

**THE IMPRINTING EFFECT OF INITIAL RESOURCES AND MARKET
STRATEGY ON THE EARLY GROWTH PATH OF START-UPS**

Ans Heirman¹

Bart Clarysse²

March 2005

2005/XXX

¹ Faculty of Economics and Business Administration; Ghent University and Vlerick Leuven Ghent Management School. Email: ans.heirman@vlerick.be

² Faculty of Economics and Business Administration; Ghent University and Vlerick Leuven Ghent Management School. Email: bart.clarysse@ugent.be or bart.clarysse@vlerick.be

ABSTRACT

Research-based start-ups (RBSUs) differ in their early growth. Some firms grow very rapidly, while others grow slowly or do not grow at all. In this paper we bring insights in the causes of the diversity in the early growth of RBSUs. To identify some of the key factors that affect growth, we study the initial resource base and the firm's market strategy. We control for age, size and industry differences. Growth is a complex, multidimensional phenomenon. Therefore, we study three growth measures, namely growth in employees, revenues and total assets. Our multivariate analyses show that raising large amounts of VC is a key driver for early employment and revenue growth. Whilst most RBSUs are founded by pure technical founding teams, we find that R&D experience has no effect on growth. Founding teams with commercial experience, on the other hand, grow significantly more in employees, revenues and total assets. Next, RBSUs, which are internationally oriented from the start, grow significantly faster in terms of revenues and total assets but not in employees. Finally, multivariate analysis indicates that firms that are closer to a market ready product at founding do not grow significantly more in terms of revenues and employees, but firms that are earlier in the product development cycle grow more in total assets during the early growth path. We use in-depth qualitative information to explain and interpret the results and discuss the sustainability of different early growth trajectories. Our findings have important implications for entrepreneurs, investors and policy makers.

INTRODUCTION

There is a popular and romantic perception that innovative start-ups, often operating in high-technology sectors, develop and commercialize new products and services that will transform their industry's and even their country's prospects. These firms – which we label as 'Research-Based Start-Ups' (RBSUs) - are perceived as the dynamos of technological development, social progress and economic growth (Schumpeter, 1934; Utterback et al., 1988). The supporters of entrepreneurial development argue that the formation of RBSUs can have an appreciable effect on regional job creation and economic renewal (Acs & Audretsch, 1990). This dominant view of rapidly growing RBSUs is also inspired by the highly visible success stories of the early and mid-nineties and the success of 'high tech clusters' such as Silicon Valley and Route 128 (Boston) in the US and Cambridge in the UK (Roberts, 1991; Saxenian, 1994; Segal Quince Wicksteed, 2000). Not surprisingly, policy makers focus upon the promotion of RBSUs as a panacea for economic problems in view of their apparent potential for job and wealth creation (Storey & Tether, 1998).

There is however some concern associated with presuming rapid growth of all RBSUs. Several researchers argue that it is a gross oversimplification to believe that all (or most) RBSUs have high growth potential (Oakey, 1995; Storey & Tether, 1998). Recent studies indeed show that in contrast to the highly visible success stories (the so-called gazelles), the vast majority of RBSUs remain very small (Roberts, 1991; Rickne & Jacobsson, 1999; Autio & Yli-Renko, 1998; Mustar, 1997; Chiesa & Piccaluga, 2000; Segal Quince Wicksteed, 2000). Hence, RBSUs seem to differ enormously in their growth potential but previous research focussed mainly on the high growth firms neglecting the majority of slowly growing firms. As a result, we know very little about which factors distinguish fast growing from slowly or not growing RBSUs. As Autio and Lumme (1998) noted: "many books and studies, while acknowledging that most NTBFs do not grow, still

explicitly focus on rapid growth and largely dismiss the study of slowly growing NTBFs.”

In this paper, we study the causes of the diversity in growth of RBSUs. More specifically, we study which initial conditions (starting resources), and aspects of the market strategy are related to growth in employees, revenues and total assets. This paper builds on previous research, which argues that founding conditions can have a long-lasting effect on firm growth and performance (Boeker, 1989). The paper is organized as follows. We start with a discussion on growth of RBSUs and how to measure it. We concisely review the literature that gives some guidance as to factors, which could contribute to growth and formulate specific hypotheses. Next, we describe our sample, the data, and analytical procedure. In the following section, we discuss the results of our analysis. We end with conclusions, limitations and directions for future research.

LITERATURE REVIEW

The high growth potential has long been the dominant view on RBSUs among researchers and policy makers. Several researchers indicate that RBSUs, once they have reached a certain critical mass, exhibit faster average employment growth rates than non-high tech starters (Mustar, 1995; Licht & Nerlinger, 1998; Storey & Tether, 1998; Delappierre et al., 1998; Autio & Parhankangas, 1998). However, in recent years several researchers showed that the idea of fast growth does not hold for most RBSUs. Rickne & Jacobsson (1999) found that the vast majority of New Technology Based Firms (NTBF) remained very small. Also Autio and Yli-Renko (1998) reported that most NTBFs in Finland did not grow at all. Similar findings were reported in France (Mustar, 1997), Italy (Chiesa & Piccaluga, 2000) and in Cambridge, UK (Segal Quince Wickstead, 2000). Delappiere et al. (1998) further argue that high tech firms that concentrate on R&D and work primarily as research subcontractors for large groups show little employment growth. In contrast, firms that deal with turning technology into new uses tend to grow and create employment as they develop their manufacturing and marketing capabilities. Clearly, there is still much discussion and uncertainty regarding the employment growth potential of RBSUs.

Measuring growth of research-based start-ups: revenues, employment and total assets

Studies on growth and performance of start-ups have come to contrasting conclusions even on the same explanatory variables (Woo et al., 1989). One possible cause might be the use of different growth and success measures such as sales growth (Lee et al., 2001), employment growth (Westhead & Birley, 1994), profitability (Spanos & Lioukas, 2001), total assets (Achtenhagen et al., 2004), first product shipment (Schoonhoven et al., 1990), self-rated perceptual growth and success measures (Pavia, 1991) or a composite performance indicator (Roberts, 1991). Delmar et al. (2003) argue that there is no “one best way” of measuring growth because firm growth is fundamentally a multidimensional rather than a one-dimensional phenomenon. They showed that high-growth firms do not

grow in the same way and that *‘what a “high-growth firm” is, conceptually and operationally, is very dependent on the growth measure used’*. Hence, of critical importance in studying the growth of RBSUs is the clear specification of growth criteria in question.

Different measures of growth have been proposed in the entrepreneurship literature such as (return-on) assets, employment, market share, physical output, profits, and sales (Ardishvili et al., 1998; Delmar, 1997). Several scholars argue that traditional accounting-based indicators of profitability are inappropriate for early stage RBSUs because most start-ups do not make any profit during their first years (Shane & Stuart, 2002). Sales, on the other hand, is an often preferred measure of firm growth and financial performance of new ventures (Ardishvili et al., 1998) because it is relatively accessible, it applies to (almost) all sorts of firms, and it is relatively insensitive to capital intensity and degree of integration (Delmar et al., 2003). Sales growth is often measured as growth in total revenues (Hanks et al., 1993). For RBSUs, it is, however, possible that assets and employment will grow before any sales will occur (Delmar et al., 2003). Resource-based view scholars value employment- and assets-based measures as a highly suitable indicator of firm growth (Penrose, 1959). If firms are viewed as bundles of resources, a growth analysis ought to focus on the accumulation of resources, such as employees and other assets. Policy makers are especially interested in identifying firms, which contribute most to job creation (Westhead & Birley, 1994). Finally, growth in terms of total assets and resource bases is increasingly receiving attention (Achtenhagen et al., 2004). In particular for RBSUs, growth in total assets might be a relevant growth measure because these firms often need to invest heavily in product and market development before generating revenues. To conclude, based on these previous studies, we argue that three measures are most appropriate to study the early growth of RBSUs, namely growth in employees, revenues and total assets.

Potential causes of firm growth

‘How and why’ start-ups grow to become successful firms is one of the least understood aspects in entrepreneurship research. Growth is argued to be a complex and

multidimensional phenomenon. Not surprisingly, there is no single theory, which can adequately explain small business growth, and chances are small that such a theory will be developed in the future (Gibb & Davies, 1990). On the other hand, several researchers argue that firms do not end up with particular growth patterns at random, but that “how firms grow” is systematically related to characteristics of these firms and their environments (Delmar et al., 2003).

While it is unlikely that a comprehensive model with predictive capability for growth will emerge, we think it is possible to identify key success factors that affect growth of RBSUs. To do so, we build on previous research which argues that the circumstances of an organization’s founding play an important role in imprinting the initial form of the organization and influence its later growth and performance (Boeker, 1989; Stinchcombe, 1965). Hence, in this study we focus on the ‘imprinting’ effects of initial conditions to explain heterogeneity in firm growth. More specifically, we use two approaches to identify factors which differ at founding and which may affect growth: (1) the resource-based view (RBV) approach, which emphasizes individual firm resources (Barney, 1991), (2) the broader market-led and international management approach, which emphasizes factors such as breadth and international scope of the market strategy. In the following paragraphs, we use these two theoretical approaches to formulate specific hypotheses regarding the determinants of growth for RBSUs. In agreement with previous empirical studies on firm growth we include differences in industry and competitive environment and the firm’s age and size as control variables.

