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Erik Stam Petra Gibcus, Jennifer Telussa and Elizabeth Garnsey

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Abstract

This paper analyses the association between dynamic capabilities and new firm growth, controlling for measures of firm resources, characteristics of the entrepreneur, and aspects of the environment. The central research question is: How strong is the relationship between dynamic capabilities and the growth of new firms? The paper opens with a review of empirical studies on employment growth in new firms and then moves on to a discussion on the role of dynamic capabilities in the explanation of new firm growth. After a description of the data and variables the results and implications of this study are discussed.

Keywords: new firms, firm growth, innovation, dynamic capabilities

Employment Growth of New Firms

INTRODUCTION

A key outcome of the entrepreneurial process is new business creation. Most new businesses employ only one or very few persons. The creation of new growing firms – a key element of Schumpeter's (1934) theory of economic development – is a relatively rare event. The few new firms that grow substantially face completely different issues during their life course than the many start-ups that remain small. These growing new firms are under pressure to act strategically, especially with respect to the expansion and renewal of their resource base (e.g. via organizational learning), innovation, alliances and possibly internationalisation. Strategic entrepreneurship (Hitt et al., 2001) is said to be a core issue here, especially the use of dynamic capabilities (Eisenhardt and Martin, 2000). Most studies on dynamic capabilities have focused on large, established firms, despite the flexible, dynamic nature of many small, new firms (cf. Piore and Sabel, 1984; Yu, 2001). Thus far there have been no studies tracing how dynamic capabilities relate to the growth of new firms. This paper will analyse the association between dynamic capabilities and new firm growth, controlling for measures of firm resources, characteristics of the entrepreneur, and aspects of the environment. The central research question is: How strong is the relationship between dynamic capabilities and the growth of new firms?

The paper opens with a review of empirical studies on employment growth in new firms and then moves on to a discussion on the role of dynamic capabilities in the explanation of new firm growth. After a description of the data and variables we discuss the results and implications of this study.

REVIEW OF EMPIRICAL STUDIES ON EMPLOYMENT GROWTH OF NEW FIRMS

So far there have been no studies tracing the relationship between dynamic capabilities and the growth of new firms.[1] There have been several empirical studies that analyse the factors associated with employment growth in new firms. These studies are summarised in table 1. This table does not give an exhaustive overview of all factors that have been used in these studies, but all factors that have been examined in at least two studies are represented. An overview of the characteristics of the samples on which these studies are based is provided in the appendix. We have categorized the factors associated with growth in employee numbers in new firms into three sets. Personal level factors include human capital, social capital, and ambitions of the entrepreneur; firm level factors include organizational capital and financial capital; variables related to the business environment of the firm are industry or geographical location. Table 1 shows that the outcomes of these studies are very scattered: hardly any study takes a similar set of factors into account, and when the same factors are taken into account sometimes contrasting outcomes are presented.

Consensus is to be found to the greatest extent regarding personal level factors. The human capital variables educational level, start-up experience, industry experience and technical experience have generally been found to have a positive relationship with growth.[2] Being a female founder or belonging to an immigrant group has a negative association with firm growth. Social capital, especially in the form of starting a firm with business partners has a consistent positive relationship with subsequent firm growth. A positive start-up motivation to realize an idea or innovation also has a positive association. Regarding the firm level factors, two have a consistent positive association: the level of start-up capital and being incorporated. Among business environment factors, starting in retail/personal services has a

negative association, while starting in manufacturing/construction has a positive relationship with new firm growth.

There is controversy on the relationship between work experience and of the initial (employment) size of the firm. As regards causal factors, work experience might provide opportunities for on the job-learning, leading to valuable knowledge for managing a growing business. However, this depends on type of activity and type of organization in which experience has been gained. Entrepreneurs with lengthy work experience could become more cautious and conservative than entrepreneurs with shorter work experience.

Contrasting evidence has been found on the relationship between the initial employment size on subsequent firm growth. In the industrial economic literature it is a stylized fact that young and small firms grow relatively fast, because they have to achieve the minimum efficient size (MES) in their industry (Mansfield, 1962; Audretsch et al. 2004). Initial size has been found to have a negative association with firm growth in these studies (Audretsch et al., 1999; Lotti et al. 2001). Smaller start-ups have a higher need to grow (Davidsson, 1991). On the other hand, relatively large start-ups have more resources at hand to realize growth and are more likely to attract financial capital and human resources, which enables them to grow more rapidly than small start-ups (cf. Westhead and Cowling 1995). These large start-ups may also be more ambitious regarding future growth. This effect can be traced by controlling for growth ambitions.

The review of empirical studies on employment growth of new firms has shown that the relationship between dynamic capabilities and the growth of new firms has not yet been taken into account. Only measures of start-up motivation to realize an innovation might indicate the emergence of a dynamic capability, and two of the three studies that took this variable into account found a positive relationship with new firm growth. In the next section we will discuss the relevance of dynamic capabilities for new firm growth.

DYNAMIC CAPABILITIES AND NEW FIRM GROWTH

Entrepreneurship results in the creation of new firms. Growing a firm to a substantial size involves strategic activities that have been termed strategic entrepreneurship (Hitt et al., 2001). It is necessary for entrepreneurs to create and adapt the resource base of the new firm. New firms often face resource base weaknesses (Garnsey, 1998; West and DeCastro, 2001) and are confronted with subsequent performance shortfalls if these weaknesses are not dealt with. As such, new firms must demonstrate dynamic capabilities to reconfigure the resource base as needed (Teece et al., 1997; Eisenhardt and Martin, 2000). Dynamic capabilities are the organizational and strategic routines by which firms achieve new resource combinations (Eisenhardt and Martin 2000, p. 1107). They include specific and identifiable processes such as R&D, inter-firm alliancing, new product development, and exporting. With knowledge creation routines (also known as R&D) new knowledge is built within the firm of particular strategic relevance in high-tech industries. Alliancing routines bring new resources into the firm from external sources, also often essential in high-tech industries (Powell et al., 1996; Baum et al., 2000; Tapon et al., 2001). With new product development routines the varied skills and backgrounds of firm members are combined to create revenue-producing goods and services. Strategic decision making, for example regarding the entrance into new (international) markets is also a dynamic capability in which firm members pool their various business, functional, and personal expertise to make the choices that shape the major strategic moves of the firm.

