rather than a business plan. The beginning of the arrow in Figure 1 presents the phase where the spin-out services select the potential projects and start offering support to spin-out companies. The spin-out services in the Low Selective model only give advice during the phase of project validation. In both Crealys and the University of Twente this approach results in a high selection rate. In the last 2 years, Crealys received 160 projects of which the selection committee approved 60.[13] Over the last two years the University of Twente selected approximately 60 projects out of a total of 130 (Karnebeek, 2001). The interview data suggests that in both cases the formal representation of the project plays a larger role than the practical test of the assumptions. It is illustrative that

13 Annual Report of 'les incubateurs publiques'.

Crealys selects projects that are based upon two criteria. First, they have to be based upon technical developments; and second, they have to be willing to cooperate with the research institute they spin-out from. No economic or financial criteria are included in the selection process.

C] IPR Assessment and Protection. Proprietary technology is unlikely to be the key trigger to spin-out a company. In the case of Crealys, French law stipulates that the technology developed by employees of the RI is owned by the parent institute. In the Twente case, in only 7% of spin-outs founded after 1980, there was a patent owned by the university. This percentage might be higher for more recent spin-outs since active patenting among university institutes is quite new. But as discussed below it may also reflect the nature of the spin-out companies, who appear not to be the result of a strategy designed to create value from R&D strategy but of the entrepreneurial mission of the university.

D] Incubation and business plan development. Spin-out support focuses mainly on the validation phase of the project. During this phase, there is no need for a large infrastructure or business space. In both the Crealys and Twente cases, space is available within the university or research laboratory facilities. 'In house' provision of support is limited to business plan advice and assistance and some IPR advice and assistance. Other support may be available via referral or marriage broker type activities and or at market rates, (e.g. space.).

E] Funding process. Crealys and Twente grant public money to these early stage projects. The Twente funds are derived from the European Social Fund and are granted in the form of loans (€ 15 000). Karnebeek (2001) concludes that the Twente entrepreneurs regard the loan as a means of subsistence rather than as spin-out capital. Crealys only invests in spin-out companies during the phase of validation of the project. The total amount to be invested in a project is a maximum of € 100 000.

F] Control of the spin-out process after start-up. The spin-out companies are selected at a very early stage and spin-out coaching is focused upon this early stage. The consequences of this model in terms of the nature of the spin-out are that a wide range of businesses are selected. Among them, as in any start-up population, many will be small, with very low levels of capitalization, more locally or nationally focused and with a poorly developed personalized management function. In Twente, the average number of jobs per company after ten years was 6, with only 4% of all spin-outs having received venture capital. In France, the Crealys initiative is too

recent to analyze growth figures, but among all projects started about 10% resulted in a growth oriented venture capital backed company.

Supportive model

This model takes its name from the extensive support that is given to the entrepreneurial team during the pre-start up phase. The Leuven R&D and BioM cases represent prime examples of the supportive model. Leuven R&D is located in Flanders, Belgium. Although the spin-out service was formally created in the early 1970s, it was only professionalized in the mid-1990s. By that time, Leuven was one of the high tech poles in Flanders. The nearby university and the presence of IMEC (see below) had resulted in a number of high tech spin-outs and had attracted several technology intensive companies in the science park (Clarysse and Heirman, 2002). The experience of this first generation of spin-outs had shown that some of them were really successful. The new dean at the university had been a founder of one of these success stories. Also many spin-outs had difficulties in surviving the first few years. In order to support these companies and enhance the creation of spin-outs in a more consistent way, the existing interface service Leuven R&D was restructured and further professionalized.

BioM is located in the south east of Germany, in the Munich area. Like the Leuven area, the Munich area already had a history of high tech and spin-outs pre BioM. The presence of the Max Planck Institute and several universities stimulated the creation of spin-outs, especially in biotechnology. In the mid-1990s, Germany wanted to create a structure to enhance and successfully support the creation of spin-outs in biotechnology. BioM was one of the five institutes that received financing from this Bioregion competition. Although today the financing constitutes only a very small part of the budget, the competition induced the creation of BioM. Both models are described below in more detail.

A] Opportunity search and awareness creation. Leuven R&D hosts the contract research activities, the IPR activities and the spin-out support of the KUL. Because of its close link to contract research and IP, most opportunity recognition happens in an indirect way. Usually, a professor looks to get support for his contract research activities and is made aware of IP possibilities by the contract research department. Once the IP is applied for, a trade off is made between the traditional path of commercializing IP (i.e. licensing) and the creation of a new spin-out. As a result,

the trigger to attract professors at a university to commercialize their research efforts is at a much lower level. They are stimulated to perform contract research. Forming a spin-out is a much later phase in the commercialization trajectory of any professor's research portfolio. BioM deploys a less formal model of opportunity recognition since it does not manage contract research or IPR activities of the related universities and research organizations. This shortcoming seems to be overcome by specialization on biotechnology and its attraction of well respected scientific advisors in biotech. First, biotech is a technology where IPR has been considered of extreme importance for a long time. Professors, active in this domain, tend to be aware of this. Second, the attraction of high level scientific advisors in the biotech field increases the respect among the nearby professors and creates a considerable level of trust.

The trigger to spin-out a company is thus quite complex and staged in this case. It is especially oriented towards professors and researchers that can have a career at the research institute. The barrier to entry is kept very low since they start to manage the contract research activities of those professors in a win-win situation. In KULeuven R&D, the professors receive support in price negotiations (i.e. have better prices for their services), are assisted in employment relations (can hire people using their preferred salary structure and contractual model), and are even allowed to pay some of the profits to themselves and/or their employees. Usually professors are already running such a "department" before they eventually spin-out an independent firm. The trigger to do so might be that extra capital is needed to finance and grow the ongoing activities.

B] Strategic choice how to commercialize R&D. Under this model there are clear selection criteria. For a business plan to be selected, it has to show growth, a clear product, and international orientation (in the long term). Support is only offered during the phase of validation of the business plan. Typically researchers have to prepare a business plan before being eligible for selection by the spin-out service. The business plan is evaluated by a team usually consisting of people with a background in the financial world and public administrators (or university representatives). BioM received 130 business plans in the last 5 years but only invested directly in 28 spin-out companies.

C] IPR Assessment and Protection. As mentioned above, Leuven R&D has a professional IP support staff. In BioM, no specific IPR support is foreseen, but close contacts are established with patent experts who might help the spin-out. In both

cases, it is clear that no technology platform is built through licensing-in pieces of technology to complement the existing technology. As in the previous case, the patent serves more as a means to commercialize the technology developed in the parent institute than as part of a technology portfolio.

D] Incubation and business plan development. Incubation and business plan support are key activities in this model. Incubation facilities can also include space and access to equipment. Support includes a wide range of business advice and coaching. BioM does not have its own incubation center, but has developed a close relationship with IZB (the CEO of BioM is the scientific CEO of IZB). IZB owns two incubation centers in the area of Munchen. The incubation center I&I, located in Leuven, is a separate legal entity, with its own independent management structure. Leuven R&D is represented on the Board of the incubation center I&I. Again, a board of directors serves as the main mechanism for providing informal support to the spin-out company. Through this mechanism, they are able to guide the spin-out and give it specialized advice when necessary. Because it takes place through the board of directors, all advice is essentially free.

E] Funding process. This type of model makes greater use of public/private partnership funds, which are usually organized as a VC fund. The amount of money invested ranges from € 350,000 to € 600,000 per business plan. The typical level of investment under this model is beyond the scope of either public funds and/or business angel support alone. But at the same time it is often too low for a VC. Therefore, it is preferable that the spin-out service has an associated fund, with banks as partners. The difference from a VC is that the banks do not have an "individual case" profitability expectation, but see the fund as a "window on opportunities". Although there is real financial screening of business plans and business plans must be complete, comprehensive and validated, the fund will tend to take more risk (i.e. invest in early stages) and be less efficient (much lower amounts) than a typical VC. In the methods by which the business plan is evaluated and the corporate governance of the company, this model is closer to a VC than to a business angel. Under this model, the spin-out service will hold equity in the company after separation. The percentage of equity taken at the early stage varies but generally it seldom comprises the majority share. For example, BioM takes on average 7% of the shares of a spin-out company.

