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, seven spin-out services in five European countries were selected for analysis. At the time of the study, each research institute under analysis had only one unique way to stimulate spin-outs. Therefore, the spin-out service and the particular Research Institution they are associated with are interchangeable as units of 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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Keywords: Spinning-out companies; Low Selective model; Supportive model; Incubator model
1. Executive summary

This paper explores the different incubation strategies of spinning-out companies employed by European Research Institutions. We focus on two central research questions: (i) What differences are there in the goals and objectives 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?

A two-stage approach is used. First, seven established and successful spin-out services in five European countries were selected for analysis.

An in-depth analysis of the seven cases identified three distinct incubation models of managing the spin-out process: Low Selective, Supportive, and Incubator. Each model 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. 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. 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. We term the spin-outs resulting from this Incubator model “exit oriented”, since the exit possibilities provide the financial opportunity.

We identify resource differences relating to finance, organization, human resources, technology, network, and infrastructure in each model. 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.

In the Supportive model, well-functioning IP department and contract research unit tend to be key. The technology-transfer unit can only use the leverage afforded by the contract research 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 20 persons is needed. In addition, the spin-outs tend to need external capital at a very early stage. Therefore, public private partnerships are set up to invest in these seed or even preseed ventures.

Finally, in the Incubator model, 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 3 years) because 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. The Incubator model will carefully prepare this type of venture using a number of milestones before a final go decision is given.

Forty-three 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, but 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 that make it extremely difficult to attract external capital for spin-outs. Finally, the board of the research institute commonly expects spin-outs to be profitable and exit-oriented to realize any financial gain. The Competence Deficient spin-out unit, therefore, faces an objective for which it lacks the necessary skills and competencies.

2. Introduction

Spinning out new ventures from public- or university-based research institutions (RIs) is a long-established phenomenon (Mustar, 1995). However, only recently have RIs previously lacking any entrepreneurial orientation devised proactive policies to stimulate the commercial exploitation of public research through spin-outs (e.g., Callon, 2001; European Commission, 1998; Siegel et al., 2003). In parallel, changes in the institutional environment have facilitated such a policy, including introduction of laws to assign ownership of intellectual property to RIs, loosening of employment laws to allow public sector researchers more contact with the private sector, and initiatives to provide early stage spin-out capital.

Commercializing knowledge from RIs via spin-out companies has become increasingly popular, but understanding of the phenomenon remains limited. The processes employed by RIs in the spinning-out of companies lack clarity. Various studies explain the reasons for starting spin-out services (Smiler et al., 1990; Mustar, 1997) or the difficulties in starting this kind of service in a university context (Steffenson et al., 1999), but few highlight the processes through which these services take place. This issue is compounded, as many RIs have traditionally operated in an environment where high-tech entrepreneurship is relatively new. Roberts and Malone (1996) stress that the spin-out process from RIs will be very different in this context compared with more developed high-tech entrepreneurial environments such as Boston or Silicon Valley (Roberts, 1991, chap. 3; 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 that is not dependent on the activities of the parent RI, but benefits from high levels of innovation within the surrounding region. 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 few other key resources, RIs may need to play a more proactive 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 spinning-out companies can utilize a range of support activities designed to provide the venture with the resources and capabilities needed 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 RIs 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 cases were drawn from Europe and have a proven, 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 paper is structured as follows. First, we explore the spin-out process 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. Fourth, we discuss the nature of these models in terms of their strategies and their performance outcomes 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.

3. 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 (2004) suggest that the founding of a spin-out can be seen as a process in which three different stages can be distinguished (see Fig. 1). The first, “invention” phase, is a period during which technical uncertainty prevails. In the second, “transition” phase, technical uncertainty becomes more limited and the business idea is validated. Finally, is the validation of growth expectation phase or “innovation” phase. The process is represented as a funnel because only a few research ideas from the invention phase will become validated as having an economic value for a spin-out. During the transition phase, still fewer business ideas will exhibit growth expectations and enter the innovation or business development stage (Branscomb and Auerswald, 2001).

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, that is, for the parent to perform an incubation role. Although the term incubation has traditionally been narrowly focused on property-based initiatives, such a definition excludes what are arguably the most important elements of facilitating support and resources required by spin-out companies (Lockett et al.,
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 involves examining choices between options of licensing and commercializing through a spin-off venture. Third is the selection of the spin-off projects based on their intrinsic potential and on the comparison with alternative projects. Fourth, business plan development is necessary. Fifth, RIs then need to channel their spin-outs towards potential source(s) of funding. Sixth, once funding is obtained, the venture can formally be incorporated, and spin-out coaching undertaken. 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 of RIs.

