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THE GROWTH TRAJECTORIES OF START-UP FIRMS:

AN EXPLORATORY STUDY

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Keywords: Firm growth, Growth trajectories, Growth patterns

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Abstract

In line with the work of Delmar and Davidsson, (1998) which examines the types of distinct growth patterns that high-growth firms exhibit and how these growth patterns and corresponding firms differ from each other in terms of their demographic affiliation, this paper discusses the existence of different growth trajectories of start-ups. Using financial data from all firms created from 1992 to 2002 in Belgium (N=152064), we identified all those that had grown in less than 10 years above micro-firm level. We developed a data set (N=741) and used Principal Component Analysis (PCA) to identify emerging clusters of trajectories. Overcoming the limitations of the existing literature identified by Delmar et al (2003), the contribution of this research is that it combines going beyond traditional sector-based approaches and using a composite, multi-indicator measure of growth.

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1. Introduction

It is generally admitted that only a minority of start-ups actually contribute significantly to economic development, be it in terms of employment or value-added (Birch, 1981; Storey, 1994; Davidson, 1995; Levie, 1997; Welbourne, 1997; Davidson Lindmark et Olofsson, 1998; OCDE, 1994, 1998b, 2002). For example, these “gazelles” or high growth companies represent between 2% and 10% of the perennial firms and generate 41% of new employment creation in Quebec, 48% in Italy, 56% in Spain and 80% in Sweden (Julien et al., 2001). In the USA, they account for 3% of firms and generate 70% of the gross creation of jobs by existing firms (Birch, Haggetty and Parsons, 1997). They are therefore a key element of regional economic development, and represent as such an interesting research subject.

However, most papers looking at those “promising firms” have focused on a sample limited to the manufacturing industry or to new technology based firms, from sectors such as software products, telecommunications or biotechnology (Baldwin et al, 1994; Delmar, 1997 Vyakarnam et al, 1997; Woywod and Lessat, 2001; Calvo and Lorenzo, 2001; Mustar, 2001; Julien 2001; Zaralis, 2001). One of the assumptions behind those approaches is that new technology is perceived as a strong vector of new business creation, requiring a higher level of capital investment but generating higher employment and revenue growth. Moreover, most of those papers focus on one single dimension of growth (e.g. sales or employment) while growth has been identified as a multidimensional and complex process (Delmar et al, 2003). Hence limited research is available concerning the growth trajectories of **“**promising firms**”** in general, as well as their characteristics and how they differ from other start-ups (Delmar and Davidsson, 1998).

On the other hand, advanced multivariate data analysis methods have been used to analyze firm decisions. For example, in (Lendasse et al, 2004), the authors have used nonlinear clustering and visualization tools (Self-Organizing Features Maps) to analyze the management strategy of investment funds and confront it to the fund announced strategy. The Self-Organizing Features Map approach can be extended to the analysis and visualization of other economic data, including data evolving over time.

In the case of the growth trajectory of promising firms, advanced multivariate data analysis methods should be used because standard data analysis and visualization tools are not designed to cope with records that represent the evolution of a firm behaviour over time. Indeed, the behaviour, or trajectory, of a firm is the evolution over several periods of time of several indicators, and most data analysis tools cannot grasp that multidimensional and temporal relationship. There is thus a need to develop specific analysis models able to cope with temporally evolving data with a high number of components.

In this context, supporting previous researches (Delmar and Davidsson, 1998; Delmar et al, 2003) which examine the types of distinct growth patterns that high-growth firms exhibit and how these growth patterns and corresponding firms differ from each other in terms of their demographic affiliation, the aim of this research project is to develop and use advanced multivariate data analysis to analyze the growth trajectories of the firms that have contributed significantly to the economic development of their region. We developed a sample from financial data of all the firms created from 1992 to 2002 in Belgium. We identified all those that had grown in less than 10 years above 9 people or 2 million Euro in turn-over or assets (i.e. above the size corresponding to micro-firms as defined by the European Commission, 2003). We analyzed the distribution and growth trajectories of those firms, using multivariate longitudinal analysis. In line with the limitations of the existing literature identified by previous researches (Delmar et al, 2003; Delmar and Davidsson, 1998; Weinzimmer et al, 1998), one of the initial contributions of this research is that it combines going beyond traditional sector-based approach and using a composite, multi-indicator measure of growth, instead of just one such as employment or sales.

The first section discusses the definition of growth and measurements. The next section introduces the research design and detailed discussion of firm selection. The third section presents preliminary results of demographic analysis of our sample and an illustration of the distinct types of growth trajectories which emerged from our data analysis approach. The last section addresses the future research agenda.

2. Literature review

This section provides a review of the literature regarding issues related to start-up growth, measurement of growth and definition of sample related to firm growth.