F] Control over the spin-out process after start-up. Under this model, the amount of money available is limited and is usually only sufficient to bridge a period of a year. Most companies founded through this process are likely or advised to seek complementary revenues through short-term contract research or consulting. This model tends to focus on businesses that have significant growth prospects and that may or may not become attractive to venture capitalists, rather than life-style businesses. In BioM, 35% of the spin-out companies have already received venture capital financing.

Incubator model

The Incubator model is labeled after the incubators that emerged in the early nineties with the specific objective to create financially attractive spin-outs. The cases of IMEC[14], TTP[15] and Scientific Generics are prime examples of this model. IMEC is located in the Leuven area, which is described above. IMEC was created in the early eighties as the inter-university institute for micro-electronic research. The main idea was to stimulate collaboration among all Flemish universities in this domain. The commercialization of research results was among the mission goals of the institute and has become one of the key activities. Today, 80% of IMEC's revenues are generated by contract research activities. Spin-outs are only one way of commercializing results. Since IMEC is so active in commercializing research, it can make a good trade-off before launching a spin-out project. Only if the spin-out project offers a better financial prospect than the other more classic ways will this option be considered.

TTP and Scientific Generics are located in the Cambridge (UK) region (Segall, Quince, Wicksteed, 2002). Generics was founded in 1986 by the serial entrepreneur Gordon Edge with four main objectives. Its core business is top level technology consulting. Second, it creates and licenses out IP. Third, it invests in the creation of spin-outs. Finally, it invests funds in other high tech start-ups. Being located in a known high tech pole, it is able to attract European top researchers to its base in Cambridge. Again, spin-outs are a way of making money and just one

14 InterUniversity Institute for Micro-electronics

15 The Technology Partnership in Cambridge, UK.

alternative to licensing out of contract research. The motivation of creating spin-offs is purely a financial one.

A] Opportunity search and awareness creation. Opportunity seeking activities are more pro-actively undertaken and managed under this model although the mechanisms by which this is achieved vary. In TTP this is rather informal whereas in Generics there are formal mechanisms for assessing all contract work for spin-out potential that extend to universities outside the UK. IMEC is a leading edge applied research institute in the field of micro-electronics and looks for projects at a very early research stage in the different universities in Flanders. In the incubator model, creating a spin-off is a decision made by the top management of the RI. Although it is desirable to have an entrepreneurial research team, they usually do not expect it to be real business entrepreneurs. Instead, some spin-outs of IMEC do not even employ the researchers that invented the technology on which the spin-off is based. Rather, they tend to recruit external top management for each spin-out. The key researchers can eventually choose to have a joint position.

B] Strategic choice how to commercialize R&D. In terms of project selection an in-house fully integrated approach is identifiable under this model covering the technology, the commercial viability, financial requirements and managerial competence. By and large, evaluation is rooted in the technical and commercial expertise of the organization. Compared to other models, the technology is likely to be quite specialized. The selection of a project happens at different stages in the project funnel. IMEC and TTP select research projects with a clear commercial potential. Generics goes one step further and selects projects with a potential for spin-out. Once the development of the project becomes more advanced, the criteria for receiving spin-out support are basically the same as the ones used by venture capitalists. A VC expects explosive growth, a very strong technical platform and a global orientation of the spin-out company. A VC thinks about the validation of growth when looking at the projects. All potential projects of IMEC are screened with the target to set up 1 or 2 spin-out companies a year.

C] IPR Assessment and Protection. The IPR policy of the different interface functions or services differs quite substantially from the previous models. Once a project is chosen to have spin-out possibilities, the IPR policy aims at building a technology platform through licensing-in other pieces of the technology and cross-licensing some parts.

D] Incubation and business plan development. The incubation processes are focused on the period before the validation of the growth (see Figure 1). The spin-off service or function provides all kinds of support ranging from management and housing of the applied research projects to the provision of offices and meeting rooms for early stage spin-outs, business plan development, recruitment of external management and the composition of their technology platform. The incubation process has thus both a long time horizon and aims at offering a fully in-house support service. For example, the initiation of the project Coware occurred in 1992. Four years later, Coware was spun out of IMEC.

E] Funding process. Both the time scale and nature of the project supported mean that funding requirements are greater than under the other two models. Typically spin-outs from this model start with a capital of € 1-4 million. Scientific Generics and IMEC maintain good contacts with the wider venture capital community. Through their preferred partnerships and informal networks with this community, they attract financing for their spin-outs at founding. TTP has its own fund which (co)-invests at spin-out. Of course, before a company is formally founded and spun out, many investments have already been made to bring the project to this stage.

F] Control over the spin-out process after start-up. We have termed this model 'incubator' because it provided extensive in-house support from idea generation right the way through to final separation from the Institution. The stage and process of separation may vary: TTP comprises a colony of related but independent organisms; separation is referred to as ‘demerging’ and at this stage the ‘spin-out’ may be very large, employing 100+ and may go straight to IPO. Separation in Generics and IMEC is earlier, often with a trade sale in Generics and always through VC involvement in IMEC. In all cases, the spin-out will have a well-development professional management team, which will probably involve outsiders. The intensive support offered by the spin-out services is focused on targeting growth ventures that can received venture capital backing.

RESOURCES EMPLOYED IN THE SPINOUT MODELS

The essential resource features of each model are summarized in Table 5.

INSERT TABLE 5 HERE

Low Selective model

A] Organizational resources. The spin-out activity is either organized as an internal department of a university (Twente) or as an interface service for different universities and/or public laboratories (Crealys). The routines developed in the interface service tend to be those of a broker or matchmaker between the researchers within the university(s), the public sources of finance and the administration.

B] Human resources. The spin-out unit employs a small team of people who are familiar with existing government grant programs. The organization needs this kind of knowledge to be able to receive funding for their spin-off companies. Their human capital is thus more public than private oriented. However, the presence of a well known and respected entrepreneur helps to achieve credibility.

C] Technological resources. The spin-out service has no technological focus for two reasons. First, the mission of the service is to support as many projects as possible, irrespective of technological area. Second, the spin-out services have a link with the universities, who perform 80% basic research and 20% applied research. Because of the relative low engagement in opportunity seeking, the spin-out service is very dependent upon the entrepreneurial spirit and mission of the research institutes or university with which it is associated. Its ability to function effectively will be dependent both upon the size of this research base and the entrepreneurial mentality of the academics who are present.

D] Physical resources. Office space and infrastructure are organized within the universities and do not play a determining role.

E] Financial resources. In order to organize this kind of resource, the spin-out service should have control over a public fund, which can distribute grants or at least have close contacts with other public sector initiatives. Crealys received €1.5 million (spread over 3 years) from the "Ministère de la recherche" because it was selected as a public incubator in the call for projects. Crealys also receives each year €200,000 from the City of Lyon, €1 million from the region Rhone-Alpes and €500,000 from the associated universities.

F] Networking resources. The success of this model seems to be very dependent upon the social network which the spin-out service has developed with

various public agencies and relations with the research departments or institutes to which it is attached. The entrepreneurial context of the wider region seems to play a lesser role (e.g. Crealys) in the stage of validation of the project. Once the companies reach the stage of validation of the business plan, the entrepreneurial context becomes more important. If a spin-out company shows growth potential, it will depend upon the entrepreneurial context to realize this growth. Since the organizations of the Low selective model do not offer support in the phase of validation of the business plan, support must be found within the entrepreneurial environment. If this environment does not exist, the spin-out company has major difficulties in realizing its growth potential.