Deficiencies in spin-outs’ initial resource endowments constrain new venture development (Shane, 2001) and may be exacerbated by an unentrepreneurial environment. Spin-outs need to develop their resources over time to progress through the different phases of development and create significant wealth (Penrose, 1959; Barney et al., 2001). Following Brush et al.
(2001), six types of resources can be identified as key to the spin-out process: human, social, financial, physical, technology, and organizational.

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.

4. Methodology

A two-stage methodology is employed. First, a qualitative approach is used to identify and explain different incubation models of the organization of university spin-out activity. Second is the empirical validation of the different incubation models we develop using a larger sample of institutions across the EU.

4.1. 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 relevant literature is U.S. centered, making hypothesis formulation and testing premature for the questions of interest. Despite the growing interest in the commercialization of research, 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 to obtain a rich understanding of how USOs evolve from research activities into commercial organizations. The multiple case design permits a replication logic (Yin, 1994), 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 the roadmap of steps/activities of Degroof (2002) to analyze spin off processes and the bundle of resources of Brush et al. (2001), which seem to be crucial in organizing spin-out activities.

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 geared towards spinning-out ventures and the context in which resources are employed. 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. 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
According to the European Report on Science and Technology Indicators (1994, p. 152, 1997), the NUTS2 level, which is the first level below the country level, usually corresponds to the administrative organization. The NUTS2 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: 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).

Table 1
Research institutions and regional economic data

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

Even the most R&D intensive region in the EU is not as intensive as comparable regions in the United States. According to the European Report on Science and Technology Indicators (1997), California and Massachusetts 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, equivalent to the median U.S. state. In contrast to U.S. 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.

A research network was created with local university researchers from each region involved in the study. Each researcher was asked to identify, for their region, technology-
transfer units associated with universities or public research institutes according to the following criteria: (1) they needed to be founded 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 was based on data collected through telephone interviews. Seven cases matched 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.4 At the time of data collection, these seven RIs had only one centrally organized model of spin-out support. Therefore, there was a linear relation between the mode of spin-out support, the RI and the type of spin-out stimulated. 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 identified through our interviews: (1) degree to which the spin-outs 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; (4) the target market; and (5) the forecast time to break even; (6) whether the spin-out received venture capital. Respondents were asked to rank the nine outcomes in terms of the TTO mission with respect to spin-outs.

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Table 2
Characteristics of reference models

<table>
<thead>
<tr>
<th>Name of scientific regions of excellence in Europe</th>
<th>Name of RI that met the selection criteria</th>
<th>RI’s objectives in creating spinout ventures</th>
<th>Number of spin-out companies (period 1995–2002)</th>
<th>Trigger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vlaams Gewest</td>
<td>Leuven R&amp;D</td>
<td>Stimulating economically profitable oriented spin-outs’’</td>
<td>27</td>
<td>Flexibility, financial return</td>
</tr>
<tr>
<td>Vlaams Gewest</td>
<td>IMEC</td>
<td>Stimulating exit-oriented spin-outs</td>
<td>12</td>
<td>Central decision</td>
</tr>
<tr>
<td>Bayern</td>
<td>BioM</td>
<td>Stimulating economically profitable oriented spin-outs</td>
<td>30</td>
<td>Financial return</td>
</tr>
<tr>
<td>Centre-Est (Rhône-Alpes)</td>
<td>Crealys</td>
<td>Stimulating self-employment oriented spin-outs</td>
<td>31</td>
<td>Entrepreneurial spirit</td>
</tr>
<tr>
<td>Oost-Nederland</td>
<td>Twente</td>
<td>Stimulating self-employment oriented spin-outs</td>
<td>60</td>
<td>Entrepreneurial Spirit</td>
</tr>
<tr>
<td>Eastern (East Anglia)</td>
<td>Scientific Generics</td>
<td>Stimulating exit-oriented spin-outs</td>
<td>9</td>
<td>Cultural Issue</td>
</tr>
<tr>
<td>Eastern (East Anglia)</td>
<td>TTP</td>
<td>Stimulating exit-oriented spin-outs</td>
<td>7</td>
<td>Central decision</td>
</tr>
</tbody>
</table>

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4 We thank an anonymous reviewer for this suggestion.
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 1 year; and (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; and (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; and (6) all received private VC money.