2.1. Start-up growth

The study of organizational growth as a focus of entrepreneurship scholarship has received considerable attention over past several decades (Delmar et al, 2003; Gundry and Welsh, 2001; Mata, 1994; Siegel et al., 1993; Welbourne, 1997; Davidsson, 1989b; Churchill, 1983). Specifically, based on its supposed importance to growth and employment creation (Dunne and Hughes, 1996; Storey, 1995; Wagner, 1992), the growth path of recently formed companies (startups) is important to management theory. Since the original "theory of the growth of the firm" in Penrose (1959), where managerial resources played a pivotal role, several factors have been suggested as affecting growth. Some of them, such as environmental carrying capacity or market forces, are external to the organization (Aldrich, 1990; Singh and Lumsden, 1990). Others are internal like capabilities, culture, or strategy and have been mainly addressed from the resource-based view of the firm (Wernerfelt, 1984; Teece et al., 1997; Boeker, 1997; Zahra et al., 2000; Canals, 2000). In particular, numerous studies of organizational growth defined various approaches to assess the amount of growth that a firm has experienced. However, research in this area has largely failed to generate cumulative results (Delmar et al, 2003; Weinzimmer et al, 1998). The common explanation is that variation in measures and variation in firm growth indicators were used in organizational growth studies (Weinzimmer et al, 1998; Delmar, 1997; Murphy et al, 1996 Chandler & Hanks, 1993). Additionally, Delmar et al, 2003, showed that the study of firm growth is heterogeneous in nature. Firm growth patterns are related to the demographic characteristics (size, age, industry affiliation, governance) of these firms. Thus, growth has been identified as a multidimensional and complex process. We will discuss main issues here.

2.2. The measurement of organizational growth

While a diversity of measurement have been used in organizational growth studies, there is no consensus on appropriate growth measures. Delmar (1997) showed that there is little agreement on which factor is the most adequate measure of growth, in a review of 55 research articles on growth published between 1989 and 1996. For Weinzimmer et al (1998) inconsistencies in the measurement of organizational growth arise from two sources: (a) the inappropriate measures and (b) the variety of concepts used to measure growth

The first source of inconsistencies in the measurement of growth stems from the use of alternative formulas. Delmar (1997) showed that the choice of absolute growth vs. relative growth criteria has substantial impact on the results. The reason is that some factors positively affecting absolute growth were unrelated or even negatively related to growth in relative terms. Additionally, Weinzimmer et al (1998), show that these types of inconsistencies have contributed to a lack of consensus in the organizational growth literature.

The second source of inconsistencies in the measurement is that different concepts of growth were used. Based on extensive reviews of the literature, Ardishvili et al. (1998) and Delmar (1997) arrive at almost identical lists of possible growth indicators: assets, employment, market share, physical output, profits, and sales (cf. Delmar et al 2003). Many researchers use change in sales as indicator of growth, but others use employees or assets, and these measures assess quite different concepts of organization. Ardishvili et al. (1998) stress that a consensus has been reached among researchers that sales growth is the best growth measure. It reflects both short- and long-term changes in the firm, is easily obtainable, it is relatively insensitive to capital intensity and degree of integration. And entrepreneurs themselves most often measure growth through the sales of the firm (Barkham et al, 1996). However, growth in other dimensions could take place without increasing sales. For example, for high-technology start-ups and the start-up of new activities in established firms, assets and employment can grow before any sales will occur. Furthermore sales are sensitive to inflation and currency exchange rates, while employment is not. Sales are therefore not the perfect indicator of growth (Delmar et al, 2003).

Other researchers argued that employment is a more direct indicator of organizational complexity, as indicated in the large number of studies that mainly focus on employment growth (Delmar, 1996; Penrose, 1959; Kogut and Zander, 1992). Moreover, measuring growth in employment seems the natural choice when a more macro-oriented interest in job creation is the focus for the study (Schreyer, 1999). So employment growth is another important aspect of organizational growth. But, the problem of employment as a growth indicator is that this measure is affected by labor productivity increases, substitution of man by machine and degree of integration. Thus it is also possible to increase sales and assets without acquiring additional resources or employing additional staff. Finally, other indicators have some obvious shortcomings that limit their applicability outside of very special contexts (Delmar et al, 2003). For example total asset value is highly related to the capital intensity of industry and sensitive to change over time.

2.3. Growth as a multidimensional process

Furthermore, in addition to the variety of growth measures, most previous researchers used only a unidimensional concept to measure growth. Weinzimmer et al (1998) show that 71 percent of 35 studies in their literature review used a single conceptual dimension to measure growth. This approach has been criticized by many researches (Delmar et al, 2003; Delmar and Davidsson, 1998; Birley & Westhed, 1990). The argument behind the disadvantage of unidimensional approach posits that different growth measures affect model building and theory development differently. So using a single measure of growth defined by a single criterion does not seem to suffice. Moreover, such studies will not address growth; they investigate one particular kind of growth and the results cannot most likely be generalized to other forms of growth (Delmar and Davidsson, 1998)

An alternative view is that growth has been identified as a multidimensional and complex process and that the study of firm growth is heterogeneous in nature (Delmar et al, 2003, Delmar and Davidsson, 1998). One of the assumptions behind those approaches is that when different aspects of growth are combined systematically, a finite number of empirical distinct and conceptually meaningful growth patterns can be identified. In this context, it is advantageous to integrate different dimensions of growth (multiple growth indicators and demographic characteristics) in empirical studies.