Supportive model

A] Organizational resources. BioM was initially created as a publicly funded project selected by the German government in its BioRegion competition (Dohse, 2000). Besides this initial investment of public money, further private and public money was attracted from local VCs, business angels, the city of Munich and the Bavaria region. Although it has public links, BioM operates as a private company. Leuven R&D is the fully integrated technology transfer office of the Katholieke Universiteit Leuven, operating within the university, using a divisional structure fully embedded throughout the university, through the implementation of an matrix organization approach (Debackere, 2000). Leuven R&D has received a large amount of budgetary and human resource management autonomy within the university itself. This implies that Leuven R&D, although being fully integrated within the university, manages its own budgets as well as the research personnel employed on those budgets. The university has created a matrix structure: research excellence prevails along the hierarchical lines of the faculties and their respective departments, whereas excellence in entrepreneurial and industrial innovation is rewarded along the lines of the LRD divisions. This structure, with its sufficient degrees of coordination between academic research and innovation, as well as guaranteeing sufficient autonomy to the faculty and staff engaged in entrepreneurial and industrial innovation activities, is the basis of the university's approach towards managing academic science and technology as a business (Debackere and De Bondt, 2002).

B] Human resources. The human resources of this model are likely to be more experienced in enterprise creation than under the previous model. BioM has a small

team of 10-13 people, of which 3 to 4 people have experience in setting up entrepreneurial technology ventures. Therefore, they can have an impact on the selection process performed by the fund with which they collaborate.

C] Technological resources. Under this model, the technological resources whether provided directly or not are likely to be more focused towards particular specific technologies. This in part provides the strength upon which technical evaluation rests. BioM has a sectored focus on biotechnology, but this has more to do with the BioRegion Competition than with a strategic choice. Leuven R&D tends to be focused on IT and Biomedical ventures during the last years. Again this has to do with the strength of the parent institute. Basically, no technical knowledge resides within the spin-out service.

D] Physical resources. As suggested earlier, physical resources will be more developed under this model. In both BioM and Leuven R&D the availability of an incubation center and a science park is very important to the functioning of the service although space is offered at market prices. The spin-out companies are in the phase of validation of the business plan when they get support from the spin-out services. In this phase, the universities and research centers cease to offer incubation space. As the spin-out companies have to search for new accommodation that is difficult to find, it is important that the spin-out services provide support in this search process. To make this search easier, most spin-out services in this model have their own incubation center. BioM does not have its own incubation center, but has developed a close relationship with IZB (the CEO of BioM is the scientific CEO of IZB). IZB owns 2 incubation centers in the area of Munchen.

E] Financial resources. BioM, is financed by three parties: tbg[16] together with VC companies, the State of Bavaria, and the local pharma and chemical industry. BioM has no real fund in the strict sense of the word. BioM just uses a part of the financing provided by the three parties to invest in spin-out companies. Approximately € 8 million has already been invested in spin-out companies. The Gemma Frisius Fond was created in 1997 as a joint venture between the Katholieke Universiteit Leuven [represented by Leuven R&D (20%), KBC Investment (40%) and Fortis Private Equity (40%)] and is a € 12.5 million fund.

16 Technologie Beteilungsgesellschaft, a specific project within Germany's public bank, which uses public money to take minority investments in high tech spin-outs.

F] Networking resources. Since this model uses boards of directors as the principal advisory mechanism for the spin-out companies a well-established network and close links with local industry, specialized advisors and the VC community are important. Further, since the value added to equity investment will essentially come from second round financing by VCs, this model is quite dependent upon the "entrepreneurial context" of the regions. In the previous model, the mission of the interface service lay in the stimulation of spin-outs, regardless of whether these spin-outs would realize exponential growth or not. Therefore, the Low Selective model is dependent for its efficiency upon the entrepreneurial climate within the university and upon the degree to which the government is willing to sponsor entrepreneurial initiatives. The supportive model however is much more dependent upon the entrepreneurial environment within the region. The interface services in this model are the hub in a network of specialized advisors, which they use to perform ad hoc services within these spin-outs. The Board of Directors is the main operating vehicle.

Incubator model

A] Organizational resources. The organizations in the incubator model are centers of excellence and independent institutes with a steady revenue stream. The emphasis may vary but the mission guiding these organizations is the commercial exploitation of the research undertaken; in fact some may not see themselves as involved in research but in development. These centers are noted for particular specialisms and as such will have strong links with commercial organizations in particular sectors. The nature of these links may be crucial. Such links will go beyond simple contractual arrangements and are likely to include more intensive forms of collaboration. It is important to note that the successful examples in this model have a sound revenue stream through contract research and are not dependent upon a public organization or a private VC. Scientific Generics was founded in 1986 by Gordon Edge as a spin-out from PA Technology.

B] Human resources. The spin-out service or function is large, employing experienced professional staff from a wide variety of backgrounds and disciplines and is able to draw upon 'in-house' specialists in particular technologies. It is very important to stress that the successful models of this kind are centers of excellence built around a small number of leading edge researchers, preferably with sufficient business experience and charisma. Such individuals are not easily found on the labor

market and it takes time to train them. There are examples of this model which started with founders who did not have this profile and which no longer exist because they could not attract the necessary funding (e.g. Starlab[17] and Twinning[18])

C] Technological resources. The centers of excellence are relatively narrowly focused on particular specialisms, in which they have a wealth of experience. The distinction between fundamental and applied research is not important, but breadth is. For example, Scientific Generics claims not to be involved in fundamental research, but is more involved in "development". But Scientific Generics is a recognized specialist in its particular narrow field. IMEC claims to be the leading institute in micro-electronics.

D] Physical resources. Because the origin of each spin-out company lies within the lab, internal office space is offered for free and infrastructure is available. This model keeps its spin-outs within the physical incubator environment of the "parent". TTP has extensive physical resources on-site at its location on the Melbourne Science Park to the south of Cambridge.

E] Financial resources. The financial resources needed to set up this kind of model are substantial. First, a large investment is needed to create a center of excellence. In the IMEC case this was only possible because the Flemish government has invested each year about € 30 million in the institute since its inception in 1984. The first spin-outs date from the early nineties and the successful ones were only generated in the second half of the nineties. By then, IMEC had its reputation and a steady stream of contract research revenues. Generics has a different history, since no public money was involved. However, the personal wealth and network of its founder, Gordon Edge, who was also involved in the founding of PA Consulting and Cambridge Consultants (later sold to Arthur D Little), provided a similar knowledge reputation and sound financial base. Examples of this kind of institution which started up without a sound financial base are bankrupt today (e.g. Atelier de l'innovation in France). In 1999, IMEC had a budget of €75 million: € 40 million came from contract research, the remaining €35 million were subsidies granted by the Flemish government for fundamental research. In 2001, IMEC had a budget of €115 million: €88 million came from contract research and € 27 million came from the Flemish

17 In this initiative the founder had no business experience.

18 The founders did not have any research reputation.

government. In TTP and Generics these 'investments' are subsidized by other mainstream commercial activities such as contract research and manufacturing.

F] Networking resources. Because the spin-out services effectively manage and support all of the stages and processes involved in research based spin-out creation, the potential for the entrepreneurial context to add to the support is quite low. The spin-out services are self contained and self sufficient. Generics is one of a small number of technical consultancy firms which have become a notable feature of the Cambridge high tech environment. Generics, and especially its founder Gordon Edge have a very high profile in the local Cambridge business environment.

REFERENCE MODELS, STRATEGY AND OUTCOMES

The three models described in the previous section tend to be complementary in their strategic choices concerning the activities they organize in order to realize their specific objectives. In this section, we discuss this issue in more detail and analyze how the combination of resources and activities deployed in our reference models serve a specific objective. In Figure 2, the level and complexity of activities are presented along the vertical axis, while the level and heterogeneity of resources are shown along the horizontal axis. Within this framework, the three reference types are presented along a diagonal axis and characterize the typology of successful strategies employed by RIs, to create and spin-out new ventures as a match is achieved between activities and resources.

