Nurture or nature? The growth paradox of research-based spin-offs

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Nurture or nature? The growth paradox of research-based spin-offs

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This study explores the effect of institutional origin (‘nurture’) and economic context (‘nature’) on the financial resource endowment and subsequent early employment growth of research-based spin-offs (RBSOs). The nurture dimensions capture the relationship between the parent research institution and the RBSO during the start-up phase: the type of incubation model, the formal vs informal transfer of technology and the extent of inventors’ involvement with the firm. The nature dimensions include the technology domain in which the RBSO operates and the complexity of the sales process. Using a unique dataset of RBSOs in Flanders (N = 85, representing 75% of the population), our analysis shows that the financial resource endowment, is predicted by both institutional origin (nurture) dimensions and economic context ones (nature). Initial capital in turn, is a key driver of subsequent employment growth of RBSOs.

Keywords: research-based spin-offs; growth

1. Introduction

Most of the current knowledge on research-based spin-offs (RBSOs) is concerned with what determines their emergence, with few studies tackling the crucial academic and policy question of whether (and which) spin-offs actually grow (Djokovic and Souitaris 2008). The heterogeneity in the nature of research-based spin-offs across Europe (Mustar et al. 2006) adds to the complexity of the issue. Therefore, we start from the following research question:

What determines the capital invested in and subsequently the employment-growth of research-based spin-offs?

To answer this empirical question, we develop a conceptual model based on two distinct theoretical perspectives, which have both contributed to understanding of firm founding and performance: resource-based theory and new institutionalism. Resource-based theory suggests that firms make economically rational choices that are shaped by the economic context of the firm. Institutional theory suggests that firms make normatively rational choices that are shaped by the social context of the firm. Oliver (1997) suggested that resource-based and institutional views actually converge.
She proposed conceptually that the resource selection, accumulation and deployment decisions (which determine sustainable advantage) are affected by both resource-based determinants (economic rationality, strategy, market imperfections) and by institutional determinants (normative rationality, institutional factors, isomorphism pressures). However, we do not know of many studies that tested empirically how combining elements from the institutional and resource-based theories can explain the investment in and the growth of entrepreneurial firms.

The purpose of this paper is to investigate to what extent the institutional context and economic context dimensions impact on the financial resource endowments (capital invested during the first 18 months after founding) and subsequently the employment growth of research-based spin-offs from public research organisations (PROs). We therefore focus on the relative effect of two types of variables. First, we analyse ‘nurture’ dimensions, capturing the type of parent PRO and the relationship with the RBSO during the start-up phase. Our three selected nurture dimensions are (1) the type of incubation model of the research institution (we test a trichotomous taxonomy developed by Clarysse et al. 2005), (2) the formal (vs informal) transfer of technology through assignment of a patent or license at time of founding (a distinction introduced by Moray and Clarysse (2005) and Clarysse et al. (2007)) and (3) the extent of inventor’s involvement with the company (we test the trichotomous taxonomy developed by Nicolaou and Birley (2003)). Second, we analyse ‘nature’ variables capturing the firm’s economic context. Our nature variables are (1) the technology domain (Shane 2002) and (2) the complexity of the sales process (Heiman, Sanchez and Tuleja 1995).

The study is important for two reasons. First, the question of why spin-offs get funded and grow is underresearched empirically but is topical and with obvious policy implications. Second, we combine elements from both institutional and resource-based perspectives to explain firm heterogeneity.

The paper is organised as follows. First, we describe the context in which the phenomenon of research-based spin-offs has increasingly gained momentum. Second, we develop the conceptual model combining elements from both institutional and resource-based perspectives, hypothesising that institutional and economic context explain initial capital and growth. Third, we discuss the data and methods employed. Fourth, we present the analyses and the results. We conclude with a discussion section pointing to the main theoretical and practical implications.