Different growth measures and calculations affect model building and theory development differently as recognized by previous researches. To this end, while most of researchers (Chandler and Hanks, 1993; Delmar, 1997; Weinzimmer et al., 1998) have suggested that research should strive towards one single way, or a limited number of ways, of calculating growth, Delmar et al (2003) have found that using multiple growth indicators allows to measure heterogeneity in firm growth. This would likely provide a more complete picture of any empirical relationships as well as provide a way to test the robustness of any theoretical model. Furthermore, they showed that patterns of high growth firms are systematically related to demographic affiliation (firm size, firm age, type of industry, and the type of governance).

The second finding of those authors supported the organizational ecologists approach (Carroll and Hannan, 2000) which indicates that there are a number of industrial and institutional covariates that are unique to each industry and which affect the development of the firms in the studied population. Although neglected in empirical studies because of limited of data as indicated by Delmar and Davidsson (1998), several aspects of this approach consisted to be considering in the studies of firms growth. Also, the demographic variables of firms should not be ignored.
In summary, organizational growth is not a unidimensional phenomenon but rather a multidimensional, dynamic and complex process.

2.4. "Promising firms"

In addition to these aspects of firm growth, most papers looking at "promising firms" have focused on a sample limited to the manufacturing industry or to new technology based firms, from sectors such as software products, telecommunications or biotechnology (Delmar, 1997, Baldwin et al., 1994). One of the assumptions behind those approaches are that new technology is perceived as a strong vector of new business creation, requiring higher level of capital investments but generating higher employment and revenue growth. Indeed, limited research is available concerning the growth trajectories of **"**promising firms**"** in general, as well as their characteristics and how they differ from other start-ups (Davidsson and Delmar, 1998)**.**

Taken together, these aspects give a richer description of firm growth than each aspect separately. So, recognizing this insight will require constructing appropriate samples and measures.

3. Research Design and Sample

The aim of our research is to analyze the growth trajectories of firms that have contributed significantly to the economic development of their region. To this end, we define the growth trajectories as the dynamic evolution of firm characteristics, over time, within growing firms. We will explore the types of distinct growth trajectories that start-ups growth firms exhibit. Finally, in the future step of our research, we will explore how these growth trajectories and corresponding firms differ from each other in terms of their demographic affiliation.

This section presents the general approach of our project and details our research design and data analysis methods.

3.1. General approach of the project

Given the considerations above, our project focuses on:
- Developing and analyzing a representative sample of the new firms that contribute to economic development (not only the “high-tech” firms)
- Integrating multiple quantitative and qualitative aspects related to firm behavior, not only a single “growth” dimension, but the more elaborated concept of trajectory
- Using advanced multivariate data analysis methods to analyze and interpret the growth trajectories of promising firms (including the temporal dimension of the trajectory)
- Addressing qualitative validation and interpretation of the typology of growth trajectories and patterns

The approach we adopted is therefore the following:
The first phase of the project is dedicated to the definition and implementation of the criteria for firm selection. Designing samples and measures is important in order to develop a unique, large and longitudinal data set for the specific purpose of analyzing the growth trajectories of start-ups. The demographic analysis of the sample will allow, among others, to compare the characteristics of our sample with the general population of firms and with the results from the entrepreneurship literature. Moreover, we explore the types of distinct growth trajectories that start-ups growth firms exhibit and offer an illustration of those trajectories.

The second phase concerns the analysis and typology of the growth trajectories of the selected firms. It will consist in the development, implementation and interpretation of advanced multidimensional approaches aimed at identifying and characterizing specific clusters among the growth trajectories of promising start-ups, and comparing them with control samples of “non-growth” firms. A clustering algorithm will be used to identify similar states; patterns of transition for a firm from a cluster to another as time goes (its trajectory) will be analyzed.

In a third phase, we will complete a qualitative validation and interpretation of the typology of trajectories. It consists of a qualitative survey through case studies of representative firms within the clusters identified as having distinct growth trajectories. The goal of this step will be to allow a better characterization of those firms and their trajectories, making it possible to explore common characteristics and factors of success for the growth of the companies within the different clusters.

This paper will present a detailed discussion of the first phase. These results will state the forefront for the continuation of our project.

3.2. Database

We present here the source of data we used, the unit of our analysis and period of observation.

***Data Source*.** Data were taken from the database BEL-FIRST developed by the Bureau van Dijk Electronic Publishing (BvD), one of Europe's leading electronic publishers of business information. BEL-FIRST contains detailed financial information on 304,000 Belgian companies and the 200 largest companies in Luxembourg. The listed information includes: contact information, activities, financial items and ratios, directors, ownership and subsidiaries. From this database, we developed a unique data set focused only on Belgian "promising" firms.

Unit of Analysis and time period. The unit of analysis in our data set is the firm. This firm may be independent or affiliate. A firm may have only one establishment.
In order to analyze growth trajectories, we concentrated on the first stage of development of firms still in existence. In our research, this stage corresponds to the company's life period before and just after the micro-firm level (see figure 1). And because the last update of BEL-FIRST used gives exclusively financial information for the interval of time from 1992 to 2002, we chose to collect data for this period of observation.

3.3. Sample and variables

Two samples were created from our database. The first (initial data set) is devoted to the companies which significantly contributed to the economic development. The second (final data set) is a subgroup of the first and will serve for the exploration of the existence of growth trajectories.