Table 1 Empirical studies on employment growth of new firms

	Factors associated with new firm growth	*Cooper et al. 1994*	*Dahlqvist et al. 2000*	*Schutjens & Wever 2000*	*Bosma et al. 2004*	*Vivarelli & Audretsch 1998*	*Colombo & Grilli 2005*	*Almus & Nerlinger 1999*	*Bruderl & Preisendorfer 1998*	*Chrisman et al.2005*
Human capital	Education level	+		0	0		+		0	0
	Immigrant	-	-						0	
	Self-employed parents	0				0				
	Management experience	0		0		+	0		0	
	Unemployment		0			0				
	Self-employment / start-up experience		+		0		+		0	+
	(Long) work experience			-	+				-	
	Industry experience			0	+		+		0	
	Technical experience						+	+		
	Male founder	+	+		+				+	
	Age entrepreneur			0	0		+			0
Social capital	Entrepreneurial networks				+				0	
	Emotional support from spouse				0				0	
	Business partners	+		+			+	0	0	
Ambitions	Start-up motivation: market need/niche		0			0				
	Start-up motivation: realize idea/ innovation		0			+	+			
	Goal: sales growth			0						
	Goal: employment growth				+					
	Start-up motive: higher income / profit				0	+				
Financial capital	Start-up capital	+		0			+		+	
Organizational capital	Incorporation		+	0				+	+	
	Start-up size: sales			+						
	Start-up size: employees			+				-	0	
	Start-up size: number of hours worked				+					
	Start-up of take-over								-	
Environment	Industry: retail or personal services	-	-	0					0	0
	Industry: manufacturing/construction			+		+			0	+/0
	Industry: high-tech manufacturing							+		
	Industry: business services			+	0	0			0	0
	Metropolitan/urban location		0/+	0				0		

Thus entrepreneurs can create and adapt the resource base of the new firm with R&D activities, developing new products, introducing products to foreign markets, and alliancing with other firms (Eisenhardt and Martin, 2000). These dynamic capabilities are central elements of strategic entrepreneurship. If an entrepreneur is able to build these dynamic capabilities early on in the life course of the firm, this will increase the likelihood of sustained growth of the new firm. Only few new firms are likely to build dynamic capabilities and these capabilities are not valuable in every context. There may be certain preconditions for the proper functioning of need for dynamic capabilities. On the personal level, the knowledge base of the entrepreneur might enable the effective use of dynamic capabilities. On the organisational level, a munificent resource base would provide the means to create and use dynamic capabilities effectively. The presence of multiple firm members may be a prerequisite for the existence of (dynamic) capabilities (Felin and Foss, 2006). As regards business context, theorists have argued that dynamic capabilities are especially valuable in (technologically) dynamic environments (Teece et al., 1997; Eisenhardt and Martin, 2000). In stable environments, the build up of dynamic capabilities might have too high opportunity costs: investing in efficiency improvements might be much more valuable.

We hypothesize that new firms with dynamic capabilities are more likely to grow but that human capital, firm resources, and environmental dynamism enhance/moderate the relationship between dynamic capabilities and firm growth. In line with the above explanation of new firm growth in terms of dynamic capabilities, the first hypothesis can be stated as:

Hypothesis 1: New firms with dynamic capabilities are more likely to grow.

Hypothesis 2: The level of human capital of the entrepreneur will moderate the relationship between dynamic capabilities and growth.

Hypothesis 3: The level of firm resources will moderate the relationship between dynamic capabilities and the likelihood of growth.

Hypothesis 4: The relationship between dynamic capabilities and the likelihood of growth is contingent on environmental dynamism.

The hypothesized effects and the relationships identified in the review of empirical studies are summarized in figure 1.

This dynamic capabilities perspective gives us more insight into for the role of 'innovation' in new firm growth. Although it is often assumed that innovation is a necessary or even sufficient condition for new firm growth, the empirical evidence is mixed (cf. Brusoni et al. 2006; Winters and Stam 2007). Innovation has many different faces (i.e. indicators in empirical research[3]), and is not always successful, which explains the lack of empirical support for the effect of innovation on new firm growth.

Although those who conduct inquires of the kind summarised in Table 1 are aware that statistical associations do not prove causal relationships, there is common use of the statistical terms 'determinants and effects' with reference to factors associated with firm growth which can be confusing for policy makers less familiar with the conventions of regression analysis. We believe that new firms are complex adaptive systems in which complex feedback effects and path dependence are at work (Fuller and Moran 2001; Garnsey et al. 2006). Causal factors are interactive and involve feedback which is difficult to capture through associations between discrete variables. However the extent of variance in growth performance remaining unexplained in statistical correlation studies is commonly attributed to stochastic factors (Davidsson 2004; Geroski 2005) and to methodological weaknesses (Woo et al. 1994). It is therefore illuminating to identify the strength of statistical relationships in a study that addresses methodological weaknesses. Our study does so by using a systematic cohort analysis covering the same business cycle for firms in diverse industries but in the same national economy. This allows for the influence of the business cycle and the national system of innovation on new firm growth. Any relationships revealed in a systematic cohort study between factors associated with new firm growth and actual growth performance outcomes can be assumed to be robust and to provide a guide to further inquiry.

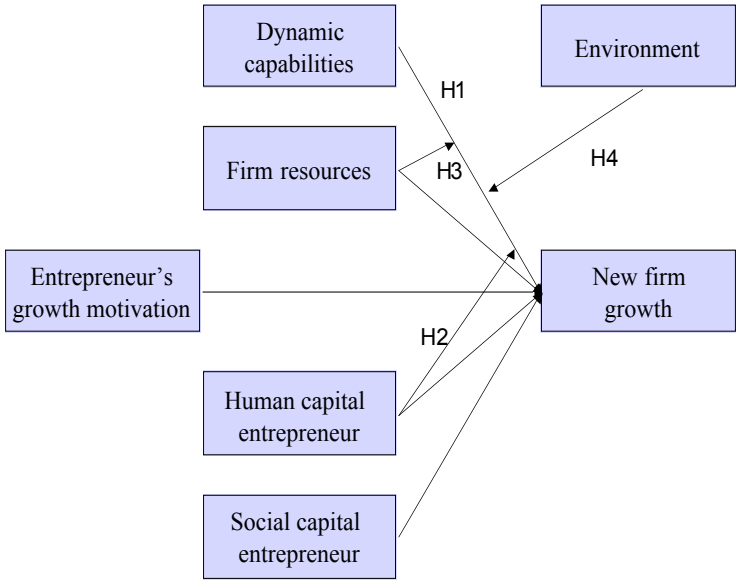

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Figure 1 Determinants of employment growth of new firms

DATA

The data used for this study are based on the 'Start-up panel: cohort 1994'. This panel has been set up by EIM Business and Policy Research (EIM). The start-up panel and the sample characteristics are described in what follows.

Start-up panel

The population in this panel consists of firms in the Netherlands that started their business in 1994. These firms were registered as independent start-ups in 1994. Approximately 12,000 firms have been approached of which almost 2,000 start-ups agreed to participate in the panel in 1994. These firms have been followed since 1994. From 1994-1999 the participants received a questionnaire by mail, while in the period of 2000-2004 the participants were approached through computer assisted telephone interviewing (CATI). In 2000 previous participants were traced and approached. The number of participants therefore increases from 1999 to 2000. Throughout the years only 23% of the initial participants remained in the panel. Some participants refused to participate in the panel in later years, ceased economic activities, went bankrupt or moved and could not be traced. In the end, 435 firms remained in the study from start up and over the decade. Just like in other studies (Barron et al. 1996; Certo et al. 2001), we have taken the age of 10 years as a boundary for new firms.