Initial resources

Researchers in the stream of the Resource-Based View (RBV) of the firm argue that success is dependent on the characteristics of the firm’s resource bundle (Barney, 1991) and that one of the new venture’s challenges is to identify and acquire an initial resource base (Penrose, 1959). RBV-scholars explicitly recognize that a firm’s initial resources are an important antecedent to current capabilities and opportunities. ‘Firm resources’ is a multidimensional construct and entrepreneurship scholars studied different aspects of a firm’s resource base such as financial resources (Hellmann & Puri, 2000), personal

characteristics of the founders or entrepreneurial team (Roberts, 1991, p. 47 – 99) and product technology (Utterback et al., 1988).

In this study, we complement this literature by studying how different starting resources relate to growth in employment, revenues and total assets. Previous research on high tech start-ups shows that firms that start with products significantly outperform those that begin as consultants or R&D contractors (Roberts, 1991; Delapierre et al., 1998). In line with this, we formulate our first hypothesis as follows:

Hypothesis 1: RBSUs, which are further in the development cycle, will grow more in terms of employees, revenues and total assets compared to RBSUs, which are earlier in the product development cycle at founding.

For financing, we study the effect of the amount of starting capital and the involvement of venture capital (VC) investors. Insufficient financial resources are often cited as a primary reason why new ventures fail. Firms with greater financial resources can invest more in product/service development, production, and marketing, and have a larger financial cushion to provide insulation against slow start-up, market downturns, or managerial mistakes. Previous research suggests that the amount of initial capital invested is positively related to new venture survival and success (Cooper et al., 1994). Next, Davila et al. (2003) give descriptive evidence on how VC is significantly associated with high growth companies. This positive association between VC and high growth might be due to VCs ability to select firms with high growth potential or to postinvestment benefits that accrue to VC-backed firms (Baum & Silverman, 2003). In this study, we aim to test the hypothesis that more initial financing and VC involvement leads to higher growth.

Hypothesis 2: RBSUs, which have more financial resources and/or raised VC, will grow more in terms of employees, revenues and total assets compared to RBSUs, which start with more modest financial resources.

Firm-specific human capital in new firms is contained within the management know-how and experience of the founder and/or founding team (Welbourne et al., 1996). VCs consistently mention the quality (experience) of the founding team as an important criterion for venture funding (MacMillan et al., 1985), which suggests that human capital is an important predictor for new venture success. In line with this, several researchers report that the entrepreneur's skills and experience are positively related to new firm success (Roberts, 1991). We study the effect of the experience of the entrepreneurial team on early growth. More specifically, we study the cumulated experiences of all members of the founding team in different functions such as R&D, business development and sales, financing, production, etc. The hypothesis can be formulated as follows:

Hypothesis 3: RBSUs started by founding teams with more experience in different functional domains (R&D, commercial, other) will grow more in terms of employees, revenues and total assets compared to RBSUs started by less experienced teams.

Breadth and international scope of the market strategy

In addition to the decision of which industry to enter, entrepreneurs must decide upon the scale with which to enter that industry. In particular, entrepreneurship scholars suggest that two important aspects of the market strategy are the breadth of the targeted market and the international orientation of the new venture. Some start-ups focus on a narrow niche market, while others target directly large markets, which are broadly defined in terms of number, size and types of customers (Cooper et al., 1986; Romanelli, 1989). Other RBSUs focus initially on a niche market but have the specific intention of differentiating into larger, broadly defined markets later on (Tiler et al., 1993). Several entrepreneurship and strategy scholars advised new ventures to pursue very narrow niche markets in order to avoid direct competition with large firms. They suggest that new ventures should concentrate on specialized products and market segments where customization and high levels of customer service create unique (to small firms) advantages, or opportunities too small to be of interest to larger, economies-of-scale oriented firms (Porter, 1980). Other scholars found that new ventures with a broader more aggressive market strategy outperform start-ups with a focused strategy (Biggadike,

1979; MacMillan & Day, 1987). Noting the mixed results of research about the breadth of the new ventures market approach, McCann (1991, p. 193) suggests that it 'is a variable that should at least be considered in any research'.

The firms in this study develop and introduce really novel products or services in the market place. Such firms may try to compensate for greater technological uncertainty by a greater market focus (Pavitt, 1998). In a similar sample of firms in the Boston area, Roberts (1991, p. 28) found that companies that focus on core technologies and markets do much better than those that diversify into multiple technologies and markets. Moore (1991) argues that focusing on a specific market segment at first is critical to market and sell new 'high tech' products. Once the potential of the product/technology is demonstrated in an early (smaller) market segment, the firm can use these first customers as a reference to go after larger, broader markets. This suggests that RBSUs with a focus or a niche strategy at first will be more successful than firms pursuing broad markets from the start. Therefore, our fourth hypothesis is:

Hypothesis 4: RBSUs targeting narrowly defined niche markets at start-up will show higher growth in terms of employees, revenues and total assets than RBSUs with a broad, less focused market strategy.

Start-ups also differ in their international orientation, ranging from a local market focus, over international new ventures, which are committed from inception to sell their products and services in multiple countries to truly global start-ups, which proactively act on opportunities to acquire resources and sell outputs wherever in the world they have the greatest value (Oviatt & McDougall, 1994). Previous research found that RBSUs tend to be more internationally oriented early on in their lifecycle compared to non-high tech starters (McDougall, 1989). As the new millennium begins, the number of young firms experiencing rapid internationalization appears to be increasing (Shrader et al., 2000). Autio et al. (2000) argue that a key strategic issue for entrepreneurial firms is whether it is better to start the internationalization process soon after founding, or to postpone international entry until the firms has accumulated significant resources. However, our

understanding of the consequences of internationalization for young firms is rudimentary. This study, we analyze the impact of an international orientation from the start on the early growth of RBSUs. Previous research argues that internationalization provides firms with growth opportunities (Autio et al., 2000). Therefore, our fifth hypothesis is:

Hypothesis 5: RBSUs with an international market orientation from the start will show higher growth in terms of employees, revenues and total assets than RBSUs focusing on local markets.

METHOD

Population of RBSUs

In this paper, we use ‘research-based start-up’ or RBSUs to overcome the conceptual confusion that exists around ‘NTBFs’ and related concepts (Storey & Tether, 1998; Rickne & Jacobsson, 1999; Rickne, 2000). We believe that ‘research-based start-up’ better captures what most researchers actually mean, namely new companies (start-ups) introducing new innovative products and services on the market, which they (partly) develop themselves (research-based).

Sampling

We study RBSUs in a homogeneous region in order to reduce the non-measured variance resulting from environmental conditions. We choose Flanders, which is a small, export-intensive economy, located in the northern part of Belgium. 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 & Iammarino, 2001). To construct the sample frame, we first identify the RBSUs among academic spin-outs, venture capital backed firms, and start-ups that received R&D subsidies. Next, we complement our sample with a random selection drawn from the entire population of companies that are active in high-tech and medium high-tech

industries. In total, our sample comprises 205 firms founded in Flanders (Belgium) since 1991. For this study, we limit our sample to the 171 firms founded between 1991 and 2000, in order to have at least three-year growth figures.

Data Collection and Descriptive Statistics

The primary data source is a structured questionnaire, which enables the reconstruction of the firm's history and particularly focuses on the firm's resources, products, market characteristics, and employees. For each item, we collect the data on the initial conditions (during their first year of operations) as well as on the current situation (time of interview). The questionnaire is conducted during personal interviews with the founder. The founders or CEO's were targeted because they typically possess the most comprehensive knowledge on the organization's history, the firm's strategy, its processes and performance (Carter et al., 1994).

Measures

A lot of debate has also been devoted to whether absolute or relative growth measures should be used (Achtenhagen et al., 2004). Absolute measures tend to ascribe higher growth to larger firms whereas smaller firms more easily reach impressive growth in percentages (i.e. relative) terms (Delmar et al., 2003). We follow the arguments of Westhead and Birley (1994) and use the absolute growth and not the percentage change. *“The obvious concern is that the same change when calibrated from different bases would be represented by different percentages. The effects of employing percentages would be particularly problematic in the sample of small start-ups with three or less employees”* (Woo et al., 1989, p 139). In other words, using relative i.e. percentage, growth measures is especially troublesome if one studies small ventures since the smallest venture naturally ends up with the highest relative growth even if in absolute terms its growth is negligible compared to the absolute growth of its larger counterparts. To assess the potential causes of employment and revenue growth, we use ‘Annual Absolute Employment Growth’, ‘Annual Absolute Revenue Growth’, and ‘Annual Absolute Total Asset Growth’, which are objective measures of the annual absolute

employee and revenue change (Hanks et al., 1993; Westhead & Birley, 1994; Delmar et al., 2003).