3.3.1. Initial data set

In order to identify the firms which had contributed most to the economic development, we started with all the Belgian firms created since 1992 and still in existence in 2002 (n = 152064). We used a composite multi-indicator measure of growth to identify all firms who had grown in less than 10 years above 9 people or 2 million Euro in turnover or assets (i.e., above the size corresponding to micro-firms as defined by the European Commission, 2003). There are 17168 such firms in Belgium, which represented our initial data set.

For each of the 17168 firms, our sample contained the following data for each year from the date of establishment until 2002:
Financial data: Average number of employees, Sales, Net added value, P/L for the period after taxes, Cash-flow, Operating P/L, Current P/L before taxes, Total Assets, Shareholders' Equity and Working capital. Those 10 different financial data collected variables were computed to examine different growth patterns. The growth construct is made up of 3 growth indicators along with 7 financial performance indicators. The 3 indicators of growth are: Employment, Sales and total Asset. In line with literature review, we used all three indicators to assess the degree to which different concepts influence growth. And we posit that this composite of growth indicators provided both important and complementary information. On the other hand, the 7 variables from accounting measures were utilized to construct financial performance and complete our composite of multiple-indicators. Following Wiklund (1999), we agree that taken together, growth and financial performance give a richer description of actual performance of the firm than each does separately. Additionally, this approach allowed to examine the degree of correspondence between growth and financial performance. i.e. to determine if firms that grow also perform well financially.

Demographic data: From demographic data, in order to provide an external validation of cluster which will emerge from our future research, we used four different variables to break down the analysis by sub-categories. (a) The first variable is industry (16 industries); we chose this variable because our sample concerned all industries sectors and it was complementary to previous researches which focused in general on manufacturing industry or service industry (Delmar, 1997; Delmar et al, 2003). (b) The second demographic variable is firm age. This variable is often used in previous researches (Delmar and Davidsson, 1998; Delmar et al, 2003) and the argument posits that younger firms are more prone to grow than older ones. (c) The third variable we used is governance such as the type of ownership. We used this variable because previous argument (e.g. Barney, 1991) posits that independent firms are more flexible whereas firms affiliated have better access to resources. (d) Finally, we used location as last variable. The region as important demographic characteristic was highlighted by Davidsson, Lindmark and Olofsson (1994); these authors have indicated important regional variations in firm formation rates (c.f. Delmar and Davidsson, 1998).

For each firms from our initial data set (n= 17168), the behaviour is described by the temporal evolution of "growth" and financial performance variables (see Figure 2). The data record defined for a given firm is composed by the values of each indicator, for each year, from the creation of the firm until 2002.

3.3.2. Final data set

In order to analyze the trajectories of those firms before and after their growth above micro-firm level, we had to extract a sub sample of firms for which sufficient data were available. We had therefore to deal with the fact that records for different firms can have different lengths and several indicators at several time steps can be missing or unknown (for example out of 17169 cases in 2002, 33% had missing value in Employment, 53% in Sales, 17% in Cash flow and less to 1% for each of resting variables). Missing information was dealt with combining interpolation and elimination of firms with insufficient data. In particular, we excluded all firms which exceeded the threshold of the micro-firm level at the time of the publication of their first financial data. Moreover, to be able to interpolate data, we excluded the companies which did not publish complete data for at least two years or firms which have less than 40% of the data available between those 2 years. Using those filters, the final data set consisted of 741 firms.

3.4. Data analysis methodology

Once the set of observations has been built according to the above-described procedure, statistical data analysis tools have been used on these data, in a first step to visualize them efficiently. More specifically, the Principal Component Analysis (PCA) has been used to project the 10-dimensional data (the 10 growth and financial performance variables described at 3.3.1.) onto a two-dimensional plane, allowing the visualization of firm trajectories over the years.

PCA is basically a projection method. Starting from a set of N observations in a d-dimensional space, PCA first finds the "maximum variance axis". The latter is defined as the axis (in the d-dimensional space) for which the variance of the N data, after orthogonal projection on this axis, is maximum. In other words, it finds the axis that best represents the observations, or that goes maximally through the observation cloud. It can be shown that this axis is also the one which minimizes the projection error, i.e. the distances (in average) between the original observations and their projection on the axis. The maximum-variance axis is also called first principal axis. As this axis is a linear combination of the d original variables, it can be easily interpreted. For example it can happen that this axis is pretty much correlated with one or two of the original variables, and not with the other ones.

Then, in a second step, the PCA finds another axis that also best represents the observations (or minimizes the projection error), under the constraint that this second principal axis is orthogonal to the first one. The procedure can be iterated up to *d* axes.

In our application, we restrict the use of the PCA to the two first principal axes. The observations are the 10-dimensional vectors of the 10 growth and financial performance indicators, for each firm during each year. The yearly data of each firm is thus a point in a 10-dimensional space. Directly visualizing this space is of course impossible. PCA is used to project these data on a two-dimensional graph, where each yearly data of each firm is again represented by a point.