The firms in the start-up panel were interviewed on such subjects as the characteristics of the firm and entrepreneur, finance, bottlenecks, strategy and goals, market and environment, realizations versus expectations. The main themes have largely remained the same over the years. Therefore the dataset not only contains information about the initial founding conditions, but also information over the life course of the firm.

It must be noted that our study may suffer from survival bias: only the firms that survived during the ten years (over the 1994-2004 period) were included in our research sample.

Sample characteristics

Of the 435 respondents that were still in the panel in 2004, 354 firms for which the complete growth paths could be identified are analysed here. The entrepreneurs in the sample are most often male (72%) and are often highly educated (71% has a bachelor or master degree). The age of the entrepreneurs in the start-up panel ranges from 19 to 61 years in 1994. The average age in 1994 was 38 years.

The distribution of the firms across industries is as follows: manufacturing (10%), construction (10%), retail and repairs (19%), wholesale (14%), catering (4%), transport and communication (4%), business services (26%) and other services (13%) (Bangma, 2007). The industrial distribution of start-ups in the Netherlands in 1994 in the sector construction and transport & communication is similar as in the panel. Furthermore the industrial distribution shows that the sectors manufacturing (NL: 6%) and retail & repairs (NL: 16%) are slightly overrepresented in the panel. The sectors catering (NL: 6%), business services (NL: 28%) and wholesale (NL: 19%) are slightly underrepresented in the panel.

On average, the firms in the panel employed 3.8 persons in 2004. The average employment creation of a start-up in 1994 was 1.7 persons (Bangma, 2007). The Dutch definition of SMEs includes all firms with less than 100

employees. None of the firms in the panel has grown so rapidly since 1994 that it has become a large firm. In fact 63% of the firms in the panel did not have any employees next to the business owner at all in 2004.

VARIABLES

The independent variables of this study were measured in the first survey in 1994, which covered the first year of the new firms' existence. The dependent – employment growth - variables were measured over the period 1994 to 2004. This time lag between independent and dependent variables enables us to make inferences about the (temporal) causality of the mechanisms tested.

Dependent variables

Growth. Growth of firms can be measured in terms of inputs (e.g. employees), value (e.g. assets) or outputs (e.g. profits). Here growth is measured in terms of the number of employees, the indicator most comparable with that used in other empirical studies on new firm growth, and provides an indicator of firm assets since human resources are among the most important assets of new firm. Changes in employee size are a conservative measure for investigating the instability of growth, in comparison to more rapidly changing figures such as sales or capital valuation. Not all firms follow a similar growth path when they grow. Four types of growth paths are explored; continuous growth, growth setbacks (a decline in firm size), early growth and/or plateau and delayed growth (cf. Garnsey et al., 2006).

The growth paths of the 354 firms that survived the first ten years of existence are shown in the pictograms in figure 2.[4] Only one firm has grown continuously over the ten year period. By far the largest group of firms (68.6%) has never grown during the period studied. A substantial group of firms (16.7%) has faced a setback during their life course, while 4.5% of the firms have seen their growth stagnating. Almost 10% of the firms only started to grow some years after start-up.[5]

In order to execute reliable regression analyses a distinction is made between the new firms that grew at least one time period (31.4%) and the majority (68.6%) that did not grow at all during the first ten years of existence. A dichotomous variable was created with a value one if the firm has grown one or more time periods and value zero if there was no growth within the first ten years of existence.

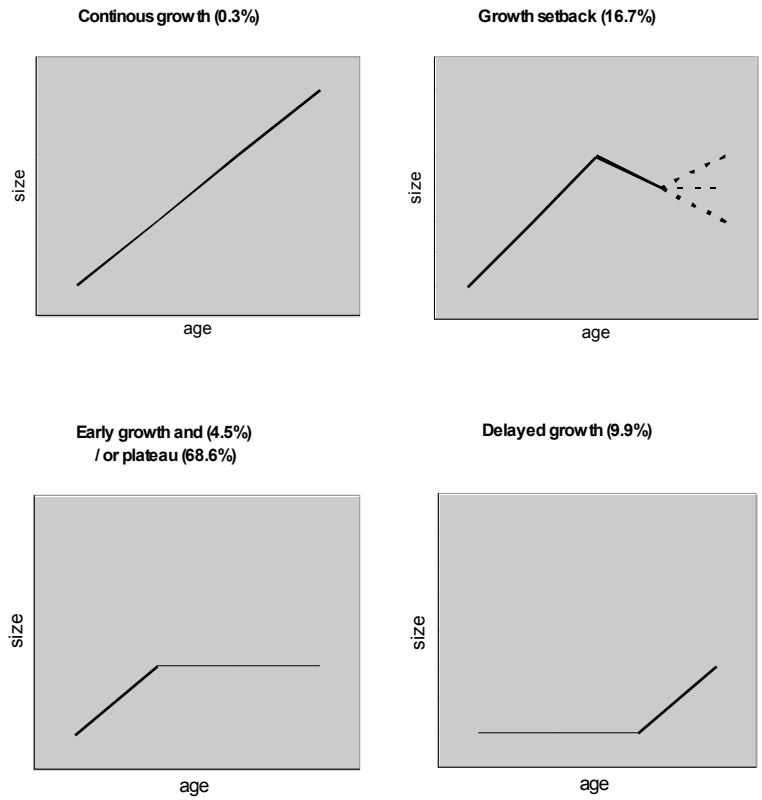

Figure 2 Growth paths of new firms

A threshold 10 employees is taken to show that a multi-person firm has been created. By our measure of growth this level had to be reached at least once within the first ten years of existence. This measure is somewhat more strict than the first measure of growth (only 12% of the firms reached this threshold once during their early life course), giving a better indication of the creation of a substantial firm. A similar threshold of 10 employees has been used in other studies like the Baron et al. (1996). Most firms never cross this threshold; more than 93% of the firms in the European business population have less than 10 employees (Aldrich 1999, p.11). In our sample only 41 firms had reached the 10-employee threshold once during the 10 post-entry years. Of these firms 41 firms, 23 had started without any employees, and only 6 had started with 10 or more employees. This measure is thus an indicator of growth in most cases, and not just an indicator of a large initial size.

Independent variables

Dynamic capabilities. To measure dynamic capabilities, four variables were used to capture the types of processes that have been labelled as dynamic capabilities in the literature (see Eisenhardt and Martin, 2000). These four

variables are: R&D activities, alliancing with other firms, developing new products, and introducing products to foreign markets.
The R&D activities variable was measured by asking whether the firms performed research and development activities in order to develop new products and/or processes for their firm. Alliancing was measured by asking whether the firms collaborated with one or more other firms in some way (this could be related to purchasing, sales, production, logistics, and R&D; but is different from 'pure' market transactions). In addition firms were asked whether they have been involved in developing new products, and in exporting in the prior year.

Different firm resources can be distinguished: financial capital and organizational capital.

Financial capital. Financial capital is measured by the amount of start-up capital.

Organizational capital. Two indicators of organizational capital have been used: whether the firm has been established through takeover and the start-up size of the firm in 1994 in terms of the number of employees.