Table I describes how the independent variables are measured. Table II gives an overview of the descriptive statistics.

INSERT TABLE I ABOUT HERE

INSERT TABLE II ABOUT HERE

Sample characteristics

The firms in the sample are between 2 and 14 years old with an average of 5 years. At start-up (during their first year of operation), these firms employed 725 people in total. At the time of survey, these firms employed 4290 people in total, which means they have grown their employment base since start-up by almost 600 percent. The mean total employment size is 21 with the majority of the firms employing less than 7 people. However, the growth is not uniform across the sample. As expected, the 20 fastest growing RBSUs (about 10% of our sample) account for more than 56 percent of net additional jobs. Overall, the RBSUs appear to be a group of firms of particular interest to policy-makers. In a relatively short time, they have created apparently viable growing businesses in a wide range of technologies, including software (42%), micro-electronics (12%), medical-related technologies, including biotech (17%) and others (29%).

RESULTS

Table III presents the Pearson Product-Moment correlations for the three dependent variables, namely Absolute Annual Employment Growth (AAEG), Absolute Annual Revenue Growth (AARG) and Absolute Annual Growth in Total Assets (AATAG). The correlation coefficients range between 0.51 and 0.68. The Cronbach Alpha for these three growth measures is 0.83 when missing data are case wise deleted and 0.71 when missing data are substituted by means. Hence, our data indicate that the three growth measures are strongly correlated. Although employment, revenues and total assets are different aspects of growth, these indicators seem to measure one underlying growth construct.

INSERT TABLE III ABOUT HERE

Multivariate regression analysis

In order to assess the combination of factors that best explains growth of RBSUs, we use general least squares (GLS) regression analysis. This statistical technique allows association of each independent variable with the dependent variable while controlling for the effects of other independent variables. The dependent variables, i.e. our growth measures, are not normal distributed. As a result statistical tests on the absolute growth measures might be invalid (Hair et al., 1984). We remedy for the non-normality by taking the logarithms of the growth measures. An undesired consequence of using the logarithms of our growth measures is that the cases in which growth is zero or negative are lost for the GLS analyses. Hence, our sample of observations on the log dependent variables is biased towards firms with positive growth figures. It is possible that the exclusion of observations introduces a sample bias in our estimation. We therefore also conduct a sample selection model, where we estimate the likelihood of positive growth in employment, revenues and total assets in separate Probit equations. We estimate these models using the Heckman two-step estimation procedure. We tried many different

combinations of variables to estimate the probit models in the first step including the same explanatory variables of the main regression as well as others such as size of founding team, age (founding year), sector, etc. None of these combinations resulted in significant lambda's and the results of the sample selection models do not differ from the GLS models. We also conducted the GLS analyses with the absolute growth measures. The interpretation of the results is not substantially different but in these models some of the control variables are also significant while they are not in the log-transformed models. The normality assumption is the most fundamental assumption for GLS. Therefore, we prefer to only report the GLS results of log-transformed data.

Table IV shows the results of three general least-squares (GLS) regression models, one for each dependent variable in this study, i.e. log employment growth, log revenue growth and log growth in total assets. Each GLS model includes all the independent variables for which we formulated specific hypotheses regarding their effect on growth and the control variables. The results from the different estimating methods reveal a reassuring consistency. Independent variables explain 28% of the variance in employment growth, 12% of revenue growth and 32% of growth in total assets.

INSERT TABLE IV ABOUT HERE

The multivariate analyses show that starting resources have an important impact on the early growth of RBSUs but the effects are not always in the direction we supposed. In hypothesis 1, we argued that firms that are closer to a market-ready product at founding would grow faster in terms of employees, revenues and total assets. Our data do, however, not support this hypothesis, on the contrary. Our multivariate analysis indicates that firms, which are earlier in the product development cycle grow significantly more in total assets during the first years than firms that are closer to market launch at founding.

In line with hypothesis 2, we find that higher amounts of starting capital and attracting venture capital during the first year are associated with higher employment and revenue growth³. However, if we include the interaction effect between the amount of start capital and whether or not venture capitalists participated in the initial capitalization, we get a very different picture. The interaction effect has a significant positive effect on employment and revenue growth. In other words, higher amounts of capital provided by venture capitalists lead to higher growth in employment and revenues. In contrast, the venture capital dummy in itself is significantly negatively associated with employment and revenue growth. Hence, raising venture capital at founding has a rather large negative effect on employment and revenue growth unless the invested capital is high.

Next, several researchers already showed that the characteristics of the founder(s) affect venture success. Therefore, we argued for a positive effect of the founder's experience on early growth of RBSUs in hypothesis 3. We tested the effect of the cumulated total experience of the founding team members as well as their experience in different functional domains such as R&D, commercial functions and business development, and other domains such as financing, legal, production, etc. We find that the total number of years of experience of the founding team has a significant positive effect on growth in employees, revenues and total assets. Taking a closer look at the type of experience that best explains growth, we find that only experience in business development and commercial functions (sales/marketing) has a significant positive effect on growth. Experience in R&D and other functional domains (finance, legal, production, etc.) have no significant effect on growth. Therefore, we choose to replace the variable measuring the total experience of the founding team by the variable measuring the commercial experience in the reported model (Table IV). Thus, hypothesis 3 is supported, especially with regard to the commercial experience of the founding team. We also calculated a team heterogeneity measure and found that more heterogeneous teams are associated with higher growth but this effect is not significant.

³ The models in which log capital and the VC dummy are introduced separately are not shown and can be obtained from the others on request. In these models the coefficients of log capital and the VC dummy are significantly positive.

Regarding hypothesis 4, we find no effect of the breadth of the firm's market strategy on employment and revenue growth states. For growth in total assets our results support our fourth hypothesis. Companies with a niche approach grow more in total assets during the early growth path compared to new ventures targeting broadly defined markets. Next, we find strong support for hypothesis 5. Going after international markets from the start leads to significantly higher growth in revenues and total assets. For employment growth we also find a positive effect of an international orientation from the start but it is not significant.

Regarding the control variables, we find that software start-ups grow significantly more in number of employees during their early growth path than start-ups in other technologies. Medical related firms, on the other hand, grow more in total assets. Firms in medical-related industries mostly need higher investment in laboratories and equipment compared to firms in other industries. Hence, it is not surprising that these firms grow more in total assets during their first years. The significant higher employment growth of software start-ups might be linked to the availability of venture capital for software companies in the late nineties. Next, we find no effect of competitive forces (entry barriers, threat of substitutes and buyer power) on the early growth of RBSUs. We used the same measures as the ones used in previous studies on start-ups and SMEs (Spanos & Lioukas, 2001). Caloghirou et al. (2004) also report that the impact of competitive forces on performance is much weaker than a firm's resources and capabilities. It is, however, also possible that these measures do not adequately capture the competitive forces at founding because these measures are subjective and self-reported by the respondents during the interview. These retrospective measures are, however, the best proxies we have to control for differences in the competitive environment. Finally, we only find a significant positive effect of age and size on growth in total assets, indicating that older and larger firms grow more in total assets.

Robustness checks

We conduct a series of checks to evaluate the robustness of our findings. First of all, growth might not be a linear function of age. We controlled for that by including age as a

control variable in our previous models and found no significant effect. However, our dependent annual growth variables are calculated as the difference between the 'size' (in employees, revenues and total assets) in the first year and the 'size' at time of interview, divided by the age (in years) of the firm. Hence, these growth measures assume a linear growth process. Therefore, we also checked the robustness of our results in sub-samples of firms with different age profiles. More specifically, we estimated similar models for the sample of firms that are between 3 and 7 years old and between 7 and 13 years old. Our results remain qualitatively the same, i.e. the directions and significances of the regression coefficients are the same. Further, we were able to obtain annual data for total assets for most companies in our sample. As an additional check, we calculated the yearly growth in total assets for the first three years (all the companies are at least three years old, hence we could calculate this measure for the full sample). Again our results remain robust.

We find that early growth in employees, revenues and total assets are significantly correlated with each other. Some independent variables such as commercial experience of the founders explain for the three forms of growth while other variables such as amount of capital and VC explain for employment and revenue growth but not for growth in total assets. Across our three growth measures different cases are missing. As a result, these models are not based on completely the same firms. In order to make a more sound judgment on whether different independent variables explain growth in employment, revenues, and total assets, we also conduct the same analysis on a reduced dataset excluding all cases where one or more variables are missing. In other words, we only include those 56 firms in the analysis for which all variables are available. The results are again comparable.

DISCUSSION

In this section, we compare our main findings with other studies. We also carefully examine the qualitative information (interview reports) of the firms in the upper and lower growth quartiles in order to explain our results and to gain deeper insights in the growth path of RBSUs,.

‘Investor’ and/or ‘market’ acceptance are the key drivers for early growth.