2. Literature

The key question regarding the spin-off phenomenon that has been investigated in the literature is ‘why they actually emerge in contrast to traditional methods of technology transfer’. Drawing on transaction cost economics, Shane (2002) has shown that patents derived from universities are more likely to be exploited through a spin-off firm when these patents are ineffective in a line of business. Efforts by universities to secure revenues from equity positions in new firms are often seen as less risky compared with licensing intellectual property to outside partners (cf. Bray and Lee 2000; Feldman et al. 2002) which is an extra incentive for universities to set up spin-offs. The Bayh–Dole act introduced in the USA in 1980 is largely seen as a decisive policy for enabling academics to pursue entrepreneurial opportunities (Shane 2004) rather than rely on licensing of patents and intellectual property.

A stream of research has emphasised the role of academics and researchers in university laboratories as central to the creation of spin-off companies. The market orientation of academic founders influences directly the attractiveness of business ideas coming out of universities (Grandi and Grimaldi 2003). The social capital of the founding team is also a signal for the acquisition of
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Further resources necessary for their survival and growth (Lee, Kyungmook and Pennings 2001; Shane and Stuart 2002; Johansson 2007). Moreover, the quality of a university’s faculty is a predictor of the number of start-up companies formed (Powers and McDougall 2005).

Apart from the individual inventors, universities can play a critical role in the spin-off process by embracing their efforts through technology transfer offices (TTOs). A number of researchers have explored the different types of these offices (cf. Markman et al. 2005) suggesting that the size, age, experience and structure of a TTO are related to their productivity in terms of spin-off generation (Nosella and Grimaldi 2009; Powers and McDougall 2005; Bray and Lee 2000). University policies towards the restriction of inventors’ involvement with practice may also discourage spin-off formation (Tornatzky, Waugaman and Gray 1999). DiGregorio and Shane (2003) have shown that the overall quality and prestige of a research institution can hamper or boost the rate of spin-off formation, because well-known institutions have more resources at their disposal.

Another stream of research in academic entrepreneurship has examined external, environmental factors that predict a smooth transfer of technology to the market. Prominent among these factors are the existence of a venture capital industry willing to invest in early-stage technologies or a well functioning financial market (Van Looy, Debackere and Andries 2003; Shane 2004).

Although researchers have studied a range of factors that lead to spin-off creation, much less is known about what determines the quality of the spin-offs created (Lockett and Wright 2005). Spin-off performance has been researched sporadically, partly because of the relative novelty of the phenomenon. Performance has been studied under a multidimensional framework including the analysis of survival rates, profitability and growth rates. It is documented that failure rates of university spin-offs are well below the national average in the USA and European countries (Degroof and Roberts 2004; AUTM 2002). Still it is inconclusive if the higher survival rates of spin-offs can be attributed to higher fitness of university spin-offs or rather to support systems of their parent organisations that are keeping them ‘alive’. In this respect Rothaermel and Thursby (2005) found that spin-offs with strong ties to their parent organisations were less likely to fail but also less likely to successfully graduate within a timely manner. Ensley and Hmieleski (2005) found that spin-offs are not necessarily better performers than other new technology based ventures. Spin-offs were significantly lower performing in terms of cash flow and revenue growth and their top management teams were less dynamic and more homogenous. These findings suggest that survival rates might not be ideal measures of spin-off performance.

Studies that have further focused on the determinants of spin-off performance have looked at the policy setting of universities and TTOs and found that policies can have an increasing effect on the potential growth of ventures (Degroof and Roberts 2004). Further, it has been found that linkages to different actors, such as clients, research laboratories, parent university and particularly investors are important determinants of success and performance (Mustar 1997; Shane and Stuart 2002).

In general, Mustar et al. (2006) identified three main theoretical research traditions in the spinout literature on performance: (1) papers looking at the resources of the firm as a differentiator and a predictor of competitive advantage (this category is labelled ‘the resource-based perspective’); (2) papers focusing on the economic context, i.e. sectoral differences, technological regime and product-market combinations that generate growth, labelled ‘the business model’ perspective; and (3) papers focusing on the link with the parent institution, labelled ‘the institutional perspective’. Mustar et al. (2006) called for more research to analyse which combinations of these factors are more effective in generating viable spin-offs.

