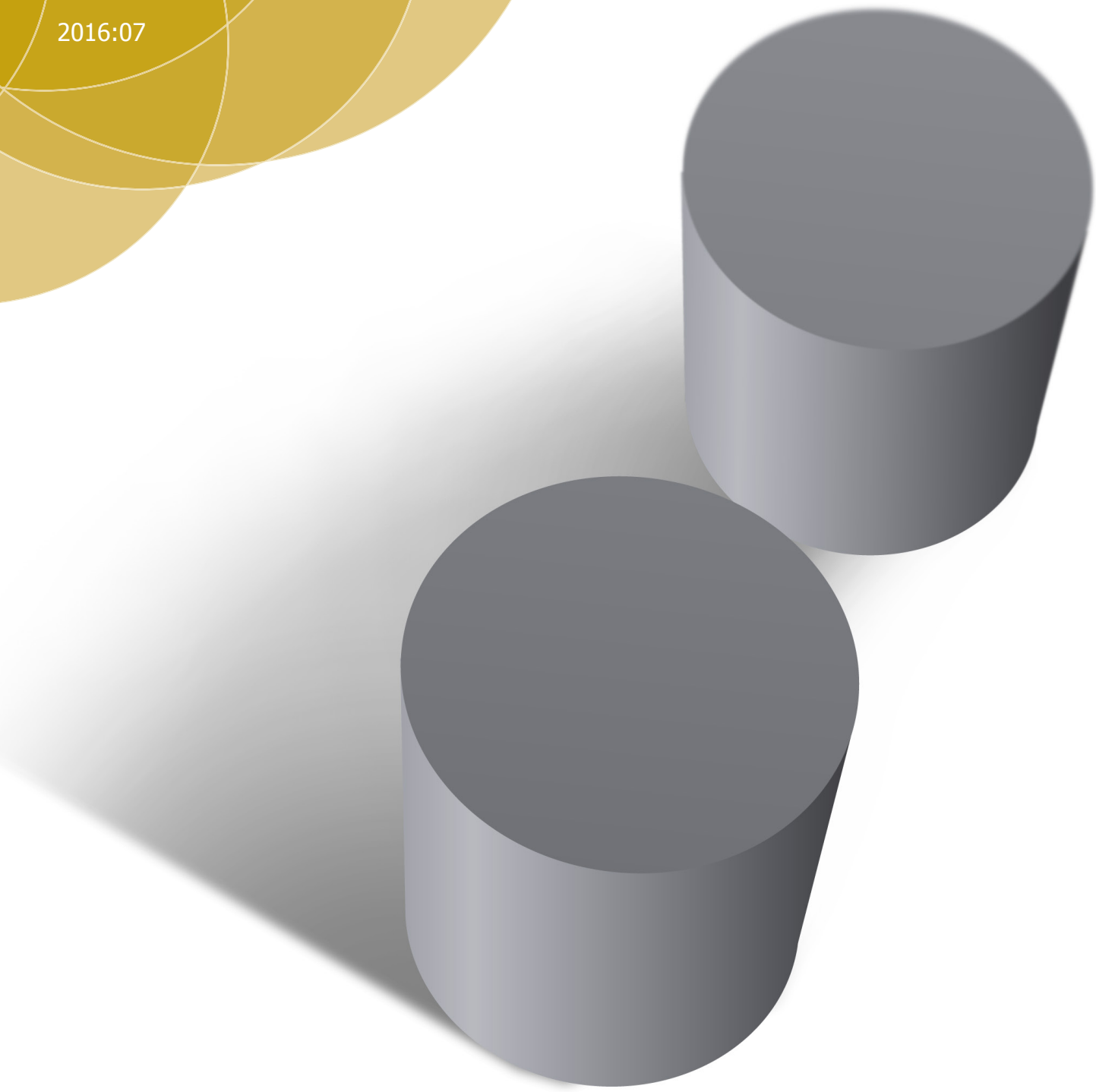
PM
2016:07



The Swedish start-up firms of 1997

Growth dynamics from a 14-year perspective

In this report, Growth Analysis studies a single cohort of start-up firms and follow their development over a relatively long time period. The purpose of the study is to describe how many firms survive and grow, as well as how this growth is distributed over time.

growth analysis

Our ref: 2014/227

Swedish Agency for Growth Policy Analysis
Studentplan 3, SE-831 40 Östersund, Sweden
Telephone: +46 (0)10 447 44 00
Fax: +46 (0)10 447 44 01
E-mail: info@growthanalysis.se
www.growthanalysis.se

For further information, please contact: Lars Bager-Sjögren
Telephone: +46 (0)10 447 44 72
E-mail: lars.bager-sjogren@growthanalysis.se

Foreword

In recent years, research on firm growth has directed its attention towards the importance of high-growth firms for the economic growth rate in a given year or time span. However, recent research relating to the growth of firms has called for additional research that takes firm age, rather than size, more explicitly into account.