Several studies show that most RBSUs start with the limited personal savings of the entrepreneurs and that only a small number of RBSUs are able to raise venture capital in their first year (e.g. Roberts, 1991; Manigart & Struyf, 1996; Heirman & Clarysse, 2004). This study clearly indicates that those firms that are able to attract large amounts of VC – and hence get ‘investor acceptance’ for their business idea early on - grow faster in terms of employees and/or revenues. All of the top 20 highest employment growers were able to raise abundant financial resources. Seventeen firms rose between 1 and 6 Mio Euros in venture capital during their first year of operations. Three firms started without venture capital but had access to other abundant financial resources early on. Two of them started with small investments by the founders and 3F money of about 75 000 Euro. Four years after founding, driven by a beneficial financial climate on the technology stock markets, these firms went public on NASDAQ Europe. The other none-vc-backed high growth company had access to the deep financial pockets of its parent company.

The importance of sufficient financial resources for growth is also observed in other studies. For example, Roberts (1991, pp. 264 - 269) and Lee et al. (2001) found a positive effect of the initial capitalization of technological start-ups on sales growth. However, Roberts (1991) found that this positive effect of initial financing on growth and success is especially strong when the companies generate revenues through product sales. In a mixed sample of product-based firms and companies, which begun without product revenues the association of initial financing and firm performance gave mixed results.

Nearly all high performing firms received high levels of initial financing, but 10 of the 23 firms, which received high levels of initial capital still belonged to the lower performers. Schoonhoven et al. (1990) found that companies with greater monthly expenditures – hence those that raised large amounts of VC - need more time to ship their first product for revenues. They argue that this might signal that firms raising larger amounts of VC focus on more technical ambitious projects. Alternatively, they argue that “just throwing money at a new venture does not appear to be a viable approach to speeding product to markets” and “may inhibit organizational performance”. These firms may show high employment growth figures during their first years because they invest heavily in R&D personnel. However, the sustainability of such a growth path depends on the firms ability to develop products and ship them to customers for revenues before all the cash is burned (Schoonhoven et al., 1990). Baum and Silverman (2003) find that VCs are attracted to firms that have technology that can lead to strong future performance but that are teetering on the edge of short-term failure. The economic function of early stage VC financing is indeed to provide financial resources for risky but promising start-ups.

Our results indicate that getting ‘investor acceptance’ (i.e. being able to raise large amounts of VC) at start-up leads to high growth in the first years but previous studies indicate that this high growth trajectory can be very risky and might not be sustainable. The number of failures in our sample is too small to do a quantitative analysis but we can get some first insights in the risks associated with fast early growth by studying the top 20 highest growers in more detail. To get more insights in the sustainability of high growth we study to what extent ‘investor acceptance’ leads to/ or is preceded by ‘market acceptance’ for the top 20 firm that grow most in employees and/ or in revenues. Revenue growth is an indicator for market acceptance, while growth in employees which is not matched by growth in revenues is possible when the firm obtains investor acceptance first.

We already showed that employment and revenue growth are strongly correlated (Table III). This relationship seems to be even stronger among the high growth firms. In particular, 15 of top 20 high employment growth firms are in the top 20 of high revenue

growth firms. This is in line with Smallbone et al. (1993) who found a strong relationship between employment growth and real turnover growth in a sample of high growth SMEs. These 15 firms were able to convince the venture capital community and get market acceptance for their products/ technology. The high employment and revenue growth can therefore be explained by acceptance of these firms' business models by the investors community and by the market they address.

For the five firms that belong to the top 20 of revenue growth, but not to the top 20 of employment growth, the driver for growth is only market acceptance and not acceptance by the venture capital community. These five firms financed their growth out of their sales activities and did not (or were not able to) raise venture capital. These five companies grew less in employment compared to other RBSUs, i.e. they are not in the top 20 of employment growth. Their ratio revenue growth to employment growth is higher than for most other RBSUs. The growth path of these companies can best be described as 'slowly' but steadily. These firms do not need high investments to finish R&D activities and the market rapidly accepts their products and services. As a result, these start-ups are able to grow their revenues under the impulse of strong demand for their products/ services. Moreover, these firms strongly focus on *profitable* growth early on. These firms are on a slower growth trajectory, but their growth seems to be less risky than their counterparts who need large upfront investments before market acceptance is established.

Next, we observe that out of the top 20 employment growth firms, three firms went bankrupt and two firms are currently in trouble, meaning that they are seriously restructuring their business activities and conduct large scale lay-offs. One drug discovery firm was acquired by a large pharmaceutical company and there is some discussion about whether this was a successful exit for the shareholders. Hence, for at least 25% of the high employment growth firms, the early growth seemed to be not sustainable. This percentage is rather high compared to the failure rate of 7% in our total sample.

If we plot the yearly revenue growth against the yearly growth in employees, we observe that the two firms that are currently restructuring their business grew their employment pool much faster than their revenues. Both restructuring firms were able to raise a lot of money in several VC-rounds and an IPO in the mid nineties. They used these funds to focus on growth without being overly concerned with profitability. As a result, these firms were accumulating the negative cash flows year after year. In line with the low performing firms in the study of Schoonhoven et al. (1990), the high burn rates of these firms did not result in fast product development and strong revenue streams. Of course, the growth-at-any-expense business model has obvious practical limits, as was shown by the late 1990's stock performance of many high-technology firms. Forced by shareholder pressure, both firms are restructuring and started to focus on the 'bottom line' (i.e. their business activities with recurrent revenues) and control the expenses. The large-scale investments in technology development are seriously diminished in order to cut costs and become cash flow positive by the end of the year.

The three firms that failed had no recurrent revenue streams and restructuring was therefore not an option to save (part of) the business once their investors ran out of patience. These firms used their capital to develop really novel technologies and products. In the late nineties, these so-called platform start-ups with a strong proprietary technology and wide range of applications, attracted a lot of attention from VCs (Baum and Silverman, 2003). One of these firms, active in the development of a telematica platform for the automotive sector, raised about 30 Mio Euro over its 7 years of existence. This money was nearly all spend for technology development and market 'education', i.e. lobbying with all key players to adopt their technological platform and develop applications for it. However, the product development as well as the market acceptance took a lot longer than initially foreseen. Raising more capital in yet another capital round seemed to be impossible and these firms failed. When the company declared bankruptcy, its technological assets were sold for 1.5 Mio Euro.

Other researchers also show the importance of market maturity and the risks associated with creating new markets. In a study of German VC-backed firms, Schefczyk (2001)

argues that both high market acceptance of a firm's products and services (resulting in growing revenue streams) as well as market and industry structure affect the performance of companies in the portfolio of venture capitalists. In line with this, Chesbrough (2003) argues that ventures that are able to grow their revenues at a faster rate in their early years are offering goods and services that customers quickly choose to buy. These ventures are more likely to turn profitable sooner, to consume less cash and are more likely to achieve a profitable liquidity event for their investors (Bhide, 1992).

The firms that failed or have the highest risk to fail (high burn rates) in the near future are the ones for who market acceptance of their products/services is very unsure. Reading through the interview reports, it seems that most of these high growth RBSUs show increasingly negative cash flows and spend the largest chunk of their capital for technology development and platform building and not for business development, marketing or sales. In a way, these firms pursue the most technical ambitious projects, which brings considerable risks to the company. Although the technology is young and immature and the market and possible applications are unclear, these firms are also the most ambitious ones with regard to the markets they address. When asked to estimate the market potential, the founders talk about the overall market of the technology, which translates in billion dollar figures globally, spread over many applications and several industries. These companies develop broad platform technologies and have development projects for several applications. Some prior work suggests however that starting on a large scale when technical uncertainty is still very high mostly leads to unsuccessful innovation projects (Branscomb & Auerswald, 2001). Many early stage platform firms are among the highest growers in terms of employees and total assets and some of them are also among the top growers in revenues. These revenues are, however, not coming from product sales but from R&D contracts with milestone payments. The focus on R&D is also visible in their employment pool. Most of their employees are active in R&D and not in commercial functions or product support. For these platform companies, the growth in total assets is not due to increased sales activities but to increasing investment in R&D. Activations of R&D costs is common practice in Belgium. Therefore, firms that are investing heavily in R&D grow in total assets even if their 'market' activities are not

increasing. The accounting practice of activating R&D costs also explains the significant negative coefficient of the NPD-variable on total asset growth. Firms that are earlier in the product development cycle invest more in R&D and since these cost are activated, they grow in total assets.

For two of the failed firms and for one of the currently restructuring firms, the interview reports point to another difference between these firms and the surviving high growth firms. The failures did not have an asset parsimonious mindset. It seems that management procedures and techniques for established businesses were inappropriately enforced on the new ventures. These firms often took too much time to make a decision, overplan, and overstaff; rather than make rapid small-chunk, spontaneous commitments. This organizational overkill can be hazardous to fragile new ventures, where timing, action and social interaction are critical (Starr & MacMillan, 1990). Schoonhoven et al. (1990) and Van de Ven et al. (1984) also observe that new ventures with high cash burns during the development period are slower to get products out. For one VC-backed firm the 'big spending attitude' seemed outrageous. In contrast to what one might expect from entrepreneurs of a start-up these founders were paid high salaries, drove expensive company cars, had large offices in an expensive building and always flew business class. The question is whether the investors' money was well spent. Interestingly, the three founders all held senior management positions in a large firm before starting their own firm. Clearly, the mindset of some large company managers is not necessarily appropriate in an entrepreneurial context.