The results of this exercise are included in the objective section of Table 2.

Data on each case were collected through 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. Using a structured questionnaire, we assessed to what extent and how each spin-out service was organized or was engaged in the particular activity.5 We also analyzed the resources developed to organize these activities on the bases identified by Brush et al. (2001) outlined above. We examined to what extent the resources that were present were crucial to organize the activities described above.6

4.2. Stage 2: validation of model

To validate the models 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 these 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

5 Details relating to the activities undertaken by each case are available from the authors.
6 Details relating to the resources of each case are available from the authors.
a spin-out strategy, but did not necessarily meet the three different criteria used as selection conditions in Stage 1.

Data were collected on each RI as for Stage 1. 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).

### Table 3

<table>
<thead>
<tr>
<th>Key figures on 43 validation cases</th>
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<tbody>
<tr>
<td>Number of cases</td>
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<tr>
<td>-----------------</td>
</tr>
<tr>
<td><strong>Low selective</strong></td>
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<td>10</td>
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<tr>
<td><strong>Supportive</strong></td>
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<td></td>
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<tr>
<td><strong>Incubator</strong></td>
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<tr>
<td><strong>Resource deficient</strong></td>
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<tr>
<td>18</td>
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<tr>
<td><strong>Competence deficient</strong></td>
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<td>6</td>
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</tbody>
</table>
5. Models of spinout activity

Based upon the data collected in Stage 1, three models of spin-out activity were compiled: (a) low selective model; (b) the Supportive model; and (c) the Incubator model. The following section outlines these models, distinguishing in turn the activities undertaken and resources required.

5.1. Activities

This section analyzes for each model 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.

5.1.1. The low selective model

This model is based on a natural selection process. The University of Twente (TOP case) in the Netherlands and Crealys in France are prime examples of this model. The region surrounding the University of Twente was confronted in the mid-1980s with relatively high levels of unemployment. The university deliberately chose to play a major role in the rejuvenation of the region by engendering an entrepreneurial climate and promoting itself as the “entrepreneurial” university. 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.

5.1.1.1. Opportunity search and awareness creation. The “opportunity seeking” activities are mainly oriented towards raising entrepreneurship awareness among researchers and/or students at the RI. Twente refers to the entrepreneurial mission of its parent university as a main driver of spin-out activity (Karnebeck, 2001). 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 easier to incentivize them than a tenured professor to start a business. As a result, many businesses are started by end-of-contract researchers and students who have just graduated. Spin-outs present an alternative to employment at an established firm.

5.1.1.2. 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. The spin-out services in the Low Selective model only give advice during the phase of project validation. In both model cases, this approach results in a high selection rate. In the last 2 years, Crealys received 160 projects, of which the selection committee approved
Table 4
Activities undertaken by the different models

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

Over the last 2 years, Twente selected approximately 60 projects out of 130 applications (Karnebeck, 2001). In both cases, the formal representation of the project plays a larger role than the practical test of the assumptions. Crealys selects projects on two criteria. First, they have to be based upon technical developments; and second, they have to be willing to cooperate with the RI they spin-out from. No economic or financial criteria are included in the selection process.

5.1.1.3. IPR assessment and protection. Proprietary technology is unlikely to be the key trigger to spin-out a company. In Twente, there was a patent owned by the university in only 7% of spin-outs founded after 1980. This percentage might be higher for more recent spin-outs since active patenting among university institutes is quite new. But it may also

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7 Annual Report of ‘les incubateurs publiques’.
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.

5.1.1.4. Incubation and business plan development.  Spin-out support focuses mainly on the validation phase of the project when there is no need for a large infrastructure or business space. In both Crealys and Twente, space is available within the university or research laboratory facilities.

5.1.1.5. 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), which are typically regarded as a means of subsistence rather than as spin-out capital (Karnebeck, 2001). Crealys invests in spin-out companies during the phase of validation of the project, up to a maximum of €100,000 per project.

5.1.1.6. Control of the spin-out process after start-up.  Spin-out companies are selected at a very early stage and coaching is focused upon this stage. The consequences of this model are that a variety of businesses are selected, many of which will be small, with low levels of capitalization. In Twente, the average number of jobs per company after 10 years was six, 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.