This study intends to contribute to the debate about spin-off performance by examining a combination of ‘institutional’ and ‘economic context’ as determinants of ‘resource accumulation’ and subsequent growth.
3. Conceptual model and hypotheses development

There is an increasing consensus that in the context of entrepreneurial firms, capital is one of the most important scarce resources. Previous research showed that the amount of initial capital invested is positively associated to new venture survival and success (Cooper, Gimeno-Gascon and Woo 1994; Davila, Foster and Gupta 2003). Especially high technology start-ups require large amounts of venture capital to conduct research, develop a product and then market it. A substantial proportion of the initial capital is used to hire technical and marketing experts and therefore it contributes directly to early employment growth. The positive association between venture capital and high growth might also be due to the venture capitalist’s (VC’s) ability to select firms with high growth potential and to post investment benefits that accrue to VC-backed firms (Baum and Silverman 2004). Overall, we predict that a main driver of early employment growth of research based spin-offs is the amount of their initial capital (we define initial capital as the capital invested in the company in its first 18 months after foundation). Therefore,

Hypothesis 1. The higher the amount of initial capital the higher the annual employment growth rate of the spin-off company.

We depart from Oliver’s (1997) broad conceptual framework which explains resource selection and accumulation and subsequently firms’ competitive advantage, combining institutional and economic contexts.

3.1. The institutional context (nurture variables)

From an institutional perspective, firms operate within a social framework of norms, values and taken-for-granted assumptions about what constitutes appropriate or acceptable economic behaviour (Baron, Hannan and Burton 1999; Davidsson, Hunter and Klofsten 2006; DiMaggio and Powell 1983). Strategic choices such as resource selection and accumulation are constrained not only by economic factors, but also by socially constructed normative rationality (like norms, habits and customs) and institutional factors (‘the way things are done around here’) (Oliver 1997). By applying the institutional perspective to our context of research-based spin-offs, we suggest that the resource accumulation choices (initial capitalisation) of the young firms depend on their institutional background. Since the firms are at the start-up stage, having just emerged out of a ‘parent’ PRO, institutional background in this context would be the ‘nurture’ they received from their parent – more specifically the type of their parent PRO and the nature of the parent–spin-off relationship. In other words, we argue that different types of PROs, and different types of relationships between PROs and the spin-off firms, will have an impact on the initial capital of the firm. We test the effect of three ‘nurture’ variables that are already established in the literature on academic entrepreneurship: (i) the type of incubation model of the research institution, (ii) the formal (vs informal) transfer of technology, and (iii) the extent of inventor’s involvement with the company.

3.1.1. The type of incubation model of the research institution

Clarysse et al. (2005) explored the different incubation strategies in European Research Institutions and identified three distinct incubation models used in practice: low selective, supportive and incubator. Each model serves different goals and objectives. The low selective model has a mission oriented towards maximising the number of entrepreneurial ventures. Self-employment oriented ventures, which rarely grow beyond critical size of employees are legitimate. The supportive
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model is oriented towards generating spin-offs as an alternative to licensing out its intellectual property (IP). This model aims to generate profit-oriented spin-offs. Finally, the incubation model makes a trade-off between the use of a body of research to generate contract research vs spinning-off this research in a separate company. This model aims to produce ‘exit oriented’ ventures, since the exit possibilities provide the financial opportunity. The spin-off formation usually takes a long time because all the assumptions have to be tested before valuable IP is given to a separate venture.

From the above, it is logical to assume that spin-offs from PROs following the incubation model will be more likely to raise larger amounts of capital, because of the way they are set-up by the PRO and marketed to investors (high-growth, exit-oriented ventures).

Hypothesis 2: Spin-offs that emerge from PROs following the incubation model will raise more initial capital than spin-offs from either low selective or supportive models.

3.1.2. Formal versus informal transfer of technology

Moray and Clarysse (2005) and Clarysse et al. (2007) distinguish between two types of research-based spin-offs. Companies of the first type are established with formal transfer of technology through assignment of a patent or license at time of founding (academic ‘spin-offs’). Companies of the second type are established without formal technology transfer using knowledge that was developed within the academic institution (academic ‘start-ups’). Although this distinction is widely accepted among professional technology transfer associations, little research exists that empirically distinguishes these two types of RBSOs when analysing resource selection and growth.