An intriguing finding is also that venture capital has a negative effect on employment and revenue growth if the raised amounts of capital are small. Looking at the lower quartile of RBSUs in terms of revenue and employment growth, we indeed find several RBSU, which started with smaller amounts of venture capital ranging between 100 000 and 1.1 Mio Euro. One explanation for the slow growth of the firms can be that they did underestimate the capital needed to finance their activities and lack the resources to grow. Next, these small amounts of capital are often provided by multiple small VC-funds without a clear lead investor. One of the entrepreneurs complained about how difficult it

was to manage the 5 VCs on his board of directors and he actually claimed that the failure of his business was due to the arguing investors who never agreed on important issues. This suggests that if a firm is not able to get investor acceptance from first tier VC-funds it might be better not to raise VC at all and use alternative financing channels. Another possible explanation is that several of these slow growing VC-backed firms are not ready yet to embark on a high growth trajectory because their technology or market or both is immature. Several of the slowly growing VC-backed firms are university spin-offs, which are funded by specialized VC-funds linked to this university. The university funds in Flanders only invest relatively small amounts in start-ups founded with the mission to develop and commercialize new technologies developed within the university. Most of these firms would not be able to raise venture capital from other private funds because their business idea is too immature. The slow growth of these 'immature' VC-backed firms could therefore be due to the small amounts of venture capital as well as to the early stage of the product technology.

Commercial experience of founders is a main determinant of early growth

Our results consistently show that founding teams with commercial experience grow significantly more in terms of employment, revenues and total assets. This is an important finding because the firms in our sample all have a strong technological (R&D) component in their business plans and the entrepreneurs mostly have pure technical backgrounds. Roberts (1991, pp. 251 – 259) also found that prior managerial work experience and prior sales experiences of the founders correlate with success in a sample of high tech start-ups. He argues that the better performance of commercial experienced entrepreneurial teams can be due to their familiarity with the market as well as to their awareness of VC sources. He argues that entrepreneurs with commercial experience not only have a better understanding of the market but mostly also have a better understanding of the financial community and how to approach investors. Feeser and Willard (1990) found that high growth firms are more often started by entrepreneurs with prior experience with the product, market and/or technology than low growth firms. The importance of founding team experience is also reflected in the venture capital literature which consistently mentions business, sector and management experience of founding

teams as one of the key criteria for VCs to make investment decisions (MacMillan et al., 1985; Zacharakis & Meyer, 1998).

However, in our population of RBSUs, the founding teams that show considerable commercial experience are rare. On average the founding teams have only 3.8 years of commercial experience and the median founding team has no commercial experience at all. On the other hand, almost all companies have at least a few years of technical experience among their founders and on average founding teams have 11 years of R&D experience. It is indeed not surprisingly that the entrepreneurial teams of RBSUs have primarily technical backgrounds and are, presumably, in need of additional members to provide necessary business skills. We observe, however, that technical entrepreneurs seldom seek co-founders with commercial experience because they underestimate the importance of market knowledge or because they believe that they have sufficient market knowledge themselves. Entrepreneurs who have commercial experience but lack technical knowledge, on the other hand, are less likely to overestimate their technical capabilities and are more open to add co-founders with the technical know-how.

The founder of the fastest growing firm in our sample formulates the importance of a partner with complementary experience as follows: *“The first major milestone in setting up this company was the attraction of a co-founder and CEO. I spotted the market opportunity (software for financial service industry) while I was working for a major bank but I knew that I was not the right person to lead a company as this one. I needed a partner with knowledge about the technology, experience in the sector and in managing technology-based ventures. After doing some desktop research, I came up with a list of 4 possible men that might be suited to become partner and CEO. Two of them were senior managers at Oracle and Microsoft, the third one was the CEO of a firm in the payment industry and the fourth one was a successful entrepreneur in the online banking industry and at that time chairman of the market leader in the sector. This fourth man was the right match. After talking back and forth for a while about the business idea and how each of us envisioned the company, he got convinced about the potential and became co-founder, CEO and investor.”* The important point is that he did not hire a CEO but

attracted an equal partner who obtained an important part of the shares. When we asked about how he felt about sharing his invention with somebody else and giving up part of the control, he replied: *“I could never have reached the point where we are today on my own. I rather have a small percentage of something big than 100% of something tiny”*.

These quotes very well illustrate Roure and Keeley’s (1999) argument that two of the most important factors affecting growth are the willingness to accept growth and to manage the consequences of growth including the willingness to add new owners. Aggarwal et al. (2004) also support the notion that direct links to industry knowledge through founders better facilitates the integration of this knowledge than grafting knowledge through hiring employees with industry experience. Despite the importance of complementing technical founding teams with founders with commercial/business experience, our data show that the majority of the RBSUs typically consist of only technical people. Other studies also report that adding people with different complementary experience to technical founding teams is not straightforward. In a case study of one of the RBSUs in our sample, Clarysse & Moray (2004) describe how entrepreneurs with technical backgrounds prefer partners who themselves have technical backgrounds. Similarly, Chandler and Lyon (2001) found that functional diversity was not a major criterion for considering additions to the new venture team in a study of 12 start-up teams in Utah, US. In that study, the most common criteria stated by the founders with respect to team member selection was having a common interest in the technology or service provided by the business. Schefczyk (2001) reports that German entrepreneurs’ focus on technology and engineering issues is accompanied by a lack of business skills. Wupperfeld and Kulicke (1993) found that for 80 percent of failing companies sponsored by public pilot programs, characteristics of the founder-manager contributed to the failure. The shortcomings were most frequently identified in business functions or skills, such as marketing and sales and general management know-how.

International orientation is an important driver for growth.

Our data show that targeting international markets from the start leads to higher growth in revenues and total assets but not in employees. Internationalization is costly and thus it is

not surprising that firms with an international orientation grow more in total assets than RBSUs focusing on local markets first. The larger international markets are translated in higher revenue growth but not in employment growth. We asked for the total number of employees of the firm and not only for the people employed in Belgium. The reason for not observing an effect of international orientation on employment growth can therefore not be explained by not counting the employees in foreign subsidiaries. A possible explanation is that most start-ups – due to their usual relative poverty of resources – often use distributors and interorganizational alliances to sell their outputs across national borders (Coviello & Munro, 1997).

During our interviews many entrepreneurs explained that early internationalization was a requirement for their firms to participate in high technology industries because competition itself is international. Other entrepreneurs argued that the small home market for their technology products and services was the main reason to have international ambitions from the start. Shrader et al. (2000) argue that innovative new ventures with high growth ambitions derive more of their revenues from foreign markets and are thus more likely to internationalize early in their existence, prior to thoroughly establishing themselves domestically. Our results are also in line with Autio et al. (2000) who found that the earlier in their development high-tech firms internationalized, the more rapidly they grew internationally. They believe that the survival and prosperity of born-global firms may be explained by their ability to adapt to and innovate more rapidly in new and dynamic environments than would ordinarily be the case for older firms.

CONCLUSIONS AND IMPLICATIONS

A first important finding is that growth in employees, revenues and total assets are highly correlated – at least during the first 3 to 13 years of the firm’s existence - and belong to one ‘growth’ construct. Hence, future research on the early growth of RBSUs could focus on one of these growth measures as a good indicator for early growth. Data on employees and revenues are more readily available of young firms than data on total assets. Total assets are also more difficult to interpret because what is included in this measure depends on the accounting practices of the firm. For example, some firms activate their R&D costs while others don’t. Therefore, we suggest to use employment and revenue growth in future studies on growth.

This study brings insights in the characteristics of the high-growth RBSUs by analyzing which starting conditions spur growth in the first years after inception. Studies of initial conditions have had the aim of describing and characterizing promising start-ups by studying traits that are visible at start-up (Gartner et al., 1998). This stream of research is highly motivated by, for example, venture capitalists with an interest in generic selection of investment criteria (Kaulio, 2003) and policy makers favoring a policy of ‘picking winners’ (Storey et al., 1987). Our results indicate that a bundle of assets, and in particular large amounts of venture capital, a founding team with commercial experience, together with an international market approach lies at the heart of the firm’s growth prospects. Starting with an almost market-ready product, on the other hand, does not affect growth in employees and revenues.

Our qualitative data indicate that fast early growth is not equal to sustainable growth. Some high growth firms focus on getting ‘investor acceptance’ first and raise large amounts of capital without proven ‘market acceptance’ for their product/technology. Short-term employment creation does not automatically lead to the development of viable competitive businesses (Smallbone et al., 1993). After the crash of technology stock markets in the late nineties, the growth-at-any-expense business model does not seem

feasible anymore. Our results indicate that entrepreneurs with the ambition to grow fast and sustainable, should try to balance employment and revenue growth. Our case studies and prior work by other researchers suggest that focussing on concrete market applications for niche markets increases the chances on success to commercialize really new technologies. Early stage technology platform companies that are started on a large scale with a broad and ambitious technology and broad market focus show high growth in employees. This is, however, a high risk growth path, which is only sustainable if the company succeeds to generate a strong revenue stream before all the cash is burned. Of course, these companies mostly have a clear exit intention and aim for an IPO or an acquisition. However, at exit the value of the company will still be determined by the market acceptance of its products/ technology and 'proven' demand.