5.2. Supportive model

This model takes its name from the extensive support given to the entrepreneurial team during the pre-start-up phase. The supportive spin-out model usually finds its origin in the rejuvenated technology-transfer policy of the RI. This model positions the spin-out as an alternative vehicle to commercialize technology vis-à-vis licensing out a patent. The Leuven R&D and BioM cases represent prime examples of the Supportive model. Although the Leuven R&D 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 the region. The nearby university and the presence of IMEC (see below) had resulted in several high-tech spin-outs and had attracted several technology intensive companies in the science park, some of which were highly successful (Clarysse et al., 2001). The new university dean had been a founder of one of these success stories. In addition, many spin-outs had difficulties in surviving the first few years. To support these companies and enhance the creation of spin-outs in a more consistent way, the interface service was restructured and further professionalized.

BioM is located in the Munich area of Germany. Like Leuven, this area already had a history of high technology and spin-outs. 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.

5.2.1. Opportunity search and awareness creation

Leuven R&D hosts the contract research activities, the IPR activities and the spin-out support of the KUL. Most opportunity recognition happens in an indirect way. Usually, a professor seeks 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 tradeoff is made between licensing and the creation of a new spin-out. Professors are stimulated to perform contract research with forming a spin-out occurring at a much later phase of commercialization. BioM deploys a less formal model because it does not manage contract research or IPR activities. This shortcoming seems to be overcome by specialization on biotechnology and its attraction of well-respected scientific advisors in biotech where professors active in this domain recognize the importance of IPR. The attraction of these advisors increases the respect among the nearby professors and creates a considerable level of trust.

The trigger to spin-out 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 because 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, are assisted in employment relations and are allowed to pay 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.

5.2.2. Strategic choice how to commercialize R&D

Spinning out usually results from a tradeoff between licensing out the technology or creating a company based on the technology. There are clear selection criteria. Typically, the researchers have to prepare a business plan to be selected by the spin-out service. If the research team is interested in creating a spin-out, this option to commercialize the technology might be favored over licensing out the technology even if the benefits of a spin-out are not so clear. BioM received 130 project plans in the last 5 years but only invested directly in 28 spin-out companies. This results in an acceptance rate of about 25%, which is 10 times the acceptance rate of a typical VC.

5.2.3. IPR assessment and protection

The IP department is the heart of the technology-transfer service. 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, no technology platform is built through licensing-in pieces of technology to complement the existing technology.
5.2.4. Incubation and business plan development

Incubation and business plan advice are key activities in this model. The researchers are assisted in writing a preliminary business plan, which can be defended in front of a semipublic seed capital fund. The business plan is more artificial in comparison with the business case usually asked for by VCs or corporates before investing. Incubation facilities also include space and access to equipment. Support includes 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), which owns two incubation centers in the Munich area. 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 its board of directors, which serves as the main mechanism for providing informal specialized support and advice. Because it takes place through the board of directors, all advice is essentially free.

5.2.5. Funding process

This 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 is beyond the scope of either public funds and/or business angel support alone, but 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 only have an “individual case” profitability expectation, but see the fund as a “window on opportunities”. There is real financial screening, and business plans must be complete, comprehensive and validated. The fund tends to invest in earlier stages and invest lower amounts than a typical VC. The evaluation and monitoring approach adopted in this model is closer to a VC than to a business angel. The spin-out service will hold equity in the company after separation with the percentage of equity taken varying but seldom comprising a majority. For example, BioM takes on average 7% of the shares of a spin-out company.

5.2.6. Control over the spin-out process after start-up

Under this model, the amount of money available is limited and is usually only sufficient for a year. Most companies founded through this process are likely to seek complementary revenues through short-term contract research or consulting. In BioM, 35% of the spin-out companies have already received venture capital financing.

5.3. 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. IMEC,8 TTP9 and Scientific

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8 InterUniversity Institute for Microelectronics.
9 The Technology Partnership in Cambridge, UK.
Generics are prime examples of this model. IMEC is located in the Leuven area. IMEC was created in the early 1980s as the interuniversity institute for microelectronic research. The main idea was to stimulate collaboration among all Flemish universities in this domain. The commercialization of research results was among the goals of the institute and has become one of the key activities. Today, 80% of IMEC’s revenues are generated by contract research activities. Since IMEC is so active in commercializing research, 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 (Segal et al., 2000). Generics was founded in 1986 with four main objectives: top level technology consulting; creating and licensing out IP; investing in the creation of spin-outs; investing 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. The motivation of creating spin-offs is purely a financial one.