INSERT FIGURE 2: TYPOLOGY OF STRATEGIES

Low Selective model

Low Selective interfaces are mainly concerned with creating as many start-ups as possible, and therefore, they use low selection criteria. Since self employment oriented spin-outs include all kinds of service or consulting companies, these firms usually do not generate high financial returns at the beginning. The use of private capital to finance these projects is not desirable, therefore, the Low Selective RIs typically use (small amounts of) public money to finance spin-out projects. Public money is thus an extremely important resource in this model. The amounts invested per company remain rather small (see Crealys and Twente). In fact, most of these

spin-outs do not need a huge amount of starting capital. The human resources needed stay limited in quantity, but are very specific in nature. The Low Selective service is typically run by a few people with the skills to enhance the entrepreneurial climate at the university (on average there was a ratio of 452:1 researchers to technology transfer officers). The critical evaluation dimension of this model is the number of spin-outs that surround the university. For instance, by the end of 2001, Crealys had created an average of 20 spin-outs per year. Twente came close to 30 spin-outs each year in 2001 and 2002.

The economic and financial attractiveness of these firms is less important (on a firm by firm basis). The businesses that tend to be supported under the Low Selective model are commonly characterized by: (i) low levels of capitalization, (ii) locally or nationally focused market, (iii) life-style rather than significant wealth creation and (iv) less developed management structures and processes. In both RIs examined here, the spin-outs received only a small amount of capital (minimum legal capital) and seem to have established a very small growth pattern that yields few jobs and financial returns to the entrepreneur and the regional economy. Of course the fact that these companies are so numerous implies that the total job creation in the regions is considerable (e.g. in the Twente area over 3000 jobs were created in total and 1500 in the Leuven area). Due to the attractiveness of the RI environment and the possibilities offered by the RI environment, graduates stay around the campus instead of returning to their home environment. We suggest, therefore, that the imprinting effect is important in the first years after start-up. However, this does not preclude some start-ups eventually turning into growth oriented companies as well (Heirman and Clarysse, 2003).

Supportive model

In contrast to the Low-Selective model, which has its roots in the basic idea of stimulating the "entrepreneurial climate" at the RI, the Supportive model originates from the general idea of commercializing technology developed at that RI through means other than just licensing. Hence, the spin-outs are considered to be an alternative option to create value from the technology. This aim is very different from that of the low selective case, where all students, researchers and professors are encouraged to start their own business as part of the RI's mission to stimulate entrepreneurship. By focusing on spin-outs as an alternative to licensing or (to a lesser

extent) contract research, the Supportive model limits the number of spin-outs in comparison to the Low Selective model.

Because the Supportive model sees spin-outs as an alternative to licensing, the returns that are focused upon are based upon economic profitability factors rather than financial gains to be obtained for investors upon exit. The activities and resources needed to stimulate these spin-outs are also very different. As discussed above, the Supportive model requires substantial resources for IP assistance and support is provided in terms of patent and license negotiation with industry (on average there was a ratio of 184:1 researchers to technology transfer officers). These resources are much less necessary in the low-selective case where most spin-outs do not have IP developed at the university. Rather than raising awareness across the university, a project-oriented approach is adopted. Initially, the technology transfer office usually tries to intensify trust-based relationships with professors to convince the latter to work with them as a partner, both for consulting and patenting. Only when a potentially interesting technology is identified is the entrepreneurship idea promoted. Once the decision is made to commercialize the technology through a spin-out, the team of researchers is intensively coached to start-up the company. The coaching includes assistance with business plan development, IP protection, looking for money (usually with the local public fund or university fund).

To realize these activities the technology transfer office attached to the RI needs very different resources than in the low selective model. First, it usually employs a larger multidisciplinary team with commercial experience and links to the financial community. The critical mass of this team seems to be around 20 people. Second, it has close contacts or even manages a public/private fund willing to invest small to medium sized amounts (€250-750k) of spin-out capital in projects that are very early and uncertain (so called pre-seed). Third, the RI needs to have a critical mass of at least 2000-3000 researchers, specialized in a limited number of technological domains (e.g. 2 or 3). Fourth, the organization needs to be organized as a separate entity with control over triggers to motivate professors to work with them (e.g. help with contract research, negotiation skills, flexibility in labor contracts etc.). Fifth, the interface service needs to have sufficient contacts with local experts, business entrepreneurs and specialized consultants in order to support the research team during the spin-out process.

The ultimate objective of this model is to create economically viable companies that stay in the region, make the environment attractive and also create contract research spill-overs with their parent RI. Interestingly, in terms of total employment (spin-outs founded post 1997), the spin-outs in the Leuven region are lagging behind those in the Twente region.

Incubator model

The Incubator model has its roots in the "incubation" concept, which arose in the early 1990s. In the mid-1990s it was observed that spin-outs created a much higher financial return than licensing or contract research contracts with established industry. As a result a genuine interest arose among many organizations that had developed proprietary technology, including RIs, to analyze the specific circumstances under which these spin-outs could become financially attractive (in terms of exit opportunities that would create capital gains for VCs). In doing so, these RIs follow closely the due diligence process which is adapted by a typical early stage venture capital firm.

Opportunity seeking is proactive and oriented towards the early detection of promising technology platforms. Instead of making the trade-off between licensing a patent out or building a venture, technology is usually assessed from a freedom to operate perspective. This means that pieces of technology may be licensed in (or cross-licensed) before the company is started. Significant in-house support is provided at all stages of the spin-out process (on average there was a ratio of only 44:1 researchers to technology transfer officers). The venture remains inside the parent RI until all resources are in place and the venture is deemed ready to look for private VC and to hire a proven management team.

It is clear that the resources needed to stimulate this kind of spin-out differ substantially from the previous two models. First, the technology transfer office usually coincides with the 'business development' division of the RI. This also means that commercial people who proactively look for clients are in place. Second, the technology transfer activity may manage its own early stage venture capital fund (that often also invests in projects that do not originate from the RI) or has close contacts with one or more early stage VC funds. Third, the interface office often has contacts with international advisors (e.g. to recruit a CEO, to build the technology platform). Fourth, the RI tends to be specialized in one technology (having 500 researchers or

more on a specific domain) and has built the physical infrastructure to develop research in this technological domain.

Our research shows that the Incubator model results in fewer spin-outs but the businesses supported will typically be more capitalized, more likely to be leading edge companies operating in global markets, and spun-out at a later stage of development. These ventures are most likely to be VC-backed growth oriented businesses, achieving higher levels of innovative activity at the leading edge of technology. At the time the spin-out companies leave the RI, they are likely to be highly product/market focused, have a balanced and experienced team and to be more adequately funded than those ventures being spun-out using other models.

Orthogonality of the models and objectives

A question, which emerges when discussing the three models, is whether they are complementary or substitutable means of reaching the same objectives. Our data seem to suggest that they are complementary and that it is difficult to achieve the aim of stimulating the three kinds of start-ups, that is self-employment-oriented, economic-profit-oriented, and exit-oriented, in parallel *in an efficient way* using just one model. Of course, some spin-outs, for instance in the low selective model, will eventually become growth oriented but this is not as a direct result of the spin-out policy of the RI. We also see the inverse. Start-ups with low growth opportunities, as generated by the low selectivity model, will have difficulties receiving support in the incubator and even supportive model. In the incubator model, project selection is competitive and the best projects, in terms of their investment attractiveness to venture capitalists, receive support.

The three objectives regarding the type of spin-out created are also not necessarily orthogonal. We can conclude that if a RI wants to efficiently support the three kinds of spin-out activity, it might be more appropriate to adopt the three models in parallel. For instance, a central unit can be set up to stimulate entrepreneurial activity in a broad sense and support students, researchers and professors from either pure, applied or social sciences to set up a company. In parallel the technology transfer unit might develop a path to create value from technological opportunities through spin-outs. Finally, the RI might be leading in a certain technological domain for which it creates a specific spin-outs support group which focuses only on the creation of VC-backed spin-outs. This could be pursued while referring the less

mature projects to the interface unit, as in the universities of Twente in the Netherlands in our reference sample and Oxford and Warwick in the UK in our validation sample (see below).

ROLE OF THE LOCAL ENVIRONMENT

In describing the different innovation activities and organizational resources of the RIs in the three models, few references were made to the local environment which influences how these models work. In this section, we analyze the interaction of these three models with the local environment and then proceed in the following section to externally validate whether the same models are found in similar environments in Europe.