We also find that some high growth RBSUs pursue market acceptance first without raising external capital. These firms follow a slow, less risky growth path and grow more in revenues during the first years than in employees. In some cases these firms raise large amounts of capital (VC or IPO) to accelerate their growth once the market potential is proven.

Finally, the firms that got 'partial' investor acceptance at founding, i.e. they raised VC but only small amounts (mostly from small VC funds) grow less than firms starting without VC. Entrepreneurs should be aware that VC is not the only way to finance RBSUs and it might not be the best option for any business. Alternative financing methods are bootstrapping or launching ventures with modest personal funds, government grants to finance R&D, loans, fuel early growth with revenues from sales and/or services, or upfront- and milestone- payments from strategic partners, or any combination of those. Our results indicate that when it is not possible to get sufficiently large VC-backing, it might be better to use alternative financing channels instead of raising small amounts of VC. The true entrepreneurial challenge often is not to raise VC but to start the business without it. Once the market potential is clear, the entrepreneurs can try to raise later stage VC to accelerate the growth.

In short, during its early growth path a company can focus on getting investor acceptance, market acceptance or both. We find that you need both to create a sustainable high growth company. Entrepreneurs may try to get either investor or market acceptance first but they should not forget the other. To create a sustainable business, it will ultimately be the market for their product/ technology that determines the value of the firm and its chances on survival in the long-term.

We find that especially commercial experience has a strong impact on the early growth of RBSUs while the majority of RBSUs is started by purely technical founding teams. The importance of commercial/business development experience is still often undervalued by technical entrepreneurs, technology transfer offices and policy makers. Technical entrepreneurs often think that the ‘technology’ is the most important aspect of their company and lack a clear market orientation. This study clearly shows that also for RBSUs commercial experience is more important for growth than R&D experience. Prospective entrepreneurs should assess their own readiness for starting a new business. If they have the ambition to grow the company they should be willing to search for business partners to complement their own experience or alternatively acquire the necessary skills themselves and postpone starting their own venture.

Also the government can play an important role in this respect. Several government initiatives exist to support firms in their ‘technical’ activities (R&D subsidies) but business support programs on the other hand are scarce. Sponsoring training programs, organizing networking events and subsidies for market research are some initiative that could really make a difference. Finally, technology transfer offices and university start capital funds also seem to emphasize the ‘quality’ of the technology more than the quality of the entrepreneurial team when selecting and investing opportunities to commercialize public research results. Technology transfer offices and university start capital funds can also play an important role in bringing business people and experienced entrepreneurs in contact with inventors and people with deep technical expertise.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

Our study only contains data on Flemish RBSUs. A positive consequence of this small geographic coverage is that it reduces the influence of non-measured variance. The trade-off, however, is that one might question the external validity of this region and our findings. Secondly, we focus on the impact of starting conditions on the early growth path of RBSUs. Of course, starting resources as well as a firm's strategy are not static. This calls for more dynamic designs, following up not only the growth variables but also the development of explanatory variables (Davidson & Wiklund, 2001). Next, future research should dig a little bit deeper with respect to what distinguishes early growth from *sustainable* early growth. This implies linking the growth literature to the literature on survival, failure and sustainable competitive advantage. Our research indicates that a promising path to follow is to study the business models of RBSUs in more detail. Do the firms have recurrent revenue streams or large one-time contracts? Is the growth in employees disconnected from their revenue growth? Does every new employee make the cash flow more negative or positive? Do they grow more in R&D employees or in sales people? Finally, we think a very interesting area for future research concerns entrepreneurial team formation. Our data clearly show that adding experienced business people to technical entrepreneurial teams facilitates early growth of RBSUs. However, functional heterogeneity brings with it various challenges, increasing both cognitive conflict and affective conflict within the decision-making team (Forbes et al., 2004). Until today, we lack insights in how technical entrepreneurs can deal with these cognitive challenges and what can be done to connect entrepreneurs with business people.

REFERENCES

Achtenhagen, L., Melin, L. & Naldi, L. (2004). Towards a Re-conceptualization of Firm Growth. *Paper presented at the 2004 Babson Entrepreneurship Research Conference, Strathclyde, Scotland.*

Acs, Z.J. & Audretsch, D.B. (1990). *Innovation and Small Firms*. MIT Press, Cambridge, Mass.

Aggarwal, R., Echambadi, R., Franco, A.M. & Sarkar, MB. (2004). Knowledge Transfer Through Inheritance: Spin-out Generation, development and survival. *Academy of Management Journal*, **47**, (4), pp. 501 – 522.

Ardishvili, A., Cardozo, S., Harmon, S. & Vadakath, S. (1998). Towards a Theory of New Venture Growth. *Paper presented at the 1998 Babson Entrepreneurship Research Conference, Ghent, Belgium.*

Autio, E. & Lumme, A. (1998). Does the Innovator Role Affect the Perceived Potential for Growth? Analysis of Four Types of New, Technology-based Firms. *Technology Analysis & Strategic Management*, **10**, (1), pp. 41 – 54.

Autio, E. & Parhankangas, A. (1998). Employment Generation Potential of New, Technology-Based Firms during a recessionary period: The Case of Finland. *Small Business Economics*, **11**, (2), pp. 113 – 124.

Autio, E., Sapienza, H.J. & Almeida, J.G. (2000). Effects of Age at Entry, Knowledge Intensity, and Imitability of International Growth. *Academy of Management Journal*, **43**, (5), pp. 909 – 924.

Autio, E. & Yli-Renko, H. (1998). New, technology-based firms in small open economies – An analysis based on the Finnish experience. *Research Policy*, **26**, pp. 973 – 987.

Barney, J.B. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*, **17**, (1), pp. 99 – 120.

Baum, J.A.C. & Silverman, B.S. (2003). Picking Winners or Building Them? Alliance, Intellectual and Human Capital as Selection Criteria in Venture Financing and Performance of Biotechnology Start-Ups. *Journal of Business Venturing*, In Press.

Bhide, A. (1992). Bootstrap Finance: The Art of Start-Ups. *Harvard Business Review*, November – December, pp. 109 – 117.

Biggadike, R.E. (1979). The Risky Business of Diversification. *Harvard Business Review*, **57**, pp. 103 – 111.

Boeker, W. (1989). The Development and Institutionalization of Subunit Power in Organizations. *Administrative Science Quarterly*, **34**, pp. 388 – 410.

Branscomb, L.M. & Auerswald, P.E. (2001). *Taking Technical Risks. How innovators, Executives, and Investors Manage High-Tech Risks*. The MIT Press, Cambridge Massachusetts.

Caloghirou, Y., Protopogerou, A., Spanos, Y. & Papagiannakis, L. (2004). Industry- Versus Firm-specific Effects on Performance: Contrasting SMEs and Large-Sized Firms. *European Management Journal*, **22** (2), pp. 231-243.

Cantwell, J. & Iammarino, S. (2001). EU Regions and Multinational Corporations: Change, Stability and Strengthening of Technological Comparative Advantages. *Industrial and Corporate Change*, **10**, (4), pp. 1007 – 1037.

Carter, N.M., Stearns, T.M., Reynolds, P.D. & Miller, B.A. (1994). New Venture Strategies: Theory Development with an Empirical Base. *Strategic Management Journal*, **15**, pp. 21 – 41.

Chandler, G. & Hanks, S.H. (1994). Market attractiveness, resource-based capabilities, venture strategies and venture performance. *Journal of Business Venturing*, **9 (4)**, pp. 331 – 349.

Chandler, G.N. & Lyon, D.W. (2001). Issues of Research Design and Construct Measurement in Entrepreneurship Research: The Past Decade. *Entrepreneurship Theory and Practice*, **Summer 2001**, pp. 101 – 113.

Chesbrough, H. (2003). The Governance and Performance of Xerox's Technology Spin-Off Companies. *Research Policy*, **32**, pp. 403 – 421.

Chiesa, V. & Piccaluga, A. (2000). Exploitation and diffusion of public research: the general framework and the case of academic spin-off companies. *R&D Management*, **30**, pp 329 – 340.

Clarysse, B. (1996). *From Research Collaboration to Product Commercialization. A Study of Power and Efficiency Along the Biotech Life Cycle*. Doctoral dissertation, Ghent University. p. 306.

Clarysse, B. & Moray, N. (2004). A Process Study of Entrepreneurial Team Formation: The Case of a Research-Based Spin-Off. *Journal of Business Venturing*, **19**, pp. 55 – 79.

Cooper, A., Gimeno-Gascon, F.J., Woo, C.Y. (1994). Initial human and financial capital as predictors of new venture performance. *Journal of Business Venturing*, **9**, pp. 371-395.