5.3.1. Opportunity search and awareness creation

Opportunity-seeking activities are more proactively undertaken and managed under this model. 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 RI in microelectronics 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 employ the researchers that invented the technology on which the spin-out 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.

5.3.2. Strategic choice how to commercialize R&D

In terms of project selection, an in-house fully integrated approach is identifiable under this model. Compared with other models, the decision to spin-out is more grounded in financial and strategic arguments. Since contract research, with or without some form of licensing, is the bread and butter of these RIs, they are very careful about spinning out parts of their core technology unless (a) they have sufficient reason to believe the spin-out will be able to generate more money than the potential revenue stream generated by the contract research, based upon the technology or (b) the technology is so specific and/or peripheral to the core mission of the RI that a contract research group based upon it would be difficult to sustain. In this case, developing a product in which the technology is embedded might be a better option. It is obvious that the choice to spin-out takes much more time than in the Supportive model and usually involves an informed and rational top management decision. Once the development of the project becomes more advanced, the criteria for receiving spin-out support are the same as those used by venture capitalists. A VC expects explosive growth, a very strong technical platform and a global orientation of the spin-out company.
5.3.3. 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 technology and cross-licensing some parts. Usually, these RIs have complex models of exclusive and nonexclusive licensing. These models need to optimize both the potential revenues for the RI (so that contract research can be continued) and to maximize the survival chances of the spin-out (i.e., VCs need to find the technology valuable enough). It is clear that these spin-outs are not one-patent companies.

5.3.4. Incubation and business plan development

The spin-off service provides support ranging from management and housing of the research projects to provision of offices, business plan development, recruitment of external management and the composition of their technology platform. The incubation process has 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.

5.3.5. Funding process

Both the time scale and nature of the project 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, 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.

5.3.6. Control over the spin-out process after start-up

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 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, probably involving outsiders.

6. Resources employed in the spinout models

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

6.1. Low Selective model

6.1.1. Organizational resources

The spin-out activity is a unit within the RI or university, which is independent from the technology-transfer unit. Instead, the unit has a particular mission to increase entrepreneurial awareness.
6.1.2. Human resources
The spin-out units employ a small team of people familiar with existing government grant programs. Their human capital is thus more public than private oriented. However, the presence of a well-known and respected entrepreneur helps to achieve credibility.

6.1.3. Technological resources
The spin-out service has no technological focus, since the mission is to support as many projects as possible, irrespective of technological area.

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

6.1.5. Financial resources
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 from the “Ministère de la recherche” because it was selected as a public incubator. Crealys

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

6.1.6. Networking resources
The success of this model depends upon the social network which the spin-out service has developed with various public agencies and the teaching curriculums of the university. Its mission lies in stimulating entrepreneurial orientation.

6.2. Supportive model

6.2.1. Organizational resources
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). Yet, it has considerable budgetary and human resource management autonomy within the university itself. This structure is the basis of the university’s approach towards managing academic science and technology as a business (Debackere and De Bondt, 2002). In terms of organizational resources, it seems that having autonomy in terms of human resource support and some sort of financial independence is the key. The operational autonomy allows the technology-transfer service at the university to create an environment that is beneficial for researchers to undertake contract research activities and other forms of research commercialization, while the financial autonomy makes the technology-transfer service less dependent upon the RI’s budgetary decisions on a year by year basis. The spin-out support service is embedded in the technology-transfer services.

6.2.2. Human resources
The technology-transfer unit, in which the spin-out support service is embedded, employs a heterogeneous team of people able to support the contract research activities, the IP issues and the activities directly related to spin-outs. This team easily consists of over 15 persons, among which, three to four are only focused on spin-out activity. The latter usually have some form of business experience or at least a business degree. Other team members have legal, HR and various technical backgrounds needed to engage in patenting activity.

6.2.3. Technological resources
The technological resources, whether provided directly or not, are likely to be more focused towards particular specific technologies. BioM has a sectored focus on biotechnology. Leuven R&D tends to be focused on IT and Biomedical ventures. The technology-transfer services and the spin-out unit, in particular, tend to cover a number of broad technological domains. Usually, the research groups in each subdomain tend to be quite small.

6.2.4. 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 business plan validation phase when they receive support.

6.2.5. Financial resources

BioM, is financed by three parties: tbg\textsuperscript{10} together with VC companies, the State of Bavaria, and the local pharma and chemical industry. BioM has no real fund, but 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.