Our research shows that the drivers behind the low selective model are related to regional development and regional job creation. Most prior US work that has focused on the link between university and spin-outs has largely overlooked this employment argument. The reason seems to be that US spin-out studies usually depart from the premise that spin-outs commercialize tangible (read patented) research results developed at the RI (Shane and Stuart, 2002; Jensen and Thursby, 1998; Colyvas et al., 2002). European country specific studies such as Autio et al. (1996) have suggested a relation between the unemployment ratio and the number of spin-outs in a region. Starting up your own company is seen as a way to (a) get into employment as a graduate and (b) stay in the region as a highly skilled person. Since most of these companies tend to be service oriented and have a local market (Karnebeck, 2001), there needs to be a local demand for knowledge intensive services. Hence, this model can only exist if the local market of established firms is large enough. The Twente region in particular fits this unemployment idea. Although the region in a strict sense needed economic help and was classified as an objective 5 region by the European Fund for Regional Development, it is within only a one hour drive from Amsterdam and other industrial districts in the Netherlands. Service companies tend to be well located next to the campus and quite close to their customers. The Rhône Alpes (Crealys) region can also to some extent be viewed in this context.

The low selective model seems only loosely related to the trend in many European countries to change legislation on IP issues (in line with the US Bayh-Dole

Act, stipulating that universities own the IP of research developed by its employees). This legislation indirectly encourages universities to take patents. In Europe, this has initially led to increases in patenting. In contrast to the low selective model, the supportive model is likely to benefit from these changes in legislation (Colyvas et al., 2002) since it is based upon IP developed within the RI. However, the two role models selected in this paper have not obtained such benefits, at least not in a direct way. Leuven R&D already had an active patenting policy and internal regulation long before the Flemish government changed the legislation in Belgium. BioM is located in one of the only countries in Europe where the IP *does not* belong to the university. Therefore, it appears that legislation has not had an impact here. Instead, Leuven R&D had already changed its structure and culture long before the legislation changed. This suggests that creating the right culture and structure to trigger the faculty seems to be the first step.

The supportive model seems to rely very much on the regional dynamic to function effectively. The technology transfer officers, who set up the companies with a local public/private seed capital fund make use of the local knowledge network to incubate the spin-outs in a market place. This is in line with previous evidence regarding the functioning mechanisms of high tech regions. Shane et al. (2002) for instance emphasize the role of personal networks in the search for venture capital by MIT spin-outs. They find that having personal contacts with these VC-funds significantly increases the company's probability of survival. Suchman (2002) stresses the important role which social networks play in the Route 128 and the Silicon Valley environment. He especially points to the knowledge intensive business service providers (e.g. specialized legal offices, patent attorneys) as drivers of innovation in these clusters. They tend to form the glue between these different high tech spin-outs. Hence, this kind of spin-out service might be dependent upon the local high tech environment. Both the Munich and Leuven area are very dynamic high tech regions in which Leuven R&D and BioM are only one actor. Next to them, we observe the existing of important public involvement (eg Bayern Kapital, State of Bavaria, Tbg and KULeuven), presence of R&D intensive, more established companies (eg. BMW, Siemens, HP/Agilent, LMS and ICOS), networking initiatives (e.g. Leuven Inc).

Finally, the Incubator is a local actor in a much broader worldwide environment, both in terms of deal inflow and outflow. Typically the research team of

this organization is specialized in a narrow technological field and is well-known and respected in this field. For example, IMEC has a worldwide reputation in terms of micro-electronic research. This makes the organization not only respected in the field, it also attracts highly talented researchers to join the organization. Scientific Generics even plays this worldwide technology role in a more pronounced way. It encourages research teams all over the world, specialized in biotech or electronics, to join the organization. Also in terms of outflow, these organizations tend to be less dependent upon the local environment. The majority of their spin-outs are started with professional venture capital, often syndicated at an international level. Hence, it is not the local social network that seems to be important here but the international contacts with professional early stage VC funds. In the period between inflow and outflow, the project is managed internally. Again, contacts are made at an international rather than a local level (e.g. by licensing in from international partners).

Despite the observations made above, TTP and Scientific Generics are located in Cambridge UK and IMEC in Leuven, which *are* high tech regions. It seems that the origin of these institutes play a role. Scientific Generics was created by Gordon Edge, who had built up his experience in this Cambridge environment before starting Generics. IMEC on the other hand was the result of a political decision to create better value from research on micro-electronics at the Flemish universities. It thus seems that "research excellence" often lies at the origin of these institutes, but the local environment interacts less with them downstream in the value chain. Of course the critical mass of research graduates in the universities surrounding them remains an important factor.

VALIDATING THE THREE MODELS IN DIFFERENT ENVIRONMENTS

To validate our three models we compare them with interface services randomly selected in the 13 European high tech regions identified above. The resources and activities were listed for each of these RIs and compared to the resources/activities described above for each of the models. This exercise was based on data collected by the local experts and performed in a group discussion which included both at least two of the researchers in our team and the local expert who had identified the interfaces in his region and who had performed the interview. The distribution of the types of models identified in the validation sample is shown in Table 6.

Departures from reference models: During this exercise, it became clear that many RIs (24 cases, 56% of the total number) differ quite notably from each of the three models discussed above (see the diagonal presented in Figure 2). From the data we concluded that two broad kinds of deviation occur. First, we observe a group of interfaces which are quite ambitious, but which do not have the resources to realize their objectives. We labeled this group the "resource deficient" interfaces. Second, we observe a number of interfaces that *have* the resources to implement one of the above models, but which do not have sufficient ability to perform the activities needed to build up a successful interface service (regardless the model); we labeled these RIs as "competence deficient".

The *resource deficient* group includes those spin-out support services with high ambition in terms of objectives (e.g. they want to realize as many highly capitalized spin-outs as possible) but which lack the resources to realize these ambitions. In our sample 42% (18) of the cases surveyed were resource deficient. The deficiency in resources has a number of implications for the RI. First, they do not have the financial resources to make decisions autonomously from the university and invest in spin-out generation over a sufficient period of time. Second, they do not have the right mix of competencies or people in terms of experience and networking to deploy these activities. Third, they are not supported by a university board with an entrepreneurial orientation and/or they cannot rely on a strong regional infrastructure and network that supports innovation and enterprise. One or a combination of these factors produces structural shortcomings that eventually leads these spin-out services to be positioned as weakly supportive models, and therefore unable to generate the type of returns that were initially sought. The objectives in terms of spin-outs of these resource deficient models are usually not clear and tend to follow the visibly successful examples in their immediate region. For instance, the Flemish universities tend to look at the Leuven R&D model and mimic its ambition, even without having the key success elements of this model. These key success elements lie in its structure/culture (trigger for the professors/researchers) and its broader regional environment as well as in its unique resource base built up over a long period of time. Imitation of such a strategy without these relevant resources tends to be unsuccessful. These RIs, which are more limited in resources, do not try to set up a low selective model which requires less resources (at least in quantity) and generates a visible output in terms of numbers of spin-outs. It seems that the lack of clarity about the kind

of outcome possible within the culture/structure of the RI and the characteristics of the broader environment is the first reason why this hybrid type of organization exists.

Our research showed that 14% (6) of the cases were classified as *competence deficient*. Closer inspection of how these RIs were performing in relation to their stated objectives indicates a lack of knowledge in the form of competencies that have been developed to employ resources productively in activities that will eventually result in the economic and social returns desired. A number of RIs in our research illustrated this point and show what can happen if an RI is supplied with a large amount of resources in order to create what we have characterized to be the Supportive and Incubator RI models. Regional planners, policy makers and RIs themselves may desire the economically and financially attractive spin-outs these models produce. However, unless there is a supply of the requisite knowledge to acquire and integrate resources to create the required competencies it is impossible to fulfill this ambition.