Cooper, A.C., Willard, G.E. & Woo, C.Y. (1986). Strategies of high performance new firms. *Journal of Business Venturing*, **1, (3)**, pp. 247 – 260.

Coviello, N.E. & Munro, H.J. (1997). Network relationships and the internationalization process of small firms. *International Business Review*, **6**, pp. 361 – 386.

Davidson, P. & Wiklund, J. (2001). Levels of Analysis in Entrepreneurship Research: Current Research Practice and Suggestions for the Future. *Entrepreneurship Theory and Practice*, **Summer 2001**, pp. 81 – 99.

Davila, A., Foster, G. & Gupta, M. (2003). Venture Capital Financing and the Growth of Startup Firms. *Journal of Business Venturing*, **18**, pp. 689 – 708.

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

Delapierre, M., Madeuf, B. & Savoy, A. (1998). NTBFs – The French Case. *Research Policy*, **26**, (9), pp. 989 – 204.

Delmar, F. (1997). Measuring Growth: Methodological Considerations and Empirical Results. In: Donckels, R., Miettinen, A. (Eds.), *Entrepreneurship and SME Research: On its Way to the Next Millenium*, pp. 199 – 216.

Delmar, F., Davidsson, P. & Gartner, W.B. (2003). Arriving at the High-Growth Firm. *Journal of Business Venturing*, **18**, pp. 189 – 216.

Feeser, H.R. & Willard, G.E. (1990). Founding Strategy and Performance: A Comparison of High and Low Growth High Tech Firms. *Strategic Management Journal*, **11**, pp. 87 – 98.

Forbes, D.P., Borchert, P.S., Zellmer-Bruhn, M.E. & Sapienza, H.J. (2004). Entrepreneurial Team Formation: An Exploration of New Venture Member Addition.

Submitted March 11, 2004 to the U. of Nottingham workshop on networks, syndicates and teams in venture capital and entrepreneurship.

Gartner, W.B., Starr, J.A. & Bhat, S. (1998). Predicting New Venture Survival: An Analysis of Anatomy of a Start-up. Cases from INC. Magazine. *Journal of Business Venturing*, **14**, pp. 215 – 232.

Gibb, A. and Davies, L. (1990). In pursuit of frameworks for the development of growth models of the small business. *International Small Business Journal*, **9**, (1), pp. 15 – 31.

Hanks, S.H., Watson, C.J., Jansen, E. & Chandler, G.N. (1993). Tightening the Life-Cycle Construct: A Taxonomic Study of Growth Stage Configurations in High-Technology Organizations. *Entrepreneurship Theory & Practice*, **Winter 1993**, pp. 5 – 29.

Harrison, R. & Mason, C. (1994). Developments in the Promotion of Informal Venture Capital in the UK. *International Journal of Entrepreneurial Behaviour and Research*, **2**, (2), pp. 6 – 18.

Heirman, A. & Clarysse, B. (2004). How and Why do Research-Based Start-Ups Differ at Founding? A Resource-Based Configurational Perspective. *Journal of Technology Transfer*, **29** (3), pp. 247 – 268.

Hellmann, T. & Puri, M. (2000). The Interaction Between Product Market and Financing Strategy: The Role of Venture Capital. *The Review of Financial Studies*, **13** (4), pp. 959 – 984.

Herron, L. & Sapienza, H. 1992. The entrepreneur and the initiation of new venture launch activities, *Entrepreneurship Theory and Practice*, **17**(1): 49-55.

Hoy, F., McDougall, P.P. & Dsouza, D.E. (1992). Strategies and Environments of High Growth Firms. I: Sexton, D.L., Kasarda, J.D. (Eds.), *The State of the Art of Entrepreneurship*. PWS-Kent Publishing, Boston, pp. 341 – 357.

Kaulio, M.A. (2003). Initial Conditions or Process of Development? Critical Incidents in the Early Stages of New Ventures. *R&D Management*, **33** (2), pp. 165 – 175.

Kazanjian, R.K. & Drazin, R. (1990). A Stage-Contingent Model of Design and Growth for Technology-Based New Ventures. *Journal of Business Venturing*, **5**, pp. 137 – 150.

Keeble, D. & Walker, S. (1994). New Firms, Small Firms and Dead Firms: Spatial Patterns and Determinants in the United Kingdom. *Regional Studies*, **28**, (4), pp. 411 – 424.

Lee, C., Lee, K. & Pennings, J.M. (2001). Internal Capabilities, external networks, and performance: A study of technology-based ventures. *Strategic Management Journal*, **22**, pp. 615 – 640.

Licht, G. & Nerlinger, E. (1998). New Technology-based Firms in Germany: a Survey of the Recent Evidence, *Research Policy*, **26**, pp. 1005-1022.

Little, A.D. (1977). *New-Technology Based Firms in the United Kingdom and the Federal Republic of Germany*. Wilton House, London.

MacMillan, I.C. & Day, D.L. (1987). Corporate Ventures into Industrial Markets: Dynamics of Aggressive Entry. *Journal of Business Venturing*, **2**, pp. 29 – 40.

MacMillan, I.C., Siegel, R., Narasimha, P.N. (1985). Criteria Used by Venture Capitalists to Evaluate New Venture Proposals. *Journal of Business Venturing*, **1** (1), pp. 119 – 129.

McCann, J.E. (1991). Patterns of growth, competitive technology, and financial strategies in young ventures. *Journal of Business Venturing*, **6**, (3), pp. 189 – 208.

McDougall, P.P. (1989). International versus domestic entrepreneurship: New venture strategic behavior and industry structure. *Journal of Business Venturing*, **4**, pp. 387 – 399.

McDougall, P.P., Covin, J.G., Robinson Jr, R.B. & Herron, L. (1994). The effects of industry growth and strategic breadth on new venture performance and strategy content. *Strategic Management Journal*, **15**, pp. 537 – 554.

Moore, G.A. (1991). *Marketing and Selling High-Tech Products to Mainstream Customers. Crossing the Chasm*. HarperBusiness, New York.

Mustar, P. (1997). Spin-off enterprises. How French academics create hi-tech companies: the conditions for success and failure. *Science and Public Policy*, **24**, pp. 37 – 43.

Oviatt, B.M. & McDougall, P.P. (1994). Toward a Theory of International New Ventures. *Journal of International Business Studies*, **First Quarter 1994**, pp. 45 – 64.

Pavia, T.M. (1991). The Early Stages of New Product Development in Entrepreneurial High-Tech Firms. *Journal of Product Innovation Management*, **8**, pp. 18 – 31.

Pavitt, K. (1998). Technologies, Products and Organization in the Innovating Firm: What Adam Smith Tells Us and Joseph Schumpeter Doesn't. *Industrial and Corporate Change*, **7** (3), pp. 433 – 452.

Penrose, E.T. (1959). *The theory of the growth of the firm*. New York: Wiley.

Porter, M. (1980). *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York, The Free Press.

Reynolds, P.D. (1987). New Firms: Societal Contribution Versus Survival Potential. *Journal of Business Venturing*, **2**, (3), pp. 231 – 247.

Rickne, A. (2000). New Technology-Based Firms and Industrial Dynamics. Evidence from the Technological System of Biomaterials in Sweden, Ohio and Massachusetts. Doctoral dissertation thesis. Chalmers University of Technology, Göteborg, Sweden, ISBN 91-7197-975-1, 340 p.

Rickne, A. & Jacobsson, S. (1999). New Technology-Based Firms in Sweden – A study of their direct impact on industrial renewal. *Econ. Innov. New Techn.*, Vol. **8**, pp. 197 – 223.

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

Romanelli, E. (1989). Environments and Strategies of Organization Start-Up: Effects of Early Survival. *Administrative Science Quarterly*, **34**, pp. 369 – 387.

Roure J.B. & Keeley R.H. (1999), ‘ ‘Predictors of success in new technology based ventures’ , *Journal of Business Venturing*, 5: 201-220.

Sandberg, & Hofer (1987). Improving new venture performance: the role of strategy, industry structure, and the entrepreneur. *Journal of Business Venturing*, **2**, pp. 5 – 28.

Saxenian, A., (1994). *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Harvard University Press, Cambridge, Massachusetts, 226p.

Schefczyk, M. (2001). Determinants of Success of German Venture Capital Investments. *Interfaces*, **31** (5), pp. 43 – 61.

Schoonhoven, C.B., Eisenhardt, K.M. & Lyman, K. (1990). Speeding Products to Market: Waiting Time to First Product Introduction in New Firms. *Administrative Science Quarterly*, **35**, pp. 177 – 207.

Schumpeter, J. (1934). *The Theory of Economic Development*. Harvard University Press, Cambridge, MA.

Segal Quince Wicksteed (2000). *The Cambridge Phenomenon Revisited*. SQW Ltd.

Shane, S. & Stuart, T. (2002). Organizational Endowments and the Performance of University Start-Ups. *Management Science*, **48**, **1**, pp. 154 – 170.