6.2.6. Networking resources

Since this model uses boards of directors as the principal advisory mechanism for the spin-outs, a well-established network and close links with local industry, specialized advisors and the VC community are important. Furthermore, 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, as the mission was the stimulation of spin-outs, regardless of growth prospects, the entrepreneurial climate within the university and the degree to which the government is willing to sponsor entrepreneurial initiatives were important in determining efficiency of the service. The Supportive model, however, is more dependent upon networks of specialized advisors in the region, which they use to perform ad hoc services within these spin-outs.

6.3. Incubator model

6.3.1. Organizational resources

The RIs in the Incubator model are focused upon contract research. The spin-out support services are part of the business development department, which is usually a key department in these RIs.

6.3.2. Human resources

Since business development and commercializing research is a core activity for these RIs, the business development department is quite well developed. Usually, we find more than 30 persons working in such a department. In addition, the spin-out unit counts several people. These spin-out support persons need not only to have a business background to write some sort of business plan. Usually, more support is needed, including the negotiation of IP, the recruitment of a top management team, etc. Hence, we find even in the spin-out unit an interdisciplinary team of experienced persons.

\textsuperscript{10} Technologie Beteiligungsgesellschaft, a specific project within Germany’s public bank, which uses public money to take minority investments in high-tech spin-outs.
6.3.3. 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 is more involved in “development” than fundamental research, but is a recognized specialist in its particular narrow field. IMEC claims to be the leading institute in microelectronics.

6.3.4. 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.

6.3.5. 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 IMEC, 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 1990s, and the successful ones were only generated in the second half of the 1990s. By then, IMEC had its reputation and a steady stream of contract research revenues. Generics has a different history because no public money was involved. However, the personal wealth and network of its founder 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 2001, IMEC had a budget of €115 million: €88 million came from contract research and €27 million came from the Flemish government. In TTP and Generics, these investments are subsidized by other mainstream commercial activities, such as contract research and manufacturing.

6.3.6. Networking resources

Because the spin-out services effectively manage and support all stages and processes 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 that have become a notable feature of the Cambridge high-tech environment. Generics, and especially its founder, have a very high profile in the local Cambridge business environment.

7. 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 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 Fig. 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.

7.1. Low Selective model

Low Selective interfaces are mainly concerned with creating as many start-ups as possible. Since self-employment oriented spin-outs include all kinds of service or consulting companies, these usually do not generate high financial returns at the beginning. These projects are not attractive to private capital, so that public money is an important resource in this model. The amounts invested per company remain small (see Crealys and Twente), as most do not need substantial 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 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 each firm is less important. The businesses supported 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. However, as these companies are so numerous, the total job creation in the regions is considerable (e.g., in the Twente area, over 3000 jobs were created in total and, in the
Leuven area, 1500). Due to 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 et al., 2004).

7.2. Supportive model

The Supportive model originates from the general idea of commercializing technology developed at the RI through means other than licensing. Hence, the spin-outs are an alternative option to create value from the technology. This aim is very different from 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 contract research, the Supportive model limits the number of spin-outs in comparison to the Low Selective model.

As spin-outs are alternatives to licensing, the returns 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 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 less necessary in the low selective case, where most spin-outs lack 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 to develop partnerships with professors, 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, including help with looking for money.

To realize these activities, the technology-transfer office 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 (€250–750 k) of in-projects that are very early and uncertain (so-called preseed). 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. Fifth, the interface service needs to have sufficient contacts with local experts, business entrepreneurs and specialized consultants 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, the spin-outs in the Leuven region lag behind those in the Twente region.
7.3. Incubator model

The Incubator model arose from growing interest among many organizations that had developed proprietary technology, including RIs, to analyze the specific circumstances under which spin-outs could become more financially attractive (in terms of exit opportunities that would create capital gains for VCs) than licensing or contract research with established industry. In doing so, these RIs follow closely the due diligence process 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.

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. Second, the technology-transfer activity may manage its own early-stage venture capital fund or has close contacts with one or more early stage VC funds. Third, the interface office often has contacts with international advisors. Fourth, the RI tends to be specialized in one technology 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 likely to be VC-backed growth-oriented businesses, achieving higher levels of innovative activity at the leading edge of technology and operating in global markets. When 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 ventures spun out using other models.