In this working paper, The Swedish Institute for Growth Policy Studies (Growth Analysis) has chosen to study a single cohort of start-up firms and follow their development over a relatively long time period (1997 through 2011). The purpose of the study is to describe how many firms survive and grow, as well as how this growth is distributed over time.

Conceived by Sebastian Krakowski (Geneva School of Economics and Management, University of Geneva) and Lars Bager-Sjögren (Growth Analysis), this paper builds on results presented by Sebastian Krakowski in his master thesis Growth Patterns of Start-Up Firms – A Cohort Study with a Quantile Regression Approach (2014), written at the Stockholm School of Economics.

Stockholm, April 2016

Enrico Deiaco
Director, Innovation and global meeting places
Growth Analysis

Förord

På senare tid har forskning om tillväxt i företag ägnat ökad uppmärksamhet åt rollen snabbväxande företag (*high-growth firms*) spelar för ett lands ekonomiska tillväxt i ett givet år eller tidsperiod. Resultaten tyder på att fortsatt forskning bör ta företags ålder, snarare än storlek, mer tydligt i beaktande.

I detta PM har Myndigheten för tillväxtpolitiska utvärderingar och analyser (Tillväxtanalys) valt att undersöka en kohort nystartade företag och följa deras utveckling under en förhållandevis lång tidsperiod (1997 till och med 2011). Syftet med studien är att fastställa hur många företag som överlever och uppvisar tillväxt.

Studien är författad av Sebastian Krakowski (Geneva School of Economics and Management, University of Geneva) och Lars Bager-Sjögren (Tillväxtanalys) och bygger på Sebastian Krakowskis masteruppsats Growth Patterns of Start-Up Firms – A Cohort Study with a Quantile Regression Approach (2014), skriven vid Handelshögskolan i Stockholm.

Stockholm, april 2016

Enrico Deiaco
Avdelningschef, Innovation och globala mötesplatser
Tillväxtanalys

Table of Contents

Summary

Background

Seeing innovation and productive entrepreneurial activity as one of the drivers of economic growth implies that the establishment of successful start-up firms is a key contributor to a country's economy. Of particular value are firms that are able to not only achieve high growth rates, but ultimately to survive in the long term and continue to provide a range of socio-economic benefits such as employment and innovations in the market.

Previous research indicates that most firms do not survive in the long term, and that even fewer qualify as "growth engines." For this very reason, they have been receiving increaseing attention in order to gain more insight into their determinants and the dynamics that affect their growth and survival.

A considerable share of previous research has suggested that the process is essentially random. However, many studies have based their analyses on cross-sectional data, as opposed to this paper, which uses longitudinal data following a specific cohort of new firms.

The study

The object of study in this paper is the 1997 cohort of Swedish start-up firms. Here, we can essentially differentiate between two types of firms. One consists of firms that originate from incumbent enterprises, i.e., spin-offs. These are often already well-connected in the market when they are created, and previous research suggests that they are the main source of the economic growth that is generated by new firms. The other type comprises start-ups with little or no previous market experience. This category also includes academic spin-offs, as well as start-ups where founders were previously unemployed. In this study, we focus on this latter type of start-ups, since they are ones that are likely to benefit most from public support for continued survival.

Results

The paper shows that over a period of 14 years, 1 517 of 19 232 (8 percent) firms survive. The sum of the surviving firms' revenue is lower than that of all firms combined in the first year. A marked growth is seen among the surviving firms ten years after their establishment. The surviving firms thus constitute a measure of "sustainable" development and can justifiably be said to have introduced innovations that have contributed to Swedish growth.