We expect ventures that are established with formal transfer of technology and codified knowledge (the ‘spin-offs’) to raise a higher amount of capital in the first 18 months (and subsequently grow faster) than ventures with no formal technology transfer from the PRO (see also Clarysse et al. 2007). There are various explanations to justify this expectation. A patent (or a patent-portfolio) transferred or licensed to the new company signals a number of issues to the stakeholders: (1) Serious, long-term work and organised effort carried out within the PRO to earn the patent – therefore the technology is better defined and more advanced; (2) a patent is a proof of novelty; (3) a patent offers legal protection against copying; (4) a patent is a valuable asset, which can be further licensed or sold; (5) the knowledge around the technology is codified rather than tacit and therefore it is easier to be transferred and used by new employees of the spin-off company.

For all the above reasons, ventures that are established with formal technology transfer have on average higher ‘pre-money’ valuation than their ‘informal’ counterparts. Especially the PRO representatives expect to justify the financial cost of applying for and maintaining the patent(s) and the risk and opportunity cost of transferring their asset to the new company. This expectation can drive up the value of the company and therefore attract more initial capital from its financiers for their typical equity share.

In general, starting business activities with a formally transferred technology is intrinsically more capital intensive since the technology needs to be valued as part of the transfer agreement between the PRO and the new venture. Therefore,

Hypothesis 3: When know-how is transferred formally to spin-off firms, they will display higher initial capital levels as compared to ventures that start activities without formal transfer of technology.

3.1.3. The extent of inventor’s involvement with the company

Nicolaou and Birley (2003) proposed a trichotomous categorisation of university spin-offs regarding inventors’ involvement. An orthodox spin-off involves both the academic inventor(s) and the
technology spinning out from the institution. A hybrid spin-off involves the technology spinning off and the academic(s) retaining his or her academic position within the company. The scenario involving some academics spinning off and some retaining their university affiliation is also subsumed under this category. Last, a technology spin-off involves the technology spinning off but the academic maintaining no connection with the newly established firm. However the possibility of the academic having equity in the company and/or offering advice on consultancy basis is not discounted. Nicolaou and Birley (2003) suggested that the type of spin-off in terms of involvement participation will have an impact on growth and performance and called for more research in this area.

The literature suggested that inventor involvement in start-ups represents a deliberate strategy towards top-management team heterogeneity which leads to superior decision-making (Eisenhardt and Schoonhoven 1990). One interpretation of these findings would suggest that orthodox and hybrid spin-offs should raise more funding due to the maximum utilisation of the inventors’ expertise (see Certo 2003).

However, there is a contrasting view. Since technologies without the support of the inventor(s) are at a disadvantage, most of them cannot pass the scrutiny of the TTO, or cannot attract a surrogate entrepreneur, and in the end are shelved. The cases of established technology spin-offs represent unique technologies that progress despite the inventors’ disinterest to commercialise them; technologies that are so valuable that pull externals to the deal (both surrogate entrepreneurs and investors) without the inventor as the natural internal champion. It is likely that on average these firms have the highest potential for raising capital. Given the contrasting views we pose the following competing hypotheses:

*Hypothesis 4a: Orthodox and hybrid spin-offs will raise more initial capital compared to technology ones.

*Hypothesis 4b: Technology spin-offs will raise more initial capital compared to orthodox and hybrids ones.*

3.2. **The economic context (nature variables)**

The resource-based view (Amit and Schoemaker 1993; Barney 1991) suggested that firm heterogeneity in acquiring and deploying resources accounts for the generation of economic rents. According to this view it is the rational identification and use of resources that are valuable, rare, difficult to copy and non-substitutable which lead to enduring firm variation and supernormal profits (Barney 1991). Within this perspective, resource selection and accumulation are seen as a function of both within firm decision-making (guided by an economic rationality) and external economic context (Eisenhardt and Schoonhoven 1990). To assess the effects of the economic context at time of founding on resource accumulation of spin-offs, we tested two variables capturing the attractiveness of the industry in which the RBSOs were founded. We labelled these economic context dimensions as ‘nature’ variables: the technology domain and the complexity of the sales process.