7.4. Orthogonality of the models and objectives

The three models may be complementary or substitutable means of reaching the same objectives. Our data 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 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. Similarly, 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 orthogonally. Hence, if an 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 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 create a specific spin-out support group, which focuses only on the creation of VC-backed spin-outs in technological domains where it is a leader. This could be pursued while referring the less mature projects to the interface unit, as in the universities of Twente, in our reference sample, and Oxford and Warwick in the UK in our validation sample (see below).

8. Role of the local environment

In this section, we analyze the interaction of the 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 U.S. work focusing on the link between university and spin-outs has largely overlooked this employment argument. The reason seems to be that U.S. spin-out studies usually depart from the premise that spin-outs commercialize patented research results developed at the RI (Shane and Stuart, 2002; Jensen and Thursby, 1998; Thursby et al., 2001; Autio and Yli-Renko, 1998). 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 a company is 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 needed economic help and was classified as an Objective 5 region by the European Fund for Regional Development, it is within a one-hour drive from major commercial 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 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,

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11 A wide variety of environmental factors have been studied, but is beyond the scope of this paper to discuss the full range. Acs et al. (1992) offers a good summary of environmental factors that influence innovation at the city level, while Agrawal and Cockburn (2003) specifically describe the important role of large ‘anchor tenant’ firms in the environment and the role they play in assisting the local economy (the ‘fringe’), such as spin-outs, with developing and commercializing university technologies.
stipulating that universities own the IP of research developed by its employees). In contrast, 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 directly obtained such benefits. Leuven R&D already had an active patenting policy and internal regulation before the legislation was changed. 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, 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 emphasizing the role of personal networks in the search for venture capital (Shane and Stuart, 2002; Suchman, 1994). Suchman (2002) points to knowledge-intensive business service providers as drivers of innovation in Route 128 and Silicon Valley. 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 important public involvement (e.g., Bayern Kapital, State of Bavaria, Tbg and KULeuven), presence of R&D intensive, more established companies (e.g., BMW, Siemens, HP/Agilent, LMS and ICOS) and networking initiatives (e.g., Leuven Inc.).

Finally, the Incubator is a local actor in a much broader worldwide environment. 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 microelectronic research. The organization is not only respected in the field, but it also attracts highly talented researchers to join the organization. Scientific Generics encourages research teams all over the world, specialized in biotech or electronics, to join the organization. In addition, in terms of outflow, these organizations tend to be less dependent upon the local environment. Most 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).

The origin of these institutes also plays 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 microelectronics 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.
9. 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 RI and compared with the resources/activities described above for each model. 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.

9.1. Departures from reference models

Many RIs (24 cases, 56% of the total number) were found to differ notably from each of the three models discussed above (see the diagonal presented in Fig. 2). From the data, we concluded that two broad kinds of deviation occur. First, we labeled as resource deficient those spin-out support services with high ambition in terms of objectives, 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 network that supports enterprise. These factors produce structural shortcomings that 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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Low Selective, n = 10</th>
<th>Supportive, n = 7</th>
<th>Incubator, n = 2</th>
<th>Resource deficient, n = 18</th>
<th>Competence deficient, n = 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spin-outs 2002 (per 1000 researchers)</td>
<td>5.8 (3.9)</td>
<td>6.0 (6.1)</td>
<td>2.6 (0.0)</td>
<td>3.6 (5.9)</td>
<td>0.9 (0.4)</td>
</tr>
<tr>
<td>New jobs created (per 1000 researchers)</td>
<td>132.9 (36.8)</td>
<td>308.7 (299.3)</td>
<td>346.0 (112.2)</td>
<td>95.9 (133.6)</td>
<td>16.3 (14.0)</td>
</tr>
<tr>
<td>Total capital raised (in million)</td>
<td>2.5 (1.8)</td>
<td>20.6 (44.5)</td>
<td>20.5 (2.4)</td>
<td>1.3 (0.7)</td>
<td>0.6 (0.5)</td>
</tr>
<tr>
<td>Total spin-outs since proactive spin-out policy implemented per RI</td>
<td>43.7 (39.6)</td>
<td>54.0 (18.8)</td>
<td>3.0 (0.0)</td>
<td>14.7 (18.2)</td>
<td>11.3 (16.2)</td>
</tr>
</tbody>
</table>
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. 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.