Typically, it took time for the RIs in the competence deficient group to identify the activities required to produce the returns generated by the Supportive and Incubator models they wished to emulate and even longer to learn how to perform these activities. Performance of these activities requires specialized competencies that can only be developed over time. For example, at Scientific Generics learning has occurred over time by teams to develop these competencies which include creating technology platforms, performing business development and raising rounds of venture capital. As an alternative to developing competencies over time, some of the competence deficient RIs tried to shortcut this learning phase by acquiring specialists from other organizations that could supply the knowledge to build competencies. The reason these RIs continued to depart from the behavior seen in the normative models was because they lacked the ability to integrate and coordinate these competencies efficiently enough to produce results reflecting their desired objectives. This was especially the case for some of the RIs in this category. These RIs can best be described as being “in transition” from one normative model to another. Having already decided to adapt from one normative model to another, their current state of evolution has left them in a position somewhere in between the two. This has resulted in an inability to deliver returns characterized by either of the normative models.

Using a chi-squared test, we do not find any indication that the prevalence of any model is higher in one specific region or country under study. Further, the

resource deficient models tend to be associated with RIs that might be just below critical mass in number of researchers (see Table 3). The RIs tend to cover all technological domains (and social sciences) which might spread their resources too thinly to achieve a critical mass in any one domain. Again, a critical mass of technological resources tends to be the starting point of a successful interface model.

Taken together, the RIs falling into each of the two categories that departed from the normative models failed to achieve their intended objectives. In many cases, inexperienced practitioners and ill-informed policy makers set out with the objective of creating economic growth and development by producing large numbers of "high-value" spin-outs. Typically, these high-value spin-outs are characterized as high-tech ventures that are expected to generate high levels of financial returns for investors and entrepreneurs as well as highly skilled employment growth for the region. In reality, the spin-outs emerging from these RIs tended to be under-capitalized with little or no growth. This emphasizes our earlier observation concerning the orthogonality of the different models that there is an inherent conflict in trying to create "self-employment", "economically profitable" and "exit" oriented spin-outs through one business model.

Those RIs that do create high value or financially attractive spin-outs have acquired specialized resources and developed competencies over time that are focused on creating a small number of ventures that do have the capacity to eventually become established corporations. They have built up an international social network to attract top-level researchers and to team up with venture capitalists downstream. In this process, a lot of economically viable projects are not supported because the organizations decide it is not worth supporting them or it is financially more attractive to license out the technology to an established partner. Self-employment oriented projects are not considered, which appears to be a deliberate strategy. The supportive model is less selective, but still looks for economic profitability oriented companies with a reasonable growth potential and time to break even. They support projects at a point when no financial investor, except possibly a business angel or public fund, would be interested. The drawback is that this approach might be too slow for certain exit oriented projects which might require more resources and a speed up of the time to market from spin-out. Incubator models are not well suited to evaluate these projects since they typically do not find VCs to syndicate with. This means that often

these companies have difficulties finding follow up money (first round financing) if the initial starting capital is not sufficient to cover the time to breakeven.

Performance Indicators: Indicators of performance for the validation cases were available in terms of cumulative number of spinouts and number of spinouts per 1000 researchers in 2002, amount of capital raised and new jobs created per 1000 researchers. As shown in table 6, while most groups perform as expected on the basis of the reference groups the performance indicators of the low selective model in the validation sample are lower than expected based upon the reference cases of Crealys and Twente. On closer inspection we note that although the RIs in the validation sample have resources and activities in line with their objectives the extent of public funding to facilitate spin-outs varied between RIs in this group and tended to be less than in Crealys and Twente, the low selective reference models. The availability of public money invested directly in start-ups and without expectations of financial returns seems to be key to realizing maximimum results in the low selective model. Hence, although several Irish spin-out services in the validation sample in particular clearly adopted a low selective model, they tended to be less effective in terms of performance than Crealys and Twente. In line with the Twente model, adding a small public grant to individual entrepreneurs might double their performance and achieve a more ambitious objective. As suggested in the discussion of the reference model cases, we find that the RIs that apply the supportive model score very well in terms of number of spin-outs per year and new jobs created. They have, however, a lower track record than the Incubator model cases, which create the same amount of jobs per year and raise more capital with far fewer spin-outs.

INSERT TABLE 6 NEAR HERE

The resource deficient model cases have a lower number of spin-outs, create fewer jobs and raise only a limited amount of capital, reflecting the problem arising from their aim to create a supportive model but their not having the resources to do this successfully. The result is that the performance of this large group of spin-out services is far below the performance of the low selective group, which needs less resources (at least in a quantitative sense).Increasing critical size through collaboration between RIs might be an option to increase performance. Alternatively,

individual RIs can change their strategy and adopt a low selective model, which is less resource demanding.

Reflecting the problem that the competence deficient model cases lack knowledge in the form of competence that must be developed to employ resources productively in activities, these cases have a quite low number of new jobs created and raise only a very limited amount of capital.

SUMMARY AND CONCLUSION

This paper has identified three types of spin-out models that have proven their efficiency. The first model supports the creation of self employment oriented spin-outs. These companies are predominantly service oriented. Many of them are created by students or young researchers based on the knowledge they have acquired at the RI. The second model stimulates the creation of economic profitability oriented spin-outs. These spin-outs might be growth oriented, but usually start with some kind of service or consulting model to limit the time to breakeven. Many of these companies target a specific niche market. They tend to start up based on a technology developed at the RI. Because of broader societal reasons or because it is incentivized by the local political environment, this RI might prefer to create a local spin-out over licensing the technology to a foreign multinational. Usually, the question whether this spin-out can survive in an economic way is central in the decision to create a spin-out. This is different for the third type, where financial gain from an eventual exit is paramount. A spin-out might be a very profitable company but completely unattractive to a potential investor because the amount of money needed is too small to be efficient or the market is simply too small to generate the multiples expected by a financial investor. For the latter kind of companies, the third model seems to be the most efficient.

It is important to note that the models differ not only in terms of the amount of resources, but also in the kind of resources, required. This means that *if* an RI has relatively few resources to deploy, it should deploy them in a different way. For example, in a relatively poor resource environment, the low selective model might be the most feasible. However, it appears to be inappropriate to acquire/generate the resources required to perform a supportive model and then try to perform activities associated with a low selective model or vice versa. This helps to explain why we observe a considerable number of resource deficient interface services in the random

validation sample. They appear to be trying to emulate one pure type of model, but do not have the necessary resources to do so successfully. This implies that it is important for RIs to be very clear about their objectives and specify clearly the resources that are needed/activities performed to meet these objectives. Our data suggests that lack of clarity about the objectives results in hybrid types that can be either resource or competence deficient.

Our research suggests that the growing body of accounts of 'successful' technology transfer models in the academic literature may be mis-specified for three main reasons. First, many accounts fail to consider initial goals, strategies employed and eventual outcomes, which limits our understanding of the processes. It is only when a RI's technology transfer strategy is analyzed in relation to its intended goals and environmental factors that we can fully judge its success. If a RI wants to stimulate the three different types of spin-outs identified here, it will probably need to have three different mechanisms among which there will only be a relatively small amount of overlap. This implies that these three models can co-exist in one RI. It means, however, that the trajectory of a project will have to be managed from the very beginning. If a RI has an objective to create significant numbers of spin-outs a year and is organized as an incubator model, then we can predict that this will not work. On the contrary, if it is only interested in financially attractive spin-outs and is organized as a low selective model, again the model is likely to lead to the achievement of objectives. Future research should give us a better insight into how these models can co-exist in one or a few RIs in the same regional environment. Second, a focus solely on improving the technology transfer function fails to take into account the importance of changing the organizational culture within RIs and establishing local environments that are supportive of entrepreneurship. Changing these last two aspects are monumental tasks compared with developing support mechanisms. Third, there is a failure to appreciate that schemes which are successful in one environment, region or context cannot be merely imitated in another. The environments found in and around Boston (USA), Cambridge (UK) and Southern California are atypical, and can be argued to act as "regional incubators". While these are often cited as models to emulate, the research in this paper suggests there may be major insurmountable barriers to their successful adoption in different environments.