Two types of capital on the person level are distinguished: social capital and human capital.

Social capital. Social capital is measured by the following variables: entrepreneurial family/friends, entrepreneurs that have contact with other entrepreneurs in their social network (entrepreneurial networks), and the number of business partners (entrepreneurial team).

Human capital. Knowledge and experience of the entrepreneur is measured by general and more specific human capital indicators. The general human capital indicator that has been used is the educational level of the entrepreneur. The more specific human capital indicator experience has been taken up in analyses on different fields: experience as a business-owner (prior to the current firm), leadership experience, human resource management experience, experience with financial management, technical experience (in current profession) and industry experience.

Environmental dynamism. Four indicators of environmental dynamism have been taken into account: dynamic industry, rapid technological change, technology-based firm and urban environment. The variable dynamic industry has been composed by adding up the annual number of entries and exits per industry in 1994. The variable rapid technological change refers to the situation in the industry of the entrepreneur whereby he/she must be on the lookout for technological changes to anticipate on. In addition a variable reflecting the technology base of the firm is taken into account, indicating whether the firm's activities are based on new basic technologies (new materials, biotech, medical technology. information technology, energy/environmental technology). The fourth variable is urban environment.

This variable distinguishes firms that are located in one of three largest cities in the Netherlands - Amsterdam, Rotterdam and The Hague and its agglomerations - from those in the countryside.

Controls. Different control variables have been included in the analyses: the (employment) growth ambitions of the entrepreneur, the age and gender of the entrepreneur. These variables have sometimes been classified – somewhat superficiously – as human capital variables. But, since we do not have a clear theoretical rationale to interpret them as human capital, we have only introduced them as control variables (in order to make the outcomes comparable with other new firm growth studies).

Whether growth firms were overrepresented in certain industries was checked. Growth firms were overrepresented in the retail, catering, transport and communication industries, and underrepresented in financial and business services, and personal services. The 10-employee threshold was more often achieved in the catering, and less often achieved in personal services. This shows that new firm growth is not restricted, or even concentrated in high tech sectors (see also Birch 1987).

Correlation analysis

Correlation analyses may be performed to identify the factors which, by our measures, are associated with growth and to check whether the independent variables are highly correlated with each other. Pearson correlation coefficients have here been used as an indicator. The significance levels of Pearson are similar to the chi-square test of independency (linear-by-linear association). High correlation among independent variables may disturb assessment of the relationship through regression analysis. The correlations between the independent and dependent variables have been checked and no high (>0.7) correlations were found. Several moderately strong (0.4-0.7) correlations could be found within the group of human capital variables: experience with financial management, leadership experience, and human resource management experience were moderately correlated. Two other – rather obvious – moderate correlations could be found between employment growth and reaching the 10-employee threshold, and between technology-based firms and rapid technological change. Finally, employment growth ambitions and employment growth (not the 10-employee threshold!) were also moderately correlated. None of the dynamic capability variables were moderately correlated, providing an indication that these are not interrelated in the firms first year of existence. This does not mean that firms only use one type of dynamic capabilities at the time: 38% of the firms use a bundle of dynamic capabilities.

Survivor bias

A fundamental problem in the analysis of firm growth is survivor bias.[6] If the investigation is only based on surviving firms it is likely that the selection of the sample is significantly correlated to the same variables that may

potentially affect firm growth. In 1994 the panel consisted of 1938 start-ups. For our analysis only 354 cases were used. It is very important to know why an exit from the panel occurred, because of possible biases in our results. We only have used data about the start-ups that survived and were willing to participate, not about the start-ups that left the panel. For example: if a certain start-up left the panel because he had no time or was not interested in participation, it does not necessarily mean that his venture was doing badly. Maybe it was going so well, that he or she needed more time to invest in the venture to keep up the success. It is a totally different case when the non-participation is caused by the bankruptcy of the firm, which also leads to exit from the panel. Unfortunately, there is very little reliable information about the nature of the non-participation of the firms in our panel. An additional 'exit-survey' was held, which did contain some more information about why a firm left the panel (see Stam et al. 2006). However, this additional survey was only performed among a minority of all the exits.

We traced the differences between the firms in our sample, and all the other 1584 firms that started in the same year, but were not among those included in our (ten year survivor) sample. If these two groups do not significantly differ in their initial conditions, our findings are unlikely to be obscured by a survivor bias. The differences between these two groups were checked for all 24 independent variables. We found that, indeed, the majority (19) of the variables had the same value in both samples. Only the values of 5 variables differed significantly between the two groups (Chi2 sign. <0.05). Older entrepreneurs[7] and entrepreneurs with high levels of technical experience were more likely to be included in our sample. New firms with low start-up capital were less likely to be included in our sample, while technology-based firms, and firms located in urban areas were more likely to be included in our sample. This may indicate that we understate the positive effect of the age of the entrepreneur and of technical experience on new firm growth (given their negative effect on the chance of 100% negative growth, i.e. firm exit). The most important proviso at the level of the firm, may be understatement of the positive effect of start-up capital, of technology-based activities, and of an urban location on new firm growth.

RESULTS

Logistic regression

The hypotheses were tested using logistic regression analysis, a method used to model dichotomous outcomes (here, the probability that the firm grows/probability the firm does not grow (beyond the 10-employee threshold)) by modelling the log odds of an outcome in terms of the values of covariates in the model. Multinomial regression analysis could not be performed with the growth paths due to a too small number of observations for each growth path. To test for multicollinearity we used the variance inflation factor (VIF). In none of the models used did multicollinearity appear to be present (VIF < 2.5).

The results are displayed in table 2. There are three consistent effects in both the growth and the 10-employee threshold models: employment growth ambitions (positive), age of the entrepreneur (negative) and inter-firm alliancing (positive). Firm resources matter, but differently so for both types of growth: a positive relation of start-up employment size with growth in general, and a positive relation of start-up capital with reaching the 10-employee threshold. R&D activities in the start-up year is also strongly related with reaching the 10-employee threshold. No significant relationships with the human and social capital variables were identified in the multivariate analyses, even though significant correlations were found in the bivariate analyses. The only exception is the negative relationship with having entrepreneurs among the circle of friends and family and reaching the 10-employee threshold.

These first analyses give some evidence for the positive association between dynamic capabilities and new firm growth. We can thus confirm our first hypothesis to a limited extent. According to our second and third hypothesis the relationship between dynamic capabilities and new firm growth will vary with the knowledge base of the entrepreneur and/or on the level of firm resources.

On the personal level, the knowledge base of the entrepreneur was expected to enable the effective use of dynamic capabilities. The knowledge base has been measured by the following variables that are significantly correlated with dynamic capabilities: educational level, technical experience an industry experience. No positive interaction effects of these variables with dynamic capabilities could be traced.

On the organisational level, a munificent resource base was hypothesized to provide the means to create and use dynamic capabilities effectively. However, in the models tracing the interaction effects of human resources and financial resources with indicators of dynamic capabilities did not produce a measurable relationship with firm growth.