3.2.1. **The technology domain**

We chose the technology domain because it is one of the most important variables that has been argued to influence growth (Delmar, Davidsson and Gartner 2003; Mustar et al. 2006). More specifically biotechnology firms have a higher minimum critical scale (Mangematin et al. 2003) and therefore can be expected to raise higher than average amount of initial capital and
subsequently to display a higher than average employment growth. On the contrary, due to the nature of their business (software development does not require expensive laboratories), we expect information technology (IT) firms to need and raise less than average initial capital. Therefore we pose the following hypotheses:

**Hypothesis 5a:** Spin-offs in biotechnology will raise more initial capital than the rest of the firms.

**Hypothesis 5b:** Spin-offs in IT will raise less initial capital than the rest of the firms.

3.2.2. The complexity of the sales process

Our choice of the sales process variable was driven by the suggestion that, in young technology firms, their ability to perform sales has an important effect on their performance (Roberts 1991). A number of scholars have discussed the importance of sales on firms’ performance (see Gruber et al. 2010).

We expect spin-offs with a more complex sales process to need and raise more capital in their first 18 months than spin-offs with a less complex sales process. That is because more complex sales cycles require a larger and more experienced sales force, which consumes invested capital. Therefore:

**Hypothesis 6:** Spin-offs with a more complex sales process will raise more initial capital than spin-offs with a less complex sales process.

We summarise our concept in Figure 1. It proposes five aforementioned determinants of initial capital (and subsequent employment growth) of research-based spin-offs.

4. Method

The empirical test of the model was carried out surveying the total population of research-based spin-offs set up in Flanders (Belgium) that were created between 1991 and 2004. The study of the total population in a homogenous region reduces non-measured variance resulting from
environmental conditions. Flanders is considered as an emerging high-tech region, experiencing a fast process of convergence between old and new technologies and thereby improving its competitive position (Cantwell and Iammarino 2001).

We surveyed key informants from each company (via a face to face interview) to identify variables regarding the initial conditions at founding (capital raised, incubation model of the parent institution, inventors’ involvement, formality of the technology transfer process, technology domain and complexity of the sales process), as well as variables related to the company’s situation at the time of the interview (number of employees, age).

On average the firms in our sample were 5 years old. Seventy-three of the 85 firms survived as independent entities. From the 12 firms that dissolved, six went bankrupt and five were acquired. Only one RBSO went public. For the 12 dissolved firms, we measured the number of their employees for the last year of their operation. At the time of the interview, the number of employees ranged between 1 and 520, with an average of 23.

4.1. Measures

Absolute annual employment growth was measured as the ratio of number of employees at the time of the interview over the age of the company in years. The logarithm of the employment growth figure was used for parametric statistical tests in order to subscribe to the normality assumption.

Initial capital was the capital raised within 18 months of start-up. The period of 18 months is introduced to allow for management discretion in the founding of academic spin-offs (Clarysse et al. 2007). The exact date of legal founding of a spin-off does not necessarily reflect its ambition. Often in Belgium neither investors nor universities want to take the risk of founder’s liability. A common way to get around this is to start-up the company with minimum capital and only the individual entrepreneurs as founders of the company. Six months later the capital of the company can be increased to the real target and the university and/or investors are included as shareholders. To circumvent these issues Clarysse et al. (2005) suggested that a period of 18 months after the official legal founding date of the company is appropriate if one wants to measure the real initial capital. The logarithm was also used for parametric statistical tests in order to subscribe to the normality assumption.

The incubation model at founding was self reported by the companies and was also cross-checked by the researchers who were familiar with the development history of the seven parent institutions that the spin-off firms came from (from previous work). The variable is a trichotomous categorical variable (1 – low selective; 2 – supportive; 3 – incubation).