Our research suggests that by looking at the potential points of discontinuity in the incubation process of spinning-out new ventures it is possible to identify

important questions, which those designing, running and evaluating schemes need to address. These fundamental questions are:

(i) The size, experience and professionalism of those undertaking the technology transfer function. These will determine the scope and intensity of the support activities that are possible.

(ii) The degree of interaction and the nature of the relationship between those undertaking the technology transfer function with departments. This will influence the likely pool of ideas.

(iii) The type(s) of spin-out companies that are catered for.

(iv) The organizational culture both within the technology transfer function and individual departments, i.e. whether it is supportive or hostile to spin-out activities. This will influence how much the TTO needs to do in creating awareness and encouraging entrepreneurship.

(v) The types of spin-out not catered for. The environment (context) in terms of the support infrastructure and availability of financial resources and the extent to which the technology transfer function (or individual departments) are embedded in the environment.

Finally, a number of limitations and areas for further research can be noted. First, examination of the broader technology transfer strategies of the RIs was beyond the scope of this study. There was some evidence that the Supportive and Incubator models tend to be embedded in a broader technology transfer strategy. Further research might usefully examine the establishment of the focus of technology transfer strategies and the balance of spin-outs versus other modes of technology transfer such as licensing and contract research. Our research suggests that the type of model adopted for spin-out incubation has a direct impact on output variables such as the number of spin-outs and total jobs created. Since successful spin-out performance tends to be rare, it might be that for some RIs (for instance resource deficient ones) spin-outs are a poor choice to commercialize their research results. Particularly when forming a company means that all IP is transferred to the spin-out, this choice has important implications for further licensing and contract research possibilities of the RI.

Second, an important issue in encouraging academics to undertake different types of spin-outs relates to both their skills and incentives. Our research indicated that in the supportive model the availability of a structural and cultural mechanism to

incentivize academics to engage themselves in contract research activities was a key element. Also in the low selective model, the "entrepreneurial culture" of the university seemed to be a key element. It is, however, questionable whether the entrepreneurial culture of the RI in the Low Selective model is similar to the one stimulated in the Supportive model. In the first, start-ups relate to the activities adopted by the entrepreneur as an individual agent, while in the supportive model, the academic only plays a role in the start-up process without being the single actor. This is in line with the contemporary notion of entrepreneurship, and science based entrepreneurship in particular, which is shifting from serendipitous and individual to being perceived as social and organized (Jacob et al., 2002 ; Moray and Clarysse, 2003). Further research may usefully examine how structural changes can be made and which cultural transitions are necessary to select and incentivize new academics towards entrepreneurial activities.

Third, although we attempted to take account of dynamic aspects, given the nature of the sector the spin-out process in many RIs is still evolving. Further research might examine the extent to which the three incubation models are sustainable in each institution and the extent to which the resource and competence deficient cases are able to overcome barriers to the successful development of spin-outs. Most of the spin-outs in the Supportive model under study are still quite young and were created in an advantageous economic climate. They have to prove their survivability in a less supportive environment. Equally, few spin-outs from the Incubator models studied have so far realized successful trade sales or IPOs. It will be interesting to analyze how the incubator model adapts itself to potential failures in the outcome of its spin-outs.

Fourth, we have been able to provide only limited data on performance metrics relating to the companies spun out from RIs' as data collection by many RIs is at best patchy. This makes it necessary in future research not to rely solely upon the data provided by the RIs concerning their spin-outs. Additional research using the spin-out firm as the level of analysis would enable more robust metrics to be identified and analyzed.

Fifth, there is a need for further analysis of the link between spin-out model and the range of industries that are appropriate to each case. The Incubator models that were identified in our research are related to RIs in biotechnology and microelectronics. It is not clear whether we would find the same models in IT related

sectors or nanotechnology. In addition, most RIs – even universities which cover all disciplines - have one or two technological domains in which they excel. This might interact with the most appropriate spin-out model for them.

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Table 1: Research Institutions and Regional Economic Data

Name of Scientific Regions of Excellence in Europe	GERD as a percentage of GDP, 1998	Number of patents applications per capita, 2000	Number of high-tech patents applications per capita, 2000
Vlaams Gewest	1.9	159.6	26.8
Région Wallonne	1.9	134.9	12.6
Baden-Württemberg	3.8	527.4	57.5
Bayern	2.7	480.6	124.0
Hessen	2.2	350.4	31.5
Ile-de-France	3.4	296.3	68.1
Centre-Est (Rhône-Alpes)	2.3 (2.3)	197.2 (221.3)	32.7 (39.5)
Northern Italy (Nord Ovest, Lombardia, Nord Est, Centro)	1.4	104.6	8.0
Oost-Nederland	2.0	136.3	17.2
Zuid-Nederland	2.3	521.7	192.9
East Midlands	1.8	114.3	15.5
Eastern (East Anglia)	3.6	238.8 (309.9)	77.1 (120.2)
Southern and Eastern Ireland	1.4	103.6	28.8

Table 2: Characteristics of Reference models

Name of Scientific Regions of Excellence in Europe	Name of RI that met the selection criteria	RI's Objectives in creating spinout ventures	Number of spin-out companies (period 1995-2002)	Trigger
Vlaams Gewest	Leuven R&D	Stimulating economical profit oriented spin-outs"	27	Flexibility, financial return
Vlaams Gewest	IMEC	Stimulating exit orientedspin-outs	12	Central Decision
Bayern	BioM	Stimulating economic profit oriented spin-outs	30	Financial return
Centre-Est (Rhône-Alpes)	Crealys	Stimulating self-employment oriented spin-outs	31	Entrepreneurial spirit
Oost-Nederland	Twente	Stimulating self-employment oriented spin-outs	60	Entrepreneurial Spirit
Eastern (East Anglia)	Scientific Generics	Stimulating exit-oriented spin-outs	9	Cultural Issue
Eastern (East Anglia)	TTP	Stimulating exit-oriented spin-outs	7	Central decision

Table 3: Key figures on 43 validation cases

	Number of cases		Number of researchers	People employed at the technology transfer service	Technological focus	Age
Low selective	10	Average	1462.6	5.3	No	7.2
		Median	1737	3		8
		Maximum	3000	15		15
		Minimum	46	1		2
		Standard deviation	1060.54	4.58		4.99
		Researchers/TTS people		274.2		
Supportive	7	Average	1808.1	6.9	No	5.3
		Median	745	4.5		4
		Maximum	11700	25		20
		Minimum	120	1		1
		Standard deviation	2902.19	6.59		5.01
		Researchers/TTS people		262.3		
Incubator	2	Average	1928.3	10.6	No	12.2
		Median	1720.5	10		8
		Maximum	3000	16		30
		Minimum	1024	2		3
		Standard deviation	817.81	4.89		10.09
		Researchers/TTS people		182.4		
Resource deficient	18	Average	1678.3	4.2	No	6.3
		Median	1175	3		5.5
		Maximum	4950	10		15
		Minimum	70	1		2
		Standard deviation	1836.79	3.56		4.63
		Researchers/TTS people		399.6		
Competence deficient	6	Average	550	12.5	Yes	5
		Maximum	750	15		8
		Minimum	350	10		2
		Researchers/TTS people		44.0		

Table 4: Activities Undertaken by the Different Models

Activities	*Low selective model* **Based upon Crealys and Twente**	*Supportive model* **Based upon Leuven R&D and BioM**	*Technology Incubator model* **Based upon IMEC, TTP and Scientific Generics**
Opportunity search and awareness creation	Rather passive, relies on entrepreneurial university	Passive; might organize a business plan competition; attracting business plans rather than ideas; relies on the reputation of the fund	Active opportunity seeking worldwide
Strategic choice how to commercialize R&D	Selection criteria are extremely low. Maximize the number of spin-outs	Among the selection criteria, growth orientation is important. But, remain lower than in private VCs	Selection criteria resemble those of the VCs
Intellectual property assessment and protection	Emphasis on commercializing technology through patents	Support in patent and license negotiation with the industry	TTO will acquire an IPR platform (not limited to one patent) at an early stage
Incubation and business plan development	Projects are offered space at the research center or university	Incubation center and Science park ; Specialized support available out house at market prices	'In house' incubation and support at all stages of the spin-out process and to a high level
Funding process	Small amounts, Ranging from €15 000 to €100 000, under the form of public grants	Public private equity fund, ranging from €250 000 to €350 000	VC money, ranging from € 1m to € 4m
Control over the spin-out process after spin-out of the spin-out company	Project is started at a pre-founding stage. All types of spin-out are selected	Spin off company is start up at a very early stage	Spin off company is start up in a late stage and with an experienced management team