The models tracing the interaction effects of personal knowledge and firm resources (start-up size) showed that these hardly changed the relation between dynamic capabilities and growth.[8] Thus, the second and third hypotheses are not supported; no moderating effect on dynamic capabilities and growth could be seen to be exerted by the level of human capital and/or firm resources.

Environments with rapid technological change are often assumed to provide relatively numerous entrepreneurial opportunities, and to be likely to stimulate firm growth (Bhidé 2000). We found no positive associations of any kind between firm growth and dynamic environments (table 2). Dynamic industries[9] and urban location actually had a significant negative association with the ability to reach the threshold of 10 employees, and growth in general, respectively.

Dynamic capabilities are said to be most valuable in dynamic environments, such as environments with rapid technological change. Thus, it may be expected that dynamic capabilities have a (stronger) relationship with growth in environments of rapid technological change. The relationship between dynamic capabilities and firm growth / 10-employee threshold is analysed in a sub sample of firms that operate in an environment of rapid

technological change. However, for firms operating in an environment subject to rapid technological change, the relationship between inter-firm alliancing and both growth and the 10-employee threshold vanishes.[10] The same applies for firms in turbulent industries. Another indicator of the importance of technological change is whether or not the firm's activities are based on a new basic technology. Therefore we explored whether dynamic capabilities were more useful for technology-based firms than the population of firms in general. Among technology-based firms, inter-firm alliancing was found to be the dynamic capability having a positive association with 'growth' and with reaching the 10-employeethreshold, as for the general population of firms.

The analyses provide only very limited support for the fourth hypothesis which states that environmental dynamism impacts the relationship between dynamic capabilities and growth. The positive relationship with inter-firm alliancing even vanishes in turbulent industries and for firms that operate in environments experiencing rapid technological change. Only a relatively weak positive relationship with new product development on reaching the 10-employee threshold in environments of rapid technological change could be found.

Table 2 Results of regression analysis for growth and 10-employee threshold

Factors associated with new firm growth	*Employment growth*	*10-employee threshold*
Constant	-2.985 ***	-4.730 ***
Dynamic capabilities		
New product development	0.022	0.084
R&D activities	-0.542	1.415 **
Inter-firm alliancing	0.815 **	0.935 *
Export	0.517	0.819
Financial capital		
Start-up capital (x 1 000)	0.157	0.497 ***
Social capital		
Entrepreneurial family/friends	0.091	-1.061 *
Entrepreneurial networks	0.427 *	0.366
Entrepreneurial team	0.608	0.641
Organisational capital		
Take-over	0.001	-0.290
Start-up size: employees	0.737 ***	X[1]
Human capital		
Educational level	0.092	-0.427
Business-owner experience	0.350	-0.701
Leadership experience	0.278	-0.093
Human resource management experience	0.111	0.399
Experience with financial management	-0.068	-0.090
Technical experience (in current profession)	0.137	0.390
Industry experience	-0.106	0.248
Environmental dynamism		
Dynamic industry	-0.051	-0.124 **
Rapid technological change	-0.196	0.400
Technology-based firm	-0.324	0.100
Urban environment	-1.497 *	0.400
Controls		
Gender entrepreneur	0.232	-0.777
Age entrepreneur in 1994	-0.778 ***	-0.832 **
(Employment) growth ambitions	0.518 ***	0.400 *
Nagelkerke R Square	0.451	0.387

Significant at *** 99%, ** 95%, * 90% level of confidence.

[1] Initial (employment) size is omitted, due to possible endogeneity problems: firms with 9 employees can much more easily reach the 10-employee threshold than the majority of 1

person businesses; the six firms with 10 or more employees at start automatically reach the threshold)

The outcomes of the analyses are summarized in figure 3 (growth in general) and 4 (10-employee threshold).

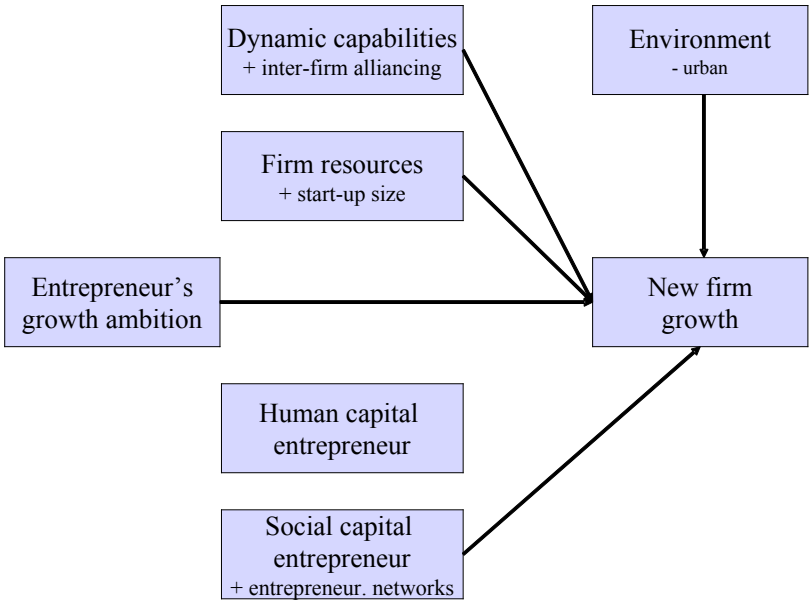

Figure 3 Factors associated with employment growth of new firms in general

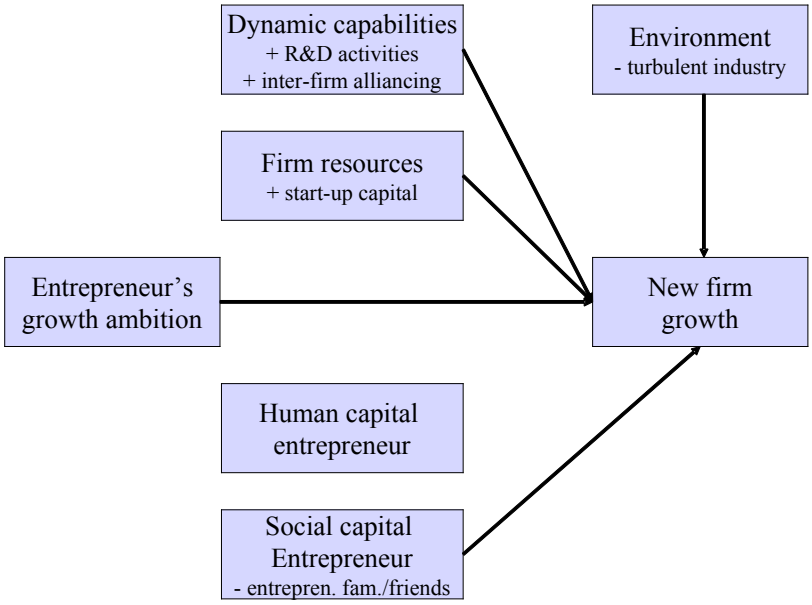

Figure 4 Factors associated with reaching the 10-employee threshold

DISCUSSION

As regards the relationship between dynamic capabilities and growth, inter-firm alliancing is revealed to have a rather consistent positive association with firm growth and with achieving the 10-employee threshold, while R&D only has a positive relation with achieving the 10-employee threshold. Exporting showed no association at all with growth. Only in dynamic technological environments did new product development turn out to have a (weak) positive relationship with achieving the 10-employee threshold. New product development was not revealed to have any association with firm growth in all other environments.