The formality of technology transfer was self-reported by the companies and cross-checked with technology transfer offices at the research institutes from which the RBSOs originated. It is a dichotomous categorical variable (1 – spin-off with formal technology transfer; 2 – start-up with informal transfer of know-how). A formal technology transfer includes either the transfer of one or more patents to the academic spin-off or the establishment of an exclusive licensing agreement with the newly created spin-off, or a non-exclusive licensing agreement with an exclusive application right in a certain domain.

The inventors’ involvement was self-reported by the companies and was also cross-checked by the researchers using the company interview reports. It is a trichotomous categorical variable (1 – orthodox spin-off with both the academic inventor(s) and the technology spinning out from the institution; 2 – hybrid spin-off with the technology spinning off and the academic(s) retaining his or her academic position within the company, the scenario involving some academics spinning off
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and some retaining their university affiliation is also subsumed under this category; 3 – technology spin-off with the technology spinning off but the academic maintaining no connection with the newly established firm).

The technology domain was self-reported by the companies. It is a categorical variable (1 – biotech; 2 – hardware/microelectronics; 3 – IT/software; 4 – other).

The sales process complexity was self-reported by the companies. It is an ordinal scale ranging from 1 to 3 representing increasing levels of complexity in identifying the buying centre at the customer side of the RBSO. Heiman, Sanchez and Tuleja (1995) differentiated between the economic, the technical and user buyer as potentially having varying levels of decision-making power in acquiring a new product, service or technology. Especially in the context of RBSOs the ‘nature’ dimension has been underestimated in the past, with entrepreneurs–researchers having too high expectations in the readiness and willingness of potential corporate customers.

1. One person is economic, technical and user buyer.
2. Different buyer roles are covered by different people in the customers’ organisation. However, the key decision makers are straightforward and are found rather easy.
3. Very difficult sales cycles: different people play different buying roles and difficult to identify all people that influence decision making or decision makers are spread over different hierarchical levels and key decision makers (i.e. economic buyers) are located high in the organisation (e.g. in corporate headquarters).

While it is intuitively possible that the complexity of the sales process is related to the technology type, we did not have any clear logic about exactly how (i.e. which technology domain would have a more complex sales process). We also tested statistically for a relationship between technology domain and complexity of sales, but the data did not reveal one. Therefore, we decided to keep sales complexity as a separate independent variable.

5. Analysis and results

To test hypothesis 1 we carried out a hierarchical regression (see Table 1) with the log of the annual growth in employees as the dependent variable. Age and industry controls were entered in the first step. We divided the sample in four industries: electronics, IT, biotechnology and other. We introduced three industry dummy variables (electronics, IT and other) leaving biotechnology as the reference category. Then the predictor variable entered in a second step (log of capital raised in the first year). We found a significant relationship between logs of capital and growth ($\text{Adj } R^2 = 0.306$, $\beta$ for log of capital = 4.653, sig 0.000). Therefore hypothesis 1 was supported.

We used Kruskal–Wallis non-parametric tests to compare means of the capital raised for the different groups of the five categorical independent variables. Non-parametric tests avoid the bias of the non-normal distribution of the capital raised. To confirm the results we carried out analysis of variance tests (ANOVAs – parametric tests) using the log of capital raised as the dependent variable (see Tables 2–6). The results confirmed hypotheses 2, 3 and 5, as they showed differences among the mean values in the predicted direction. Hypothesis 4b was also confirmed at the expense of its competing hypothesis 4a, meaning that total capital at founding was considerably higher for technology spin-offs.
Table 1. Hierarchical regression results.