Second, we labeled those interface services 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 as “competence deficient”. Six cases (14%) fell into this category. There was 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. These cases show what can happen if an RI is supplied with a large amount of resources to create the Supportive and Incubator RI models. Even with a desire to create the economically and financially attractive spin-outs these models produce, without the requisite knowledge to acquire and integrate resources to create the required competencies, it is impossible to fulfill this ambition.

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. 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. These RIs continued to depart from the behavior seen in the reference models because they lacked the ability to integrate and coordinate these competencies, efficiently enough to produce results reflecting their desired objectives. Some RIs in this category can best be described as being “in transition” from one normative model to another. Having already decided to make this shift, their current state of evolution has left them in a position somewhere between the two and resulted in an inability to deliver returns characterized by either model.

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. The observed frequencies of incidence of each model are equally spread over the different regions. As a result, observed minus expected frequencies were close to 0 in each cell; thus, the chi-square statistic was not large enough to allow us to reject the null hypothesis of no relation. Furthermore, the resource deficient models tend to be associated with RIs that might be just below critical mass in number of researchers (Table 3). The RIs tend to spread their resources too thinly to achieve a critical mass in any one domain, which 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. Typically, 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. These high-value spin-outs are characterized as high-tech ventures expected to generate high levels
of financial returns for investors and entrepreneurs, plus 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.

RIs creating high value or financially attractive spin-outs have acquired specialized resources and developed competencies over time, focused on creating a small number of ventures with the capacity to 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 it is financially more attractive to license out the technology to an established partner. Self-employment oriented projects are deliberately not considered. 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 other financial investors are unlikely to be interested. This approach might be too slow for exit-oriented projects, requiring 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 if the initial starting capital is not sufficient to cover the time to breakeven.

9.2. Performance indicators

Indicators of performance for the validation cases were available in terms of cumulative number of spin-outs and number of spin-outs per 1000 researchers in 2002, amount of capital raised and new jobs created per 1000 researchers. Table 6 shows that while most groups perform as expected on the basis of the reference groups, indicators of the low selective group 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 availability of public money invested directly in start-ups and without expectations of financial returns seems to be key to realizing maximum 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 RIs applying 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.
The resource-deficient model cases have fewer 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. 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 competencies to employ resources productively, these cases have a quite low number of new jobs created and raise only a limited amount of capital.

10. 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. 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. 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 be 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.

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 explain why we observe many resource-deficient interface services in the random validation sample. They appear to be trying to emulate one pure type of model, but without the necessary resources to do so successfully. Hence, 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 suggest that the 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 misspecified 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 an RI’s technology-transfer strategy is analyzed, in relation to its intended goals and environmental factors, that we can fully judge its success. If an 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 be relatively little overlap. This implies that these three models can coexist in one RI, but that the trajectory of a project will have to be managed from the beginning. If an 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. If it is only interested in financially attractive spin-outs and is organized as a Low Selective model, again, the model is unlikely to lead to the achievement of objectives. Future research should give us a better insight into how these models can coexist 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 that 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 that there may be major insurmountable barriers to their successful adoption in different environments.

Our research suggests that those designing, running and evaluating schemes need to consider several issues. First, the size, experience and professionalism of those undertaking the technology-transfer function will determine the scope and intensity of the support activities that are possible. Second, the degree of interaction and the nature of the relationship between those undertaking the technology-transfer function with departments will influence the likely pool of ideas. Third, there is a need to consider the type(s) of spin-out companies to be catered for and those that will be excluded. Fourth, the organizational culture both within the technology-transfer function and individual departments will influence how much the TTO needs to do in creating awareness and encouraging entrepreneurship.

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. Further research might usefully examine the establishment of the broader focus of technology-transfer strategies and the balance of spin-outs versus other modes of technology-transfer such as licensing and contract research. Since successful spin-out performance tends to be rare, it might be that for some RIs, 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. 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. In addition, in the Low Selective model, the “entrepreneurial culture” of the university was important. 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. 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., in press; 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. For example, few spin-outs from the Incubator models have so far realized successful trade sales or IPOs, and it will be interesting to analyze how this model adapts to failures in expected outcomes of its spin-outs. It will also be interesting to examine the extent to which the resource and competence-deficient cases are able to overcome barriers to the successful development of spin-outs. Fourth, we have been able to provide only limited data on performance metrics relating to spin-outs, as data collection by many RIs is at best patchy. This makes it necessary in future research to use the spin-out firm as the level of analysis to enable more robust metrics to be identified and analyzed.

Finally, 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 identified here 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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