Considering one single firm, the successive observations over the years can be connected on the graph. Each year is then characterized by its trajectory in the PCA plane. As the two PCA axes will have some interpretation with regards to the 10 original variables, they will also be connected to economic interpretation. Therefore, it can be expected that firms having a similar economic development (growth pattern) will have similar trajectories on the graph. The PCA graph is thus used as a low-dimensional visualization tool, in which it is expected that clusters of similar trajectories will emerge, corresponding to clusters of firms having similar growth patterns. This method will be illustrated in Section 4.2 on a small set of firm trajectories.

4. Results

We will discuss in this section the descriptive analysis of the samples and the preliminary result of the PCA analysis.

4.1. Descriptive analysis of the samples

This sub section presents industry sector analysis, sample description through composite indicators of growth, and the contribution to economic development of selected firms

4.1.1. Industry sectors analysis

Two results emerged from our analysis of the industry sectors of promising firms: First, all the sectors seem to be present in our samples (15 for initial sample and 13 for final sample, on the list of the 17 principal sectors included in the standard industry classification using the Belgian equivalent Code NACE (NACE-BEL)). The most important were "*Real estate, renting and business activities*" (31% of firms), "Wholesale *and retail trade; repair of motor vehicles, motors cycles and personal and household goods*" (25% of firms) and "*Manufacture*" (11%).
Second, Only 3% of firms of our initial data set (n=17168) and 3.5% of firms of our final data set (n=741) belong to high technology sectors. To identify the firms related to "high tech" sectors, we defined a conversion table between the Code NACE-BEL and the Code US SIC classification of industry sectors according to technological intensity (from the Bureau of the Census and Walcott (2001)) (see appendix 1). These results supported our approach vs. limited sample to manufacture or high tech.

4.1.2. Sample description through composite indicators of growth

In order to support our assumption that multiple growth indicators provided both important and complementary information, we analyzed within the final sample (n=741) the structure of the three growth criteria used in this study (employment, assets and sales). This structure analysis provides interesting insights (figure 3): When considering only a single growth indicator, only 8% of firms selected fill the assets, criterion, 50% the employment criterion and 33% the sales criterion. But those meeting two criteria simultaneous were less important. Only 5% of selected firms fill a composite of sales and employment measures, 3% for sales and assets and only 1% related to the employment and assets. Finally only 2% of the 741 firms meet at the same time the three growth indicators. This approach provides a way to analyze a complete demography of firms concerned by the study and to assess the degree to which different concepts influence outcomes. Those results supported our multiple growth indicators approach.

4.1.3. Contribution to economic development

The promising firms identified in our sample represented 6% of all the existing Belgian companies in 2002 and 11% of the companies created since 1992 and still in existence in 2002. However, they generated (in 2002) respectively 19% and 80% of gross job created.

Furthermore, only 7% of job creation was done by the promising firms from high technological sector (representing 3% of promising firms). Sales and asset contribution analysis reveal the similar results, confirming the interest of multi-sector approach.

4.2. Preliminary results of data analysis (PCA) methodology

The method presented in Section 3.4 has been applied on our final dataset mentioned in Section 3.3.2. The first PCA is relative to the opposite of the first principal component axis identified as correlated with the financial performance indicators, the second is correlated with the three growth indicators (employment, sales and assets) and value added. The first two principal components account for 75% of the total variance in the data.

The projection of several firm trajectories on those two axes is illustrated in Figure 4. Each square represents the two principal axes with the horizontal axe being the First Principal Component. Each trajectory is represented in a separate box to avoid overlapping of the trajectories that could make the drawing difficult to read. Each projection of the yearly data of a firm is represented with a plus sign, the plusses are connected according to their temporal order and circle indicates the first year. Moreover, trajectories have been gathered together according to their shapes. The first group (the top six charts) represents rather linear trajectories: the firms grow according to both directions (related to both principal components) at the same time. The second group (the top five charts) gathers sigma-shaped trajectories. They indicate that the growth of the firms has not been smooth over the years, with some periods that may even correspond to decay of the firm. The third group (the top three charts) presents angular trajectories going up first then bifurcating to the left, which can be interpreted as a growth in two stages; first increasing size then increasing financial performance.

The method has thus helped us represent and identify “typologies” firm trajectories, possibly relating to different growth strategies.

5. Conclusion and limitations

This study had several limitations which should be noted. The first limitation is the use of only secondary data source, given the need for longitudinal data and the need for our data analysis to explore the trajectories of start-up growth. The second concerned the lack of information in order to be able to distinguish between organic growth and growth by acquisition.

This analysis may be regarded as a first step into the understanding the growth trajectories of start-ups, in which the main points are to examine the types of distinct growth trajectories that start-up growth firms exhibit and how these growth trajectories and corresponding firms differ from each other in terms of their demographic affiliation.

Firm growth is fundamentally a multidimensional rather unidimensional phenomenon (Delmar et al, 2003). Hence, using multiple measures and methods for exploring organizational growth is important for understanding a firm growth process. The contribution of this research is that it combines going beyond traditional sector-based approach and using a composite, multi-indicator measure of growth.

6. Research agenda

In line with phase 2 and 3 of our general approach presented in section 3.1. the research agenda will use approaches, to develop better models (advanced multidimensional approaches) aimed at identifying and characterizing specific clusters among the growth trajectories of promising start-ups, and compare those with control samples of "non-growth" firms. Furthermore, case studies and survey research will be use to improve the quality of our current data to perform the study.