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Step 1</th>
<th>Step 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1: Control variables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronics dummy (0–1)</td>
<td>0.016</td>
<td>−0.008</td>
</tr>
<tr>
<td>IT dummy</td>
<td>0.052</td>
<td>0.232</td>
</tr>
<tr>
<td>‘Other’ dummy</td>
<td>−0.302</td>
<td>−0.164</td>
</tr>
<tr>
<td>Age</td>
<td>−0.211</td>
<td>−0.058</td>
</tr>
<tr>
<td>Step 2: Predictor variable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log of capital raised in the first year</td>
<td>0.513**</td>
<td></td>
</tr>
<tr>
<td>Overall $R^2$</td>
<td>0.158*</td>
<td>0.350**</td>
</tr>
<tr>
<td>$\Delta R^2$</td>
<td></td>
<td>0.192**</td>
</tr>
<tr>
<td>$F$</td>
<td>3.459*</td>
<td>7.870**</td>
</tr>
<tr>
<td>$\Delta F$</td>
<td></td>
<td>4.411**</td>
</tr>
</tbody>
</table>

Note: *$p < .05$, **$p < .01$. 

Table 2. Comparison of mean capital in the first year for different incubation models (total capital at founding in euros).

<table>
<thead>
<tr>
<th>Incubation model</th>
<th>Mean</th>
<th>N</th>
<th>Kruskal–Wallis</th>
<th>ANOVA (for log of capital)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\chi^2$</td>
<td>$F$</td>
</tr>
<tr>
<td>1 Low Selective</td>
<td>403,436.1</td>
<td>19</td>
<td>19.082</td>
<td>9.649</td>
</tr>
<tr>
<td>2 Supportive</td>
<td>580,610.9</td>
<td>47</td>
<td>19.082</td>
<td>9.649</td>
</tr>
<tr>
<td>3 Incubation</td>
<td>3,373,653</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,056,281</td>
<td>81</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Comparison of mean capital in the first year for spinoffs vs start-ups (total capital at founding in euros).

<table>
<thead>
<tr>
<th>Formality of technology transfer</th>
<th>Mean</th>
<th>N</th>
<th>Mann–Whitney</th>
<th>ANOVA (for log capital)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>$U$</td>
<td>$F$</td>
</tr>
<tr>
<td>1 Spinoff</td>
<td>1,211,249</td>
<td>55</td>
<td>527</td>
<td>6.440</td>
</tr>
<tr>
<td>2 Start up</td>
<td>703,511.6</td>
<td>27</td>
<td>527</td>
<td>6.440</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>82</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. Discussion

Generally we found that the major predictor of early growth of RBSOs is the initial capital invested in the companies. No other control variable (age or industry) had a direct effect on growth and that is an interesting finding in itself. Moreover, capital invested is determined by ‘nurture’ variables (the incubation model of the parent, the formal transfer of technology and the
Table 4. Comparison of mean capital in the first year for different inventor involvement classes (total capital at founding in euros).

<table>
<thead>
<tr>
<th>Inventors’ involvement</th>
<th>Mean</th>
<th>N</th>
<th>Kruskal–Wallis</th>
<th>ANOVA (for log capital)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Orthodox</td>
<td>624,125</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Hybrid</td>
<td>576,081</td>
<td>36</td>
<td>10.315</td>
<td>6.975</td>
</tr>
<tr>
<td>3 Technology</td>
<td>3,888,986</td>
<td>11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,041,001</td>
<td>82</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Comparison of mean capital in the first year for different technology domains (total capital at founding in euros).

<table>
<thead>
<tr>
<th>Technology domain</th>
<th>Mean</th>
<th>N</th>
<th>Kruskal–Wallis</th>
<th>ANOVA (for log capital)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Mainly biotech</td>
<td>1,439,954</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 mainly hardware microelectronics</td>
<td>1,269,864</td>
<td>14</td>
<td>12.872</td>
<td>5.611</td>
</tr>
<tr>
<td>3 mainly IT</td>
<td>360,419</td>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Other</td>
<td>1,123,147</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,023,966</td>
<td>84</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6. Comparison of mean capital in the first year for complexity of the sales process (total capital at founding in euros).