Assumed opportunity rich environments – environments with rapid technological change, turbulent industries, and urban environments – turned out to have no significant relationship with growth or even had a negative relationship in some of the analyses.

Moving from associations to causes, the proposed moderating influence of personal knowledge and firm resources on the effect of dynamic capabilities on firm growth have not been found in this study.

In comparison to the prior empirical studies on employment growth of new firms, many variables (entrepreneurial team, educational level, business-ownership experience, technical experience, industry experience, gender, and new product development (i.e. innovation ambitions)) did not have the presumed relationship. The level of start-up capital only partly had the expected positive association. Employment growth ambitions had a strong positive association with firm growth in general, and a somewhat less strong relation with reaching the 10-employee threshold. A large initial size seems to be much more important here than growth ambitions per se. For example starting with nine employees makes it easier to reach the 10-employee threshold then starting with one employee. Another surprising outcome was the negative relationship with having entrepreneurial family/friends and reaching the 10-employee threshold. Perhaps it is true that "ties that bind can easily turn into ties that blind" (Grabher 1993) in the case of firm growth. Another, contrasting outcome was the negative association between the entrepreneur's age and firm growth. The latter outcome may however also be related to the long time span we took into account (10 years; in contrast to the 3-6 years of most other studies), perhaps providing fewer incentives for entrepreneurs older than 50 years at start-up to grow their business over this period.

LIMITATIONS

Approaches like organizational ecology (Hannan and Freeman, 1984) and evolutionary economics (Klepper, 2002) argue that initial conditions at founding are of decisive importance for explaining the long term performance of organizations. Several empirical studies have claimed to show the long-term influence of initial conditions on the performance of new firms (Geroski et al. 2006; Hannan et al. 2006). This does not imply that

changing post-entry conditions do not matter. Even though the explained variance of our models are relatively high (ranging from 0.451 to 0.387)[11], we should not expect that initial conditions provide the best explanation of the growth of new firms over a ten year period. A large part of the variance in the relationship between start-up attributes and growth remains unexplained. Factors of this kind defy integration into linear style explanatory models.[12] The responses of firms to the conditions they encounter may be critical and are not readily modelled by conventional statistical approaches. Changing conditions both internal and external to the firm are likely affect firm growth over the early life course of firms. This is in line with the argument that dynamic capabilities must be built through experience (Teece et al. 1997). Relevant experience can of course be built up prior to the creation of the firm, but if it is to be a distinctive asset of the firm (i.e. firm-specific) it is more likely to be built up through teamwork over the years in the early life course of the firm (Penrose 1959). Accordingly strategic options pursued and changes in strategy are mentioned in literature as a mediating factor between capabilities and growth (Wiklund 1998; Edelman et al. 2005). We have also only used relatively restricted dichotomous dependent variables, which do not differentiate between firms that grow fast and those that grow slowly. Further work will investigate these issues.

FUTURE RESEARCH AND IMPLICATIONS

Our study provided supported for earlier work showing that initial conditions have a major influence on the long term growth of new firms. There is additional insight to be gained in the growth process by investigating the post-entry dynamics of the firm. Prior longitudinal studies have shown that firm growth is not a linear process, and may take off or be constrained in later phases of the life course. These dynamics in the growth paths may be explained by (random) external shocks (Geroski, 2005). However the response of firms to circumstances may be a critical factor (Hugo and Garnsey, 2003). There is a need for a systematic analysis of firms' ability to resist external shocks: "If there is a high probability of any negative event occurring and the hardship it imposes are generic, then one can incorporate the effect of random events through the venture's capacity for withstanding a common set of probable difficulties" (Woo et al. 1994, p. 520). Such an analysis would, for example, imply a focus on keeping open multiple options and on pre-emptive and remedial measures to deal with uncertainty and on the various buffers which enable young firms to reduce or cope with the impact of random jolts (cf. Venkatamaran and Van de Ven, 1998). Growth path dynamics should be viewed in terms of the inherent problems of firm growth and the changing ability of firms to solve these problems and accumulate firm-specific competences (Penrose, 1995; Garnsey, 1998) and dynamic capabilities (Arthurs and Busenitz, 2006).[13]

Next to these problem-driven mechanisms, more opportunity-driven mechanisms (innovation) may be important. The EIM start-up panel offers the unique opportunity to trace the emergence of problems and opportunities

during the growth paths of new firms (cf. Stam and Schutjens, 2006), and also to take into account the subsequent solution of these problems and the associated learning efforts and investments by these firms over time. Problem solving and learning may be important for the development of organizational capabilities later on in the life course of these new firms (cf. Zahra et al., 2006). Until now such analysis on the growth and problem-solving of new firms has mainly been done with case studies (see e.g. Hugo and Garnsey, 2005; Stam and Garnsey, 2006). Future large scale quantitative research analysing the changing conditions (both firm-internal as firm-external) will deliver insights into whether the dynamic capabilities are developed during the life course of the firm and whether they are effective in changing the resource base of the firm in order to sustain competitive advantage in a dynamic environment. This research should focus on providing improved explanations of new firm growth by analysing process events (problems, innovation) and learning (entrepreneurial, organizational; inter-organizational) during the life course.

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REFERENCES

Aldrich, H. (1999), *Organizations Evolving*, London: Sage.

Almus, M., & Nerlinger, E.A. (1999), Growth of new technology-based firms: which factors matter?, *Small Business Economics*, 13: 141-154.

Arthurs, J.D. & Busenitz, L.W. (2006), Dynamic capabilities and venture performance: The effects of venture capitalists, *Journal of Business Venturing*, 21(2): 195-215.

Audretsch, D.B., Santarelli, E. & Vivarelli, M. (1999), Start-up size and industrial dynamics: some evidence from Italian manufacturing, *International Journal of Industrial Organization*, 17(7): 965-983.

Audretsch, D.B., Klomp, L., Santarelli, E. & Thurik, A.R. (2004), Gibrat's Law: Are the services different?, *Review of Industrial Organization*, 24(3): 301-324.

Bangma, K.L. (2007), *Bedrijvendynamiek en werkgelegenheid: periode 1987-2006* (Firm dynamics and employment: period 1987-2006), EIM, Zoetermeer.

Baron, J.N., Burton, M.D. & Hannan, M.T. (1996), The Road Taken: The Origins and Evolution of Employment Systems in Emerging High-Technology Companies, *Industrial and Corporate Change*, 5: 239–276.

Baum, J.R., Locke, E.A. & Smith, K.G. (2001), A multidimensional model of venture growth, *Academy of Management Journal*, 44 (2): 292-303.