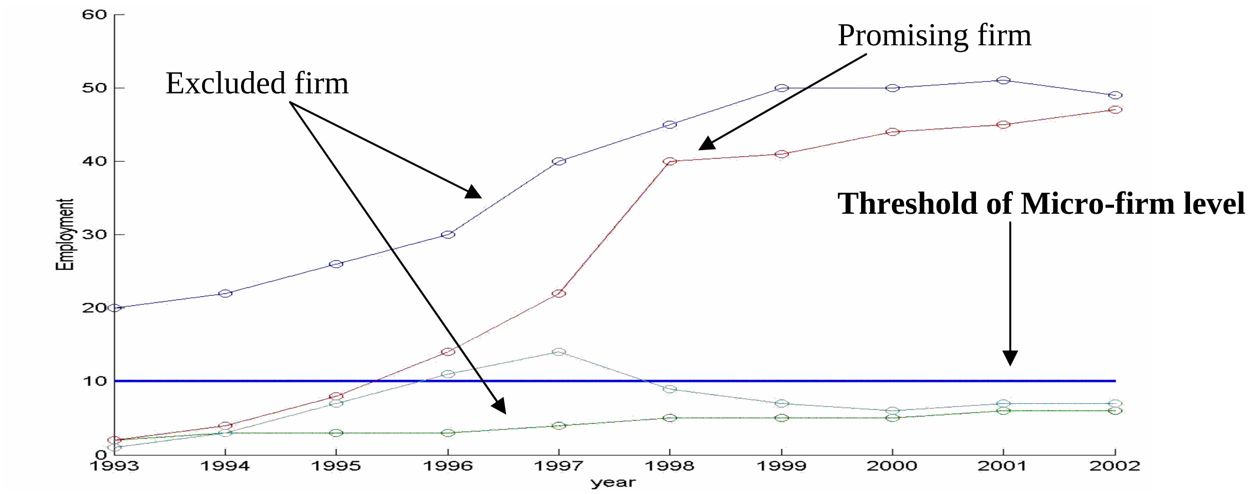

Figure 1: The growth trajectories of promising firm (according to the employment criterion)

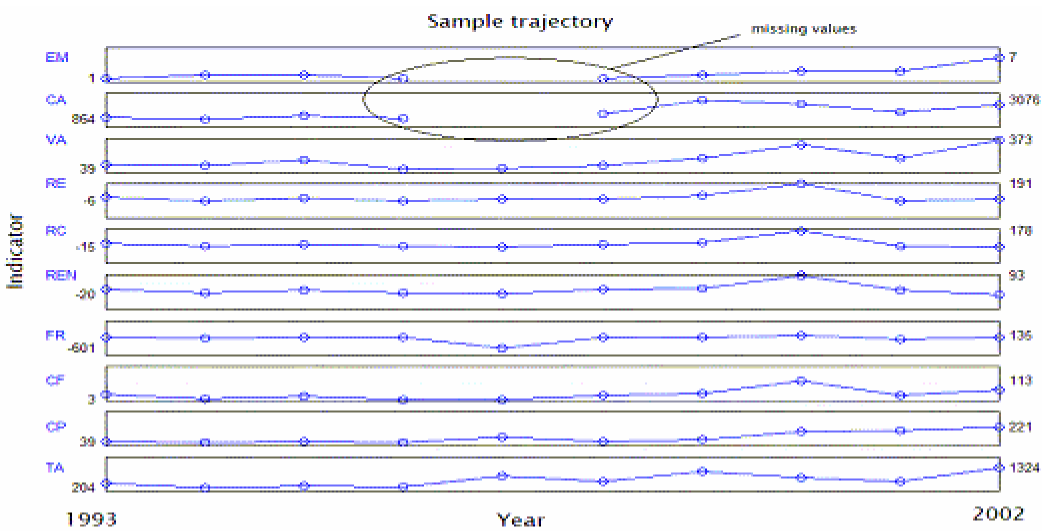

Figure 2: Example of data collected about one firm. EM: Average number of employees; CA: Sales; VA: Net added value; REN: P/L for the period after taxes; CF: Cash-flow; RE: Operating P/L; RC: Current P/L before taxes; TA: Total Assets; CP: Shareholders' Equity; FR: Working capital

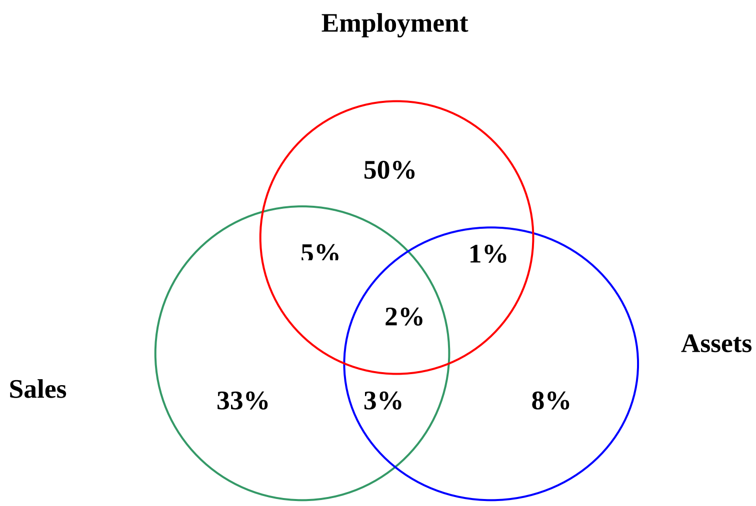

Figure 3: Final sample description through a composite of multiple indicators of growth