<table>
<thead>
<tr>
<th>Complexity of the sales process</th>
<th>Mean</th>
<th>N</th>
<th>Kruskal–Wallis</th>
<th>ANOVA (for log capital)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 One person buyer</td>
<td>380,913</td>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Identifiable buying centre</td>
<td>819,113</td>
<td>26</td>
<td>7.624</td>
<td>4.278</td>
</tr>
<tr>
<td>3 Difficult to identify buying centre</td>
<td>1,516,151</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>794,345</td>
<td>66</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Inventors’ involvement) and by ‘nature’ variables (technology domain and sales complexity). The study makes the following contributions to the literature:

(1) An empirical contribution to the spin-off literature stream in entrepreneurship by identifying determinants of early financing and growth, which is an under-researched area. Traditionally, researchers have looked at broader environmental circumstances in understanding resource accumulation in new ventures. For example, the availability of venture capital or public capital in a region and a network of entrepreneurs/experienced managers have traditionally been argued to be important for the successful establishment of the resource base of a firm (Roberts 1991). In most studies to date, resources of new firms are evaluated in view of their external environment and how the company succeeds in managing these interrelationships. This study
substantially adds to these research endeavours by integrating “nurture” and “nature” dimensions, meaning that both characteristics related to the genesis of the RBSO at the PRO and characteristics of the external environment are included in the analysis.

(2) A mid-range theoretical contribution, as we developed a model linking the three main theoretical traditions in spin-off performance research (Mustar et al. 2006). The model shows that specific ‘institutional’ and ‘economic context’ dimensions simultaneously influence acquisition of financial ‘resources’, which subsequently determine growth.

(3) A wider theoretical contribution to the management theory as we combined elements from both the resource-based and the institutional perspectives to explain the investment in and the early growth of entrepreneurial firms. Both the neo-institutional framework and the resource-based view have been individually criticised: the institutional framework for its focus on homogeneity and persistence of organisational forms (Dacin, Goodstain and Scott 2002); the resource-based view for not taking into account the context of resource acquisition (Ginsberg 1994). Oliver (1997) conceptually argued that we need an integrative approach that combines both theories to explain sustainable competitive advantage. This study is an empirical step towards this direction.

7. Policy implications

Academic entrepreneurship looms large in the public arena (Henrekson and Rosenberg 2001). A number of countries worldwide are experimenting with policies to stimulate the commercialisation of public research and, more specifically, the creation of RBSOs (Chiesa and Piccaluga 2000; Mustar 1997). Identifying determinants of the spin-offs’ ability to attract capital and subsequently to grow is a key policy concern.

The main implication for universities and policy makers is that the key to growth is initial capital. Capital should be invested if we are looking seriously at growth, either by the parent or by public funds or by private investors. Universities and spin-offs can control their attractiveness to investors by:

(1) Having interesting, high-potential technologies that can be pulled from the market (even) without the participation of the inventors (technology spin-offs). Often attracting the attention of surrogate entrepreneurs and investors with the piece of technology only, is a real test of its potential. This implication is important both for the research strategy at the level of the university or research institute and at the level of the technology transfer office.

(2) Transferring technology formally to the companies (real spin-offs rather than academic start-ups).

(3) Having an incubation policy squarely targeting growth (an incubation model).

8. Limitations and conclusions

This is an exploratory empirical study and has multiple limitations. First, since some companies in the sample are still relatively young, it might be too early to rightfully assess the growth that these companies display. Previous research has shown that it can take a long time before RBSOs, and technology companies in general, actually grow. Second, our measures were not multi-item scores. We opted for factual, objective data which we double-checked from multiple sources. Third, the characteristics of the relatively small sample N did not allow us to employ multi-variate regressions analysis to test our model as a whole. Fourth, our sample comes from one region of
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Belgium (Flanders) and the external validity of the findings should be checked in future studies. Nevertheless, we had a sample of nearly a total population, which is unique as it avoids problems of selection bias and ensures a high internal validity.

In conclusion, this was one of the first empirical studies combining institutional and economic context dimensions to predict the ‘quality’ of RBSOs, in terms of growth. Combining different theoretical perspectives, this study should be built upon to generate more comprehensive and holistic models to better understand the growth of RBSOs.

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References

AUTM. 2002. AUTM Licensing Survey. Association of University Technology Managers, Norwalk, CT.