Table 5: Resources Required by the Different Models

Resources	*Low selective model* **Based upon Crealys and Twente**	*Supportive model* **Based upon Leuven R&D and BioM**	*Incubator model* **Based upon IMEC, TTP and Scientific Generics**
Organizational resources	Public organizations, linked with universities	Private organizations linked with universities	Center of excellence, close link with industry
Human resources	Small team, familiar with public sector	Larger (5-7 persons) multidisciplinary team, with links to the financial world to be able to evaluate the business plans	Experienced professional staff. Able to draw upon 'in house' specialists
Technological resources	No technological focus or specialisms	Focus on the best performing departments of the universities Mainly applied research	Relatively narrowly focused on particular specialisms in which it has a wealth of experience
Physical resources	Offer office space and infrastructure within the universities	Offer office space and infrastructure within an incubation center, at market prices	Internal research space and infrastructure is offered for free
Financial resources	Need a large amount of public money to offer at the spin-outs	Need to set up an associated fund with public/private partners	Invested money is private money, the TTO may have its own VC fund
Networking resources	Entrepreneurial climate within university or research center is very important	Entrepreneurial context is very important	Entrepreneurial context is scarcely important

Table 6 : Performance metrics in validation cases

Variable	Low Selective N= 10	Supportive N= 7	Incubator N= 2	Resource Deficient N= 18	Competence Deficient N= 6
Spin-outs 2002 (per 1000 researchers)	5.8 (3.9)	6.0 (6.1)	2.6 (0.0)	3.6 (5.9)	0.9 (0.4)
New Jobs Created (per 1000 researchers)	132.9 (36.8)	308.7 (299.3)	346.0 (112.2)	95.9 (133.6)	16.3 (14.0)
Total Capital Raised (in million)	2.5 (1.8)	20.6 (44.5)	20.5 (2.4)	1.3(0.7)	0.6 (0.5)
Total spin-outs since proactive spin-out policy implemented per RI	43.7 (39.6)	54.0 (18.8)	3.0 (0.0)	14.7 (18.2)	11.3 (16.2)

Figure 1: The spin-out funnel

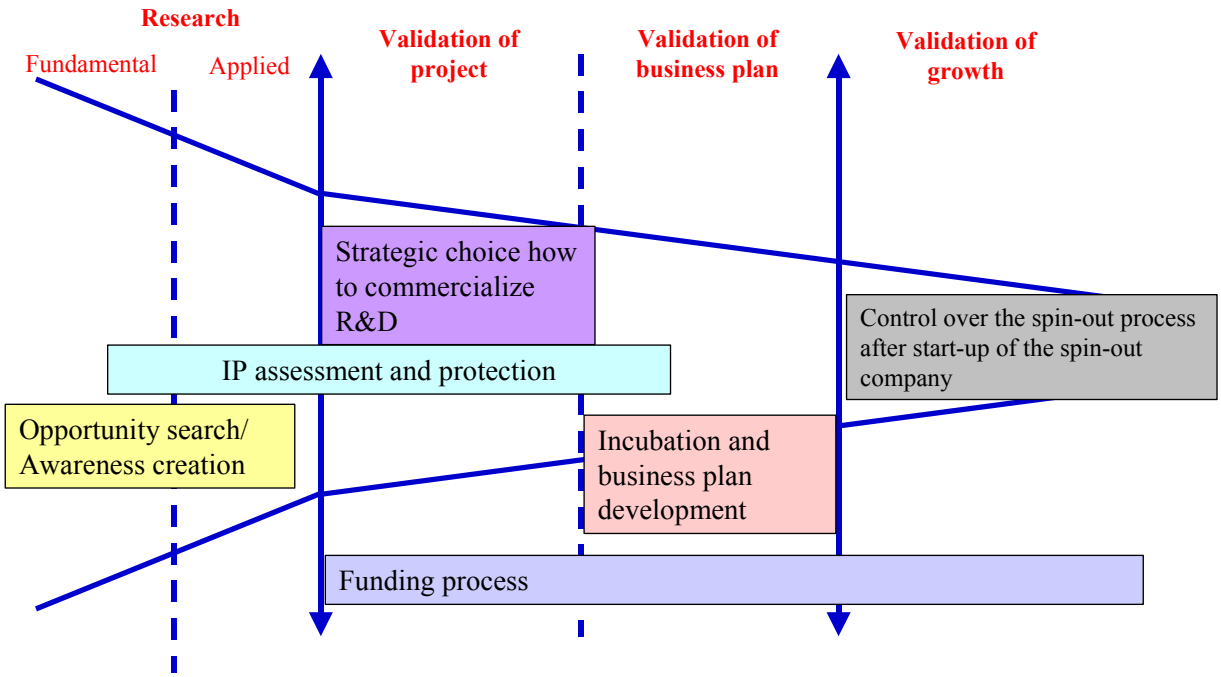
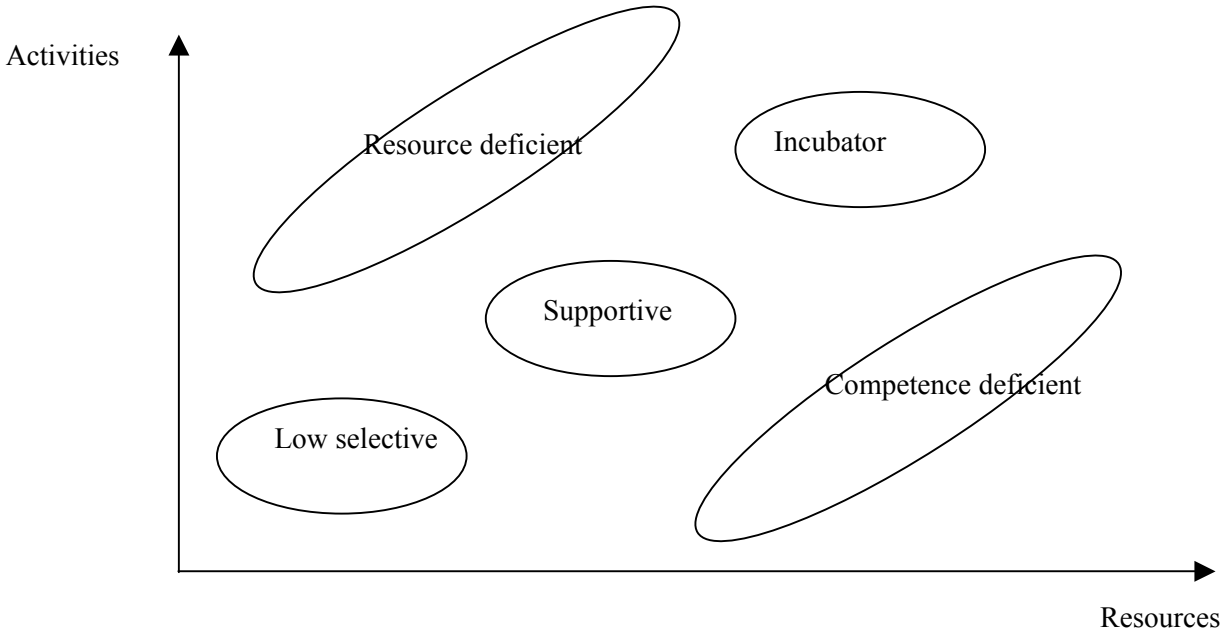


Figure 2: Typology of spinout strategies and outcomes



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