In general, the results corroborate the notion that growth plays an important role in promoting a firm's chances of survival. Furthermore, early growth is clearly associated with increased survival. Finally, firm size and geographic expansion do not appear to have a significant effect, while, somewhat surprisingly, subsidiaries appear to be less prone to survive.

Conclusion and future studies

The study corroborates previous findings that growth leads to a greater likelihood of survival for new firms. This pattern has also been found in previous studies using similar methods.

Possibly fruitful paths for future research include additional studies of market selection processes and what determines long-term sustainability in firm survival. For instance, the question remains under which circumstances subsidiaries actually benefit from their parents' resources in terms of long-term survival, rather than mere short-term resilience to market selection.

Sammanfattning

Bakgrund

Givet att innovation och produktiv entreprenörsverksamhet har en avgörande betydelse för tillväxt ses nystartade och framgångsrika företag som en särskilt gynnsam del av ett lands ekonomi. Särskilt värdefulla är företag som inte bara uppvisar höga tillväxttakter, men som även lyckas överleva och upprätthålla denna tillväxt över en längre tidsperiod. Under denna tid genererar de en rad socioekonomiska fördelar såsom jobb och innovationer som introduceras på marknaden.

Tidigare forskning har visat att de allra flesta företagen inte överlever på lång sikt, och att endast en bråkdel av överlevande företag hör till kategorin ”tillväxtmotorer.” Därför har de ägnats särskild uppmärksamhet med syftet att utröna vad som föranleder deras förekomst och överlevnad.

En stor andel av tidigare forskning kommit till slutsatsen att det i stort rör sig om en slumpmässig process. Dock har en väsentlig del av tidigare studier baserats på tvärsnittsdata, till skillnad från denna studie som använder longitudinell data som följer en specifik kohort av nystartade företag.

Denna studie

Detta PM följer 1997 års svenska nystartade företag och deras utveckling till och med 2011. Företagen kan grovt sett delas in i två kategorier. Den ena består av företag som knoppas av från ett existerande företag, dvs. spin-offs. Dessa företag har ofta redan starka kopplingar till marknaden när de bildas, och tidigare forskning tyder på att de står för majoriteten av den ekonomiska tillväxt som genereras av nya företag. Den andra kategorin består av företag med begränsad eller obefintlig marknadserfarenhet, vilket också omfattar akademiska spin-offs och företag där grundarna saknar tidigare anställning. Denna studie fokuserar på denna senare kategori av nystartade företag, eftersom det är dessa som sannolikt kan hjälpas mest av statligt stöd för fortsatt överlevnad.

Resultat

PM:et följer 1997 års kohort av nystartade företag till och med år 2011, en period på 14 år. Av 19 232 nystartade företag överlever 1 517 hela perioden. Med andra ord överlever endast 8 procent av de ”genuint” nya företagen på lång sikt. Dessa överlevande företag har dock en lägre total omsättning än vad omsättningen var initialt för alla nystartade företag. En markerad tillväxt i gruppen överlevare sker omkring det tionde levnadsåret.

Överlag stödjer resultaten teorin att tillväxt spelar en viktig roll gällande företags chanser att överleva, och att tidig tillväxt är kopplad till överlevnad. Därutöver finner studien bevis för att de första åren efter grundandet är de allra mest riskfyllda för ett företag, och att chansen till överlevnad ökar med tilltagande ålder. Slutligen finner vi att företagens storlek och geografiska expansion inte uppvisar någon påtaglig effekt med hänseende till överlevnad, medan dotterbolag, något överraskande, påvisar lägre snarare än högre benägenhet att överleva.

Slutsats och framtida studier

Studien finner stöd för resultat från tidigare forskning som tyder på att tillväxt ökar sannolikheten för att nystartade företag ska överleva. Denna slutsats har även dragits i tidigare studier som använt liknande metodik.

Framtida studier skulle kunna undersöka processer i tidigt skede mer i detalj, och därvid ägna särskild uppmärksamhet åt marknadsselektion och vad som föranleder överlevnad på lång sikt. Exempelvis kvarstår frågan under vilka omständigheter och i vilken mån dotterbolag är behjälpta av moderbolagens resurser med hänseende till långsiktig överlevnad, snarare än rent kortsiktig överlevnadsförmåga.