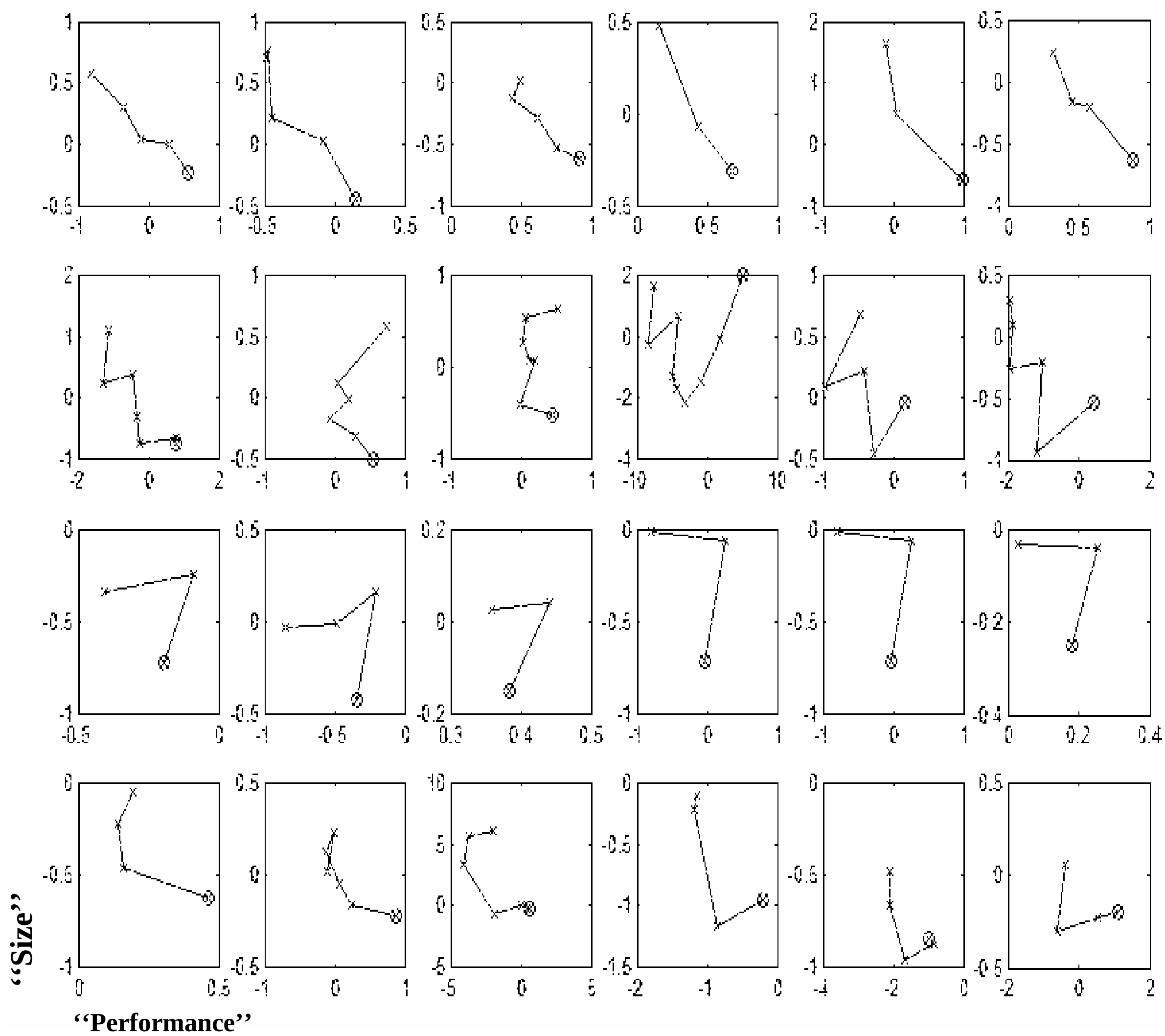

Figure 4 : An illustration of multidimensional trajectory analysis.