Birch, D. (1987), *Job creation in the America*, New York: Free Press.

Bosma, N.S., Praag, C.M. van, Thurik, A.R. & Wit, G. de (2004), The Value of Human and Social Capital Investments for the Business Performance of Startups, *Small Business Economics*, 23(3): 227-236.

Brusoni, S., Cefis, E., Orsenigo, L. (2006), Innovate or die? A critical review of the literature on innovation and performance, No 179, CESPRI Working Papers, Bocconi, Milano.

Brüderl, J., & Preisendörfer, P. (2000), Fast growing businesses: empirical evidence from a German study, *International Journal of Sociology*, 30: 45-70.

Certo, S.T., Covin, J.G., Daily, C.M. & Dalton, D.R. (2001), Wealth and the effects of founder management among ipo-stage new ventures, *Strategic Management Journal*, 22(6/7): 641-658.

Chandler, G.N., & Jansen, E. (1992), The founder's self-assessed competence and venture performance, *Journal of Business Venturing*, 7: 223-236.

Chrisman, J.J., McMullan, E. & Hall, J. (2005), The influence of guided preparation on the long-term performance of new ventures. J*ournal of Business Venturing* 20: 769–791.

Colombo, M.G. & Grilli, L. (2005), Founders' human capital and the growth of new technology-based firms: A competence-based view, *Research Policy*, 34(6), 795-816.

Cooper, A.C., F.J. Gimeno-Gascon & C.Y. Woo (1994), Initial human and financial capital as predictors of new venture performance, *Journal of Business Venturing*, 9(5): 371-395.

Dahlqvist, J., Davidsson, P. & J. Wiklund (2000), Initial conditions as predictors of new venture performance: a replication and extension of the Cooper et. al. study, *Enterprise & Innovation Management Studies*, 1(1): 1-17.

Davidsson, P. (1991), Continued entrepreneurship: Ability, need and opportunity as determinants for small firm growth, *Journal of Business Venturing*, 6: 405-429.

Davidsson, P. (2004), *Researching Entrepreneurship*. New York: Springer.

Edelman, L.F., Brush, C.G. & Manolova, T. (2005), Co-alignment in the resource-performance relationship: strategy as mediator, *Journal of Business Venturing*, 20(3): 359-383.

Eisenhardt, K. M. & Martin, J.A. (2000), Dynamic Capabilities: What are they?, *Strategic Management Journal*, 21: 1105-1121.

Felin, T. & N. J. Foss (2006), Individuals and Organizations: Thoughts on a Micro-Foundations Project for Strategic Management and Organizational Analysis, DRUID Working paper 06-01.

Fuller, T. and Moran, P. (2001), Small enterprises as complex adaptive systems: a methodological question? *Entrepreneurship & Regional Development* 13(1): 47-63.

Garnsey, E. (1998), A Theory of the Early Growth of the Firm, *Industrial and Corporate Change*, 7: 523-556.

Garnsey, E., E. Stam & P. Hefferman (2006), New Firm Growth: Exploring processes and paths, *Industry and Innovation*, 13(1): 1-24.

Geroski, P.A. (2005), Understanding the implications of empirical work on corporate growth rates, *Managerial and Decision Economics*, 26(2): 129-138.

Geroski, P.A., Mata, J., Portugal, P. (2006), Founding conditions and the survival of new firms. Paper presented at the Max Planck Institute of Economics Workshop on Firm Exit and Serial Entrepreneurship, January 2006, Jena, Germany.

Grabher, G. (1993), *The embedded firm: On the socioeconomics of industrial networks*, London: Routledge.

Greiner, L.E. (1972), Evolution and Revolution as Organizations Grow, *Harvard Business Review*, July-August, 37-46.

Hitt, M.A., Ireland, D., Camp, M., & Sexton, D.L. (2001), Guest editors' introduction to the special issue Strategic Entrepreneurship: Entrepreneurial Strategies for Wealth Creation, *Strategic Management Journal,* 22: 479-491.

Hannan, M.T. & Freeman, J. (1984), Structural Inertia and Organizational Change, *American Sociological Review*, 49: 149-164.

Hannan, M.T., Baron, J.N., Hsu, G. & Koçak, Ö. (2006), Organizational identities and the hazard of change, *Industrial and Corporate Change*, 15: 755-784.

Harhoff, D., Stahl, K. & Woywode, M. (1998), Legal form, growth and exit of West-German firms – Empirical results for manufacturing, construction, trade and service industries, *Journal of Industrial Economics* , 46(4): 453-488.

Hugo, O. & Garnsey, E. (2005), Problem-solving and competence creation in the early development of new firms, *Managerial and Decision Economics*, 26(2): 139-148.

Hutchinson, P. & Ray, G. 1986, 'Surviving the Financial Stress of Small Enterprise Growth', in *The Survival of the Small Firm. Volume 1: The Economics of Survival and Entrepreneurship*, eds J. Curran J., Stanworth and D. Watkins, Gower Publishing, Aldershot, England: 53-71.

Klepper, S. (2002), The capabilities of new firms and the evolution of the US automobile industry, *Industrial and Corporate Change*, 11: 645-666.

Klepper S., Graddy, E., (1990), The evolution of new industries and the determinants of market structure, *RAND Journal of Economics,* 21(1): 27-44 .

Lee, C., Lee, K., & Pennings, J.M. (2001), Internal capabilities, external networks and performance: a study on technology-based ventures, *Strategic Management Journal*, 22: 615-640.

Lotti, F., Santarelli, E. & Vivarelli, M. (2001), The relationship between size and growth: the case of Italian newborn firms, *Applied Economics Letters*, 8: 451-454.

Mansfield E. (1962), Entry, Gibrat's Law, Innovation, and the Growth of Firms, *American Economic Review* , 52, 1023-1051.

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

Piore, M. J. & Sabel, C. F. (1984), *The Second Industrial Divide: Possibilities for Prosperity,* Basic Books: New York.

Powell, W.W., Koput, K. & Smith-Doerr, L. (1996), Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology, *Administrative Science Quarterly*, 41(1): 116-145.

Schumpeter, J.A. (1934), *The Theory of Economic Development*, Oxford University Press: New York.

Schutjens, V.A.J.M. & Wever, E. (2000), Determinants of new firm success. Papers in Regional Science, 79(2): 135-159.

Schutjens, V.A.J.M. & Stam, E. (2006), Starting anew: Entrepreneurial intentions and realizations subsequent to business closure, Discussion Papers on Entrepreneurship, Growth and Public Policy 2006-10, Max Planck Institute of Economics, Group for Entrepreneurship, Growth and Public Policy.

Siegel, R., Siegel, E., & Macmillan, I.C. (1993), Characteristics distinguishing high growth ventures. *Journal of Business Venturing*, 8: 169-180.

Stam, E., Audretsch, D. & Meijaard, J. (2006), Renascent entrepreneurship, Working paper Max Planck Institute of Economics, Jena, Germany.