1 The growth dynamics of new firms

Many of today's public policy instruments are directed at promoting new and small firms, with the intention of supporting their growth and employment capability. However, there is still a lack of understanding regarding the performance patterns of new firms from a quantitative perspective. This study aims to discuss two areas of interest for public policy. Firstly, we examine whether, and if so to what extent, growth has a positive effect on the survival of start-ups. Secondly, we investigate whether early growth is beneficial not only for firms in particular, but possibly also for society in general in terms of socioeconomic benefits, such as job creation. We also hope to contribute to the ongoing discussion on high-growth firms (HGFs),[1] or gazelles, by analyzing more broadly which factors appear to be driving growth and, in extension, possibly also firm survival and job creation.

1.1 Why focus on new firms?

From an innovation perspective, start-up firms[2] are a highly relevant object of study. Baumol (2002: Chapter 1) holds that innovation, rather than price competition in the neo-classical sense, is the main driver of the capitalist "growth miracle." Innovation, rather than price setting, is the principal competitive tool used by modern firms. Seen through the lens of Baumol's (2002) model of innovation-based growth economics, start-ups can thus provide an innovative injection to the economy that complements the innovations produced by incumbents. Geroski (1995: 431) has noted that "high rates of entry are often associated with high rates of innovation." Robinson, O'Leary and Rincon's (2006) review of the literature similarly demonstrates the intricate link between market entry and innovation, and how the early years of new firm entry is particularly volatile. This process of continuous entry and exit in industries is referred to as "economic churn," and is seen as contributing to an economy through competition, innovation and increased cost efficiency. However, there is no single, universally accepted approach to measuring innovation, but rather a multitude of ways. These range from R&D expenditures and routine technical implementations, over patents all the way to rare events such as major product launches and comprehensive organizational restructuring (Geroski, Van Reenen & Walters, 1997). Thus, we maintain that start-up firms' contribution to innovation in the economy is most adequately studied over an extended period of time, in order to account for this ubiquitous volatility and allow for significant rare events to unfold.

Besides innovation, new firms are frequently also seen as a considerable, if not the most important, source of job creation (e.g., de Wit & Kok, 2013; Decker, Haltiwanger, Jarmin & Miranda, 2014). For instance, Haltiwanger, Jarmin and Miranda (2013: 347-348) showed that "firm births contribute substantially to both gross and net job creation" in the

[1] High-growth firms are often defined as the top percentage(s) of firms in a given population in terms of growth rates, although there are also other definitions, such as annualized employment growth over a three year period (Halvarsson, 2013). The OECD uses the latter kind of definition, specifically denoting as HGFs "all enterprises with average annualized growth greater than twenty percent per annum, over a three-year period, and with ten or more employees at the beginning of the observation period" (OECD, 2014: 70). A caveat, however, is that due to considerable heterogeneity in observed growth rates, this definition of HGFs leads to conflicting empirical results in terms of which firms actually qualify as HGFs (Daunfeldt, Halvarsson & Johansson, 2012; Delmar, Davidsson & Gartner, 2003). Furthermore, Daunfeldt et al. (2012) warn that the commonly employed OECD definition would disregard 95 percent of Swedish surviving firms, along with roughly 40 percent of private jobs created in the years 2005 through 2008.

[2] In this paper, the terms "new firm" and "start-up" are used interchangeably.

U.S. Similarly, results from a Swedish study spanning the years 1991 through 2009 analyzed dynamic employment mechanisms in the economy and concluded that the main contributor of new jobs were in fact new firms (Heyman, Norbäck & Persson, 2013b).

The question of what precisely constitutes a new firm is not entirely straightforward. A formal, legal definition would typically imply that a firm is new when it is legally registered for the first time. Yet, for the purpose of this study, namely to analyze new firms as drivers of innovation, we deem it necessary to move from an administrational to a business perspective. Establishing a business and becoming a part of the economy can take considerable time. This period, known as "gestation," has been found to range from one month up to 10 years, with studies finding that most firms report a window of three years or less (Cassar, 2004; Reynolds & Miller, 1992). Davidsson and Klofsten (2003) also indicate that three years is an appropriate time period during which a firm can be characterized as being new. They also state that in order to establish a firm, the founder(s) need to succeed in several key areas.[3] In summation, these relate to:

- the offering of a functioning product or service
- effective communication with the market in which the firm is acting and attracting customers
- the development of the internal organization in such a way that the firm's offering can be provided in a cost-efficient way.