Shrader, R.C., Oviatt, B.M. & McDougall, P.P. (2000). How new ventures exploit trade-offs among international risk factors: Lessons for the accelerated internationalization of the 21st century. *Academy of Management Journal*, **43**, **(6)**, pp. 1227 – 1247.

Smallbone, D., Leig, R. & North, D. (1993). The characteristics and Strategies of High Growth SMEs. *International Journal of Entrepreneurial Behaviour & Research*, **1**, **(3)**, pp. 44 - 56.

Spanos, Y.E. & Lioukas, S. (2001). An Examination into the Causal Logic of Rent Generation: Contrasting Porter's Competitive Strategy Framework and the Resource-Based Perspective. *Strategic Management Journal*, **22**, pp. 907 – 934.

Starr, J.A. & MacMillan, I.C. (1990). Resource Cooptation via Social Contracting: Resource Acquisition Strategies for New Ventures. *Strategic Management Journal*, **11**, pp. 79 – 92.

Stinchcombe, A.L. (1965). Social structure and organizations. In March, J.G. (ed.), *Handbook of Organizations*, pp. 142 – 193. Chicago: Rand McNally.

Storey, D.J., Keasey, K., Watson, R. & Wynarczyk, P. (1987). *The Performance of Small Firms: Profits, Jobs and Failures*. London: Croom Helm.

Storey, D.J. & Tether, B.S. (1998). Public policy measures to support new technology-based firms in the European Union. *Research Policy*, **26**, pp. 1037 – 1057.

Tiler, C., Metcalfe, S. & Connell, D. (1993). Business Expansion through Entrepreneurship: the influence of internal and external barriers to growth. In: Dodgson, M. and Rothwell, R. (eds.). *International Journal of Technology Management, Special Publication on Small Firms and Innovation*, pp. 119 – 132.

Utterback, J.M., Meyer, M., Roberts, E. & Reitberger, G. (1988). Technology and Industrial Innovation in Sweden: A Study of Technology-Based Firms formed between 1965 and 1980. *Research Policy*, **17**, pp. 15 – 26.

Van de Ven, A.H., Hudson, R. & Schroeder, D.M. (1984). Designing new business startups: Entrepreneurial, organizational, and ecological considerations. *Journal of Management*, **10**, pp. 87 – 107.

Welbourne, T.M., Andrews, A.O. (1996). Predicting the Performance of Initial Public Offerings: Should Human Resource Management be in the Equation? *Academy of Management Journal*, **39**, **4**, pp. 891 – 920.

Westhead, P. & Birley, S. (1994). Employment growth in New Independent Owner-managed Firms in Great Britain. *International Small Business Journal*, **13**, **3**, pp. 11 – 33.

Woo, C.Y., Cooper, A.C., Dunkelberg, W.C., Dallenbach, U. & Dennis, W.J. (1989). Determinants of Growth for Small and Large Entrepreneurial Start-Ups. In Brockhaus Sr., R.H., Churchill, N.C., Katz, J.A., Kirchoff, B.A., Vesper, K.H. and Werzel, Jr. W.E. (eds.), *Frontiers of Entrepreneurship Research, 1989*, Boston: Babson College, pp. 134 – 147.

Wupperfeld, U. & Kulicke, M. (1993). *Mißerfolgskfaktoren junger Technologieunternehmen*. Karlsruhe: Fraunhofer-Institut.

Zacharakis, A.L. & Meyer, D.G. (1998). A lack of insight: Do venture capitalists really understand their own decision process? *Journal of Business Venturing*, **13**, pp. 57 – 76.

Zahra, S.A. (1996). Technology Strategy and New Venture Performance: A Study of Corporate-Sponsored and Independent Biotechnology Ventures. *Journal of Business Venturing*, 11, pp. 289 – 321.

Table I: Description of explanatory variables

Variable Name	Description
<i><u>Starting Resources</u></i>	
Start Capital	Amount of capital raised in the first year (Euro)
VC	Dummy indication whether capital was raised from venture capital investors during the first year (1 = yes; 0 = no)
Experience of Founders	Cumulated numbers of years of experience of all members of the founding team in R&D, a commercial function (business development), and other functional domain such as finance, production, etc. (N)
Stage NPD	Stage of development of core product : Ranging from (0) no α -prototype, (1) over α -prototype, (2) β -prototype, to (3) a market-ready product at founding
<i><u>Market Strategy</u></i>	
Market breadth	Breadth of the targeted market at founding ranging from (1) niche or focus strategy, over (2) temporary niche with specific intention to penetrate larger market later on, (3) large and broadly defined market
International orientation	Geographic coverage of market ranging from (1) local focus, over (2) European to (3) global orientation
<i><u>Control variables</u></i>	
Industry	4 dummy variables indicating whether the firm is active in (1) medical-related, micro-electronics, software or other sector; (0) otherwise
Entry	Barriers to entry the industry ranging from (1) very low (very easy to enter) to (5) very high (very difficult to enter)
Substitutes	Threat of substitutes ranging from (1) not at all to (5) very high
Buyer power	Power of the customers of the firm ranging from (1) very weak to (5) very strong
Age	Number of years since founding (N)
Initial size	Number of fulltime employees during first year of operation (N)

Table II: Descriptive Statistics for Metric Variables

Variables	N	Mean	Median	Minimum	Maximum	SD
<u>Dependent variable</u>						
Annual Absolute Employee Growth (AAEG)	170	2.44	0.80	-5.00	21.00	4.40
Log AAEG	136	0.17	0.14	-0.99	1.33	0.55
Annual Absolute Revenue Growth (AARG)	140	333208	81054	-400000	6336142	761744
Log AARG	115	5.12	5.20	3.70	6.80	0.68
Annual Absolute Total Assets Growth (AATAG)	155	214070	45860	-3397500	6472250	812277
Log AATAG	116	1.94	1.89	-0.20	3.81	0.74
<u>Independent variables</u>						
Start Capital	169	477009	62000	6200	6000000	1081703
Total Experience of Founders (years)	170	19.29	15	0	102	17.83
Total R&D Experience of Founders	170	11.52	8	0	61	13.16
Total Commercial Experience of Founders (years)	170	3.80	0	0	47	7.71
Total Other Experience of Founders	170	3.95	0	0	83	9.15
Stage NPD	170	0.93	0	0	3	1.14
International orientation	169	2.14	2	1	3	0.83
Market breadth	169	1.46	1	1	3	0.69
Entry barriers	158	3.82	4	1	5	1.23
Substitutes	149	2.80	3	1	5	1.00
Supplier power	79	3.09	3	1	5	1.04
Buyer power	145	3.70	4	1	5	1.06
<u>Control variables</u>						
Employees in first year	168	3.78	2.00	0	30	4.78
Age (years)	171	6.15	5	2	14	2.63

Table III: Correlation Table between dependent variables: Absolute Annual Employment Growth, Absolute Annual Revenue Growth, Absolute Annual Total Assets Growth

	DV1	DV2	DV3
DV1 Log AAEG	1		
DV2 Log AARG	0.51	1	
DV3 Log AATAG	0.53	0.68	1

All correlations are significant at $p < 0.05$

Table IV: Multiple Regression Models⁴

Variable	Log Employment Growth	Log Revenue Growth	Log Total Asset Growth
Intercept	-0.559 (0.470)	4.169**** (0.710)	1.088 (0.730)
Age	0.002 (0.019)	0.030 (0.029)	0.0468* (0.274)
Initial Size (FTE)	-0.014 (0.013)	0.008 (0.019)	0.042** (0.027)
Medical	0.234 (0.153)	-0.099 (0.232)	0.513** (0.246)
Micro electronics	0.199 (0.165)	-0.058 (0.248)	0.106 (0.265)
Software	0.386**** (0.110)	0.081 (0.171)	0.079 (0.157)
Log Start Capital	0.011 (0.084)	0.091 (0.121)	-0.053 (0.134)
VC	-2.816** (1.517)	-3.583* (2.190)	-0.352 (2.178)
VC * Log Start Capital	0.546** (0.258)	0.608* (0.372)	0.159 (0.366)
Total Commercial Exp	0.013** (0.005)	0.022*** (0.009)	0.014* (0.008)
Stage NPD	0.027 (0.043)	-0.004 (0.062)	-0.116** (0.058)
Market breadth	0.116 (0.080)	0.013 (0.124)	-0.242** (0.124)
International orientation	0.104 (0.066)	0.208** (0.099)	0.377**** (0.092)
Entry barriers	-0.006 (0.042)	-0.001 (0.062)	0.021 (0.054)
Substitutes	-0.024 (0.040)	-0.014 (0.062)	0.009 (0.056)

⁴ Reported Models are GLS models. The results remain robust when the same models are estimated with sample selection models (following Heckman's two-step estimation procedure).

Buyer power	-0.009 (0.047)	-0.065 (0.074)	-0.016 (0.069)
R2 adjusted	0.28	0.12	0.32
N	113	92	98
'F'	3.84	1.83	3.71
Prob. Model	<0.0001	0.04	<0.0001

*p < .10; ** p < .05; *** p < .01; **** p < .001; Coefficients are reported; standard errors are in parentheses