Stuart, R.W., & Abetti, P.A. (1990), Impact of entrepreneurial and management experience on early performance, *Journal of Business Venturing*, 5: 151-162.

Tapon, F., Thong, M. & Bartell, M. (2001), Drug discovery and development in four Canadian biotech companies, *R & D Management*, 31(1): 77-90.

Teece, D.J., Pisano, G. & Shuen, A. (1997), Dynamic capabilities and strategic fit, *Strategic Management Journal*, 18: 510-533.

Vivarelli, M. & Audretsch, D. (1998), The Link between the Entry Decision and Post-entry Performance: Evidence from Italy, *Industrial and Corporate Change*, 7: 485-500.

West, III, P.G. & DeCastro, J. (2001), The Achilles heal of firm strategy: resource weaknesses and distinctive inadequacies, *Journal of Management Studies*, 38(3): 417– 442.

Westhead, P., & Cowling, M. (1995), Employment change in independent owner-managed high technology firms in Great Britain, *Small Business Economics*, 7: 111-140.

Wiklund, J. (1998), *Small firm growth and performance: entrepreneurship and beyond*, PhD Thesis, Jonkoping International Business School.

Wiklund, J. and Shepherd, D. (2005), Knowledge accumulation in growth studies: the consequences of methodological choices. Paper presented at ERIM workshop ‘‘Perspectives on the Longitudinal Analysis of New Firm Growth’’, Erasmus University Rotterdam, the Netherlands, 18–19 May.

Winters, R. & Stam, E. (2007), Beyond the firm: Innovation and networks of high technology SMEs, In: Arauzo, J.M. and Manjón, M. (eds.), *Entrepreneurship, Industrial Location and Economic Growth*, Cheltenham, Edward Elgar: 235-252.

Woo, C., Daellenbach, U. & Nicholls-Nixon, C., (1994), Theory building in the presence of randomness: The case of venture creation and performance, *Journal of Management Studies*, 31(4), 507-524.

Yu, T.F.L. (2001), Toward a capabilities perspective of the small firm, *International Journal of Management Reviews*, 3(3): 185-197.

Zahra, S., Sapienza, H.J., Davidsson, P. (2006), Entrepreneurship and Dynamic Capabilities: A Review, Model and Research Agenda, *Journal of Management Studies*, 43(4): 917-955.

APPENDIX

Authors	*Time period*	*Industries*	*Number of firms*	*Region*
Cooper et al. 1994	1985-1987 (3 years)	Representative for new firm population	1,053	US
Dahlqvist et al. 2000	1994-1997 (3 years)	All except agriculture, forestry, hunting, fishery, and real estate	6,377	Sweden
Schutjens and Wever 2000	1994-1997 (3 years)	All except agriculture and mining	563	Netherlands
Bosma et al. 2004	1994-1997 (3 years)	All except agriculture and mining	758	Netherlands
Vivarelli & Audretsch 1998	1985-1993 (<9 years; mean age 3 years)	All	100	Emilia (Italy)
Colombo & Grilli 2005	1980 (or later)– 2004 (max. 13 years)	High tech sectors (computers, electronic components, telecommunication equipment, optical, medical, and electronic instruments, biotechnology, pharmaceuticals, advanced materials, robotics, and process automation equipment, multimedia content, software, internet services, and telecommunication services)	506	Italy
Almus & Nerlinger 1999	1992/1996-1998	Manufacturing industries (both 'High-Tech Industries' (R&D-intensity above 3.5%) and 'Non-High-Tech Industries' (R&D-intensity below 3.5%).	8,739	Germany
Brüderl & Preisendörfer 1998	1985/86-1990 (4 years)	All except crafts, agriculture, physicians, architects, and lawyers	1,710	Munich and Upper Bavaria (Germany)
Chrisman et al. 2005	1992/1997-2001 (3-8 years)	All (received outsider assistance at start)	159	Pennsylvania (US)

NOTES

[1] There have been some studies on how certain aspects of dynamic capabilities are related to other indicators of new firm growth like sales growth (Lee et al., 2001) or on the probability of IPO (initial public offering).

[2] Chandler and Jansen (1992) found similar positive relationships between the entrepreneurial, managerial and technical skills of the entrepreneur on sales growth in new firms. The positive association between industry experience and sales growth of new firms was also found in Siegel et al. (1993), while Stuart and Abetti (1990) found that only entrepreneurial experience (previous new venture involvements) and not managerial and technical experience were important factors in a composite indicator of new firm growth (based on sales, employment, profit and productivity growth).

[3] Kirchhoff (1994) empirically defines innovation on an industry basis: high innovation firms are those firms belonging to industries where business activity is characterized by: (1) above average employment of scientists, engineers, and technical professionals; and (2) above average expenditures in research and development. This definition does not take the heterogeneity of firms (other than industry affiliation) into account, and focuses on inputs in the innovation process, not outputs (more relevant for firm growth). Definitions like this one mix up high tech industries with innovation. He found that during their first six years of existence 'high innovation' new firms are more likely to grow, but do not have higher probabilities to survive than 'low innovation' new firms.

[4] These growth paths highlight growth inflections and are based on 5% employment change thresholds; we also used 10% employment change thresholds in another analysis, this however hardly changed the distribution of growth paths over the sample (only the number of firms in the setback category was significantly less in the 10% analysis).

[5] These numbers are different from the Garnsey et al. (2006) study, because they analysed a cohort of firms in the 1990-2000 period (thus before the early 2000s recession) and their sample only included incorporated firms (and thus excluded sole-proprietors, which make up the majority of our sample). These differences might be responsible for the relatively small percentage of continuously growing firms, and the relatively high percentage of plateau firms. An analysis of all the firms started in 1977 and 1978 in the US showed that more than half of all firms that survived for six years did not show any growth in employment (Kirchhoff 1994).

[6] Wiklund and Shepherd (2005) found that firm survival (of all incorporated firms, registered in Sweden between 1994-1998) is positively correlated with absolute and relative employment growth.

[7] This is in contrast with our expectation that older entrepreneurs are more likely to have closed their business (voluntarily) (see Harhoff et al., 1998). On the other hand, young entrepreneurs are more likely to be mobile on the labour and housing market, which causes a higher non-response rate among them because they are harder to trace year after year (see e.g. Stam et al., 2006).

[8] Regression models with the interaction effects are available from the authors.

[9] Klepper and Graddy (1990) argued that especially in new, turbulent industries firm growth is rather limited because of the high levels of uncertainty about their costs and product qualities relative to those of competitors.

[10] For the 10 employees-threshold model we found a weak (only at a 10% significance level) positive effect of new product development in environments of rapid technological change.

[11] For example, Harhoff et al. (1998) could only explain about 8% of the variance in their models on employment growth of West-German firms over a 5 year period.

[12] According to Davidsson (2004, p.45) we should even be suspicious about research that explains more than half of the variance, because "[t]here is just too much idiosyncratic variation and unavoidable measurement error".

[13] This is not to say that there are invariant stages of growth (Greiner 1972).