Appendix 1: Correspondence table between the United State Standard Industrial Classification according to technological intensity (from the Bureau of the Census and Walcott (2001))

Code US SIC	*Label (US SIC)*	Code NACE-BEL	*Label (NACE-BEL)*
283	Drugs	244	Manufacture of pharmaceuticals, medicinal chemicals and botanical products
2833	Medicinal chemicals and botanical products manufacturing	2441	Manufacture of basic pharmaceutical products
2834	Pharmaceutical preparations manufacturing	2442	Manufacture of pharmaceutical preparations
2835	In vitro and in vivo diagnostic substances manufacturing	247	Manufacture of man-made fibres
2836	Biological products, except diagnostic substances manufacturing	241	Manufacture of basic chemicals
35		30	Manufacture of office machinery and computers
357	Computer and office equipment	300	Manufacture of office machinery and computers
3571	Electronic computers		
3572	Computer storage devices		
3575	Computer terminals		
3577	Computer peripheral equipment, not elsewhere specified		
3578	Calculating and accounting machines, except electronic computers		
3579	Office machines, not elsewhere specified		
36	Electronic and other electrical equipment and components, except computer equipment	31	Manufacture of electrical machinery and apparatus n.e.c
361	Electric transmission and distribution equipment	312	Manufacture of electricity distribution and control apparatus
365	Household audio and video equipment, and audio recordings	32	Manufacture of radio, television and communication equipment and apparatus
3651	Household audio and video equipment	322	Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy
3652	Phonograph records and prerecorded audio tapes and disks	323	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods
366	Communications equipment		
3661	Telephone and telegraph apparatus		
3663	Radio and television broadcasting and communications equipment		
3669	Communications equipment, not elsewhere specified	313	Manufacture of insulated wire and cable
367	Electronic components and accessories	321	Manufacture of electronic valves and tubes and other electronic components
3671	Electron tubes		
3672	Printed circuit boards		
3674	Semiconductors and related devices		
3675	Electronic capacitors		
3676	Electronic resistors		
3677	Electronic coils, transformers and other inductors		
3678	Electronic connectors		
3679	Electronic components, not elsewhere specified		
372	Aircraft and parts manufacturing	355	Manufacture of other transport equipment n.e.c
3721	Aircraft manufacturing		
3724	Aircraft engines and engine parts manufacturing		
3728	Aircraft parts and auxiliary equipment, not elsewhere specified manufacturing		
376	Guided missiles and space vehicles and parts manufacturing	353	Manufacture of aircraft and spacecraft
3761	Guided missiles and space vehicles manufacturing		
3764	Guided missile and space vehicle propulsion units and propulsion unit parts manufacturing		
3769	Guided missile and space vehicle parts and auxiliary equipment, not elsewhere specified manufacturing		
38	Measuring, analyzing and controlling instruments; photographic, medical and optical goods; watches and clocks manufacturing		
3812	Search, detection, navigation, guidance, aeronautical and nautical systems and instruments	351	Building and repairing of ships and boats
382		333	Manufacture of industrial process control equipment
			Manufacture of instruments and appliances for measuring, checking, testing, navigating and
3821	Laboratory apparatus and furniture manufacturing	332	Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment
3822	Automatic controls for regulating residential and commercial environnements and appliances		
3823	Industrial instruments for measurement, display and control of process variables and related products		
3824	Totalizing fluid meters and counting devices		
3825	Instruments for measuring and testing of electricity and electrical signals		
3826	Laboratory analytical instruments		
3827	Optical instruments and lenses		
3829	Measuring and controlling devices, not elsewhere specified		
384		331	Manufacture of medical and surgical equipment and orthopaedic appliances
3841	Surgical and medical instruments and apparatus	3310	Manufacture of medical and surgical equipment and orthopaedic appliances
3842	Orthopedic, prosthetic and surgical appliances and supplies	33103	Manufacture of orthopaedic appliances
3843	Dental equipment and supplies	33101	Manufacture of electrical equipment for medical, dental and veterinary activities
3844	X-ray apparatus and tubes and related irradiation apparatus	33102	Manufacture of non-electrical equipment for medical, dental and veterinary activities
3845	Electromedical and electrotherapeutic apparatus		
3861	Photographic equipment and supplies	334	Manufacture of optical instruments and photographic equipment
		3340	Manufacture of optical instruments and photographic equipment
		64	Post and telecommunications
481	Telephone communications	642	Telecommunications
4812	Radiotelephone communications		
4813	Telephone communications, except radiotelephone		
482			
4822	Telegraph and other message communications		
484	Cable and other pay television services		
4841	Cable and other pay television services		
489	Communications services, not elsewhere specified		
4899	Communications services, not elsewhere specified		
737	Computer programming, data processing, and other computer related services	72	Computer and related activities
7371	Computer programming services	722	Software consultancy and supply
7372	Prepackaged software	724	Data base activities
7373	Computer integrated systems design		
7374	Computer processing and data preparation and processing services	723	Data processing
7375	Information retrieval services		
7376	Computer facilities management services		
7377	Computer rental and leasing	721	Hardware consultancy
7378	Computer maintenance and repair	725	Maintenance and repair of office, accounting and computing machinery
7379	Computer	726	Other computer related activities
87		74	Other business activities
871	Engineering, architectural, and surveying services	742	Architectural and engineering activities and related technical consultancy
8711	Engineering services		
8712	Architectural services		
8713	Surveying services	741	Legal, accounting, book-keeping and auditing activities; tax consultancy; market research and public opinion polling; business and management consultancy; holdings
873	Research, development, and testing services	73	Technical testing and analysis
8731	Commercial physical and biological research	731	Research and experimental development on natural sciences and engineering
8732	Commercial economic, sociological, and educational research	732	Research and experimental development on social sciences and humanities
8733	Noncommercial research organizations		
8734	Testing laboratories	743	Technical testing and analysis

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