Thus, taking into consideration that it takes several years for firms to establish themselves on the market, along with the considerable volatility and churn often observed in this timeframe, we will be applying a longitudinal perspective that allows for the initial market selection to unfold. We thereby submit the issue of firm growth and survival, and in particular early growth, to closer study with the discussed time frames in mind.

1.2 To grow or not to grow – the post-entry performance of start-ups

Two major schools of thought have shaped research on firm growth and size distributions, namely the "Stochastic" and the "Deterministic" (sometimes also referred to as the "Empiricist") approaches. The former view essentially holds that post-entry performance is "stochastically distributed across firms" and thus independent with respect to observable characteristics (Audretsch, Santarelli & Vivarelli, 1999: 968). Hereby, Gibrat's early work is arguably one of the most influential contributions. Gibrat's (1931) "law of proportionate effect," or simply "Gibrat's law," states that the growth of a firm is independent of its size. Most conventional interpretations of the law see it as assuming that growth itself is a stochastic process (Coad, 2009).

The deterministic approach, on the other hand, commonly refers to cause and effect mechanisms in the industry, grounded in visible differences in industry characteristics and firm behavior. Entrepreneurial and managerial skills are suggested to be determinants that are conducive to both the establishment of a firm, as well as its consequent growth. A particularly pervasive framework in this regard is the "managerial view" first developed by Baumol (1959) and Marris (1964), among others. From this perspective, managers play a vital role in determining the growth of a firm. Specifically, they seek to increase their

[3] Specifically, Klofsten (2009) presents eight important areas, namely the firm's idea, the product or offering, the market, organization, competence, driving forces, customer relationships and, finally, other relationships.

firm's size as a means to maximizing their own utility function through expected gains such as compensation, status and promotion. This opens up for the misalignment of managerial and firm objectives, as managerial actions are only subject to the pursuit of a minimum profit rate for the firm's shareholders (Coad, 2009). Penrose (1959) made significant contributions towards shaping the widely influential "resource-based view." This approach sees firms as bundles of idiosyncratic resources that allow for the creation of sustained competitive advantages. Furthermore, excessive growth runs the risk of diverting managerial attention towards expansion and exploration, at the expense of cost control. Exceeding these managerial limits to growth eventually leads to the "Penrose effect," namely more fast-growing firms incurring higher operating costs than their peers. As Jovanovic (1982) later does, she invokes an explicit learning perspective, explaining how firms pursue growth in order to accumulate knowledge with experience and thereby realizing "economies of growth."

From an empirical perspective, studies have found that the majority of firms do not grow at all, and most new firms do not survive longer than a decade at most (see Henrekson & Johansson, 2010). Results from Sweden indicate that most start-ups exit the market in the long term, but that survival is positively associated with firm age, firm size, surviving the first few years, as well as access to resources (Persson, 2004). Growth has also been found to negatively correlate between individual years (Daunfeldt & Halvarsson, 2011). Spin-offs and mergers have exhibited lower mortality rates, which is attributed to their industry experience and access to tangible and intangible resources available in parent firms and networks (Andersson & Klepper, 2013). The fact that spin-offs outperform other kinds of start-ups and that parent firm size is associated with larger growth in the employment rate of the spin-offs is evocative of the aforementioned knowledge and learning perspective. In fact, one proposed reason is that these entrepreneurs possess more knowledge of the market as compared to genuinely new entrants. Thus, it seems that from a policy perspective, the antecedents of new firms are important to consider when designing policy instruments.

There has been slow progress in the conventional regression analysis of determinants of firm growth, with analyses yielding low explanatory power (i.e., low R^2 values). Consequently, research has redirected its attention towards "modes of growth," specifically growth histories and growth paths. These analyses typically take their starting point in observing the autocorrelation of firm growth rates, which should be uncorrelated if Gibrat's law holds. For instance, Coad *et al.* (2013) take as their theoretical starting point that growth follows a random walk, and that continued survival is contingent on the accumulation of resources (i.e., "Gambler's Ruin" theory). They find that growth paths are approximatively random, and thereby best described as a random phenomenon. They nevertheless find that growth, along with certain financial variables, have a significant positive effect on survival. While previous stylized findings show that larger firms exhibit positive autocorrelation whereas that of smaller firms is typically negative, they still find "lagged growth … a poor signal of future growth" (Coad et al., 2013: 617), pointing to the need for additional research on this topic.

Environmental forces also appear to affect new firms' probability of survival. For instance, Box (2008) shows that firms founded in times of macroeconomic expansion (contraction) tend to experience a lower (higher) liability of newness (i.e., the tendency for new firms to experience higher mortality rates). In addition, Delmar, McKelvie and Wennberg (2013) provide evidence suggesting that profitability is conducive to survival and growth, while growth promotes profitability but negatively affects survival. The authors' contention that

"growth generally hurts the likelihood of survival while improving profitability" (Delmar et al., 2013: 287) contradicts results of other studies (e.g., Coad et al., 2013). They draw on an evolutionary framework to suggest a theoretical explanation for this contradictory finding. Specifically, they suggest that adaptation associated with growth may be "costly and uncertain," and that it may be the case that mediating factors influence strategic decisions. "Satisfying behavior" may for instance leave firms reluctant to grow despite experiencing profitability (Delmar et al., 2013: 288). This argument is reminiscent of Penrose's suggested managerial limits to growth, where managerial capabilities act as a constraint on firm growth (Penrose, 1959).

1.3 Growth dynamics – when is growth important?

HGFs have been receiving increasing academic and political attention in recent years, and previous research going all the way back to the 1980s suggest that a small share of the firms in an economy play a disproportionately important role in the economy (Birch, 1981; Henrekson & Johansson, 2010). Yet, only a few of these firms achieve sustained growth and survive in the long run (Falkenhall & Junkka, 2009). Nevertheless, currently prevailing theory suggests that they are one of the key determinants of a country's economic performance. As Davidsson and Henrekson (2002: 1) explain, "productive entrepreneurship" may explain "part of observed cross-country differences in economic performance." Thereby, countries or regions with high entrepreneurial activity are expected to see a high number of HGFs. In addition to HGFs in general, OECD singles out "gazelles" as a subset of firms that are of particular importance for policy makers (OECD, 2014).[4]

These firms' suggested contributions to the economy are numerous. They are considered to be "outstanding job creators" that generate a disproportionally large share of new employment (Henrekson & Johansson, 2010: 227) - this is said to particularly be the case with gazelles (OECD, 2014). Furthermore, among new firms in an economy, they are disproportionately responsible for introducing innovations on the market. Thus, they are in fact the "main vehicles for economic renewal" (Henrekson & Johansson, 2009: 1). For instance, HGFs accounted for 60 percent of net created jobs in the years 2006 to 2009 (Oreland, 2012). Consequently, there are policy measures specifically aimed at increasing their numbers (Coad, Daunfeldt, Johansson & Wennberg, 2011; Daunfeldt et al., 2012), but the determinants and timing characteristics of firm growth remain an issue in research on HGFs. There is no consensus on optimal ways to identify and support these firms, and there is mixed evidence on the timing and persistence of high growth rates (Daunfeldt, Elert & Johansson, 2010; Halvarsson, 2013). If it is the case that growth is random or excessively erratic over time, or if positive growth rates are typically followed by negative ones, further studies into start-up growth rates and their antecedents are unlikely to yield any relevant insights with respect to the identification and promotion of the these kinds of firms through public policy (Daunfeldt & Halvarsson, 2011).

Nevertheless, some work has been done in mapping the nature of the HGF life cycle and attempting to identify appropriate policy measures. Lerner (2009) points to the importance of an "understanding of the entrepreneurial process," which is marked by complex dynamics. Daunfeldt et al. (2010: 17) state that "new firm formation and early growth of new firms are vital for the prevalence of HGFs" (see also Delmar et al., 2013). With this in mind, we take as our starting point that early growth is essential for HGFs, since it

[4] The OECD defines gazelles as a subset of HGFs, namely those "that have been employers for a period of up to five years" (OECD, 2014: 70).

provides them with resources that can be leveraged in the continued pursuit of competitiveness and growth.

To test the above reasoning, this study will follow a cohort of Swedish start-ups for an extended period of time in order to identify growth patterns and their importance with respect to HGFs. Up to a certain point, growth is expected to lead to a positive spiral for the firms, where growth in turn enables continued growth.[5] They thereby constitute a more or less sustainable contribution to the economy, after having survived the initial churn and market selection during the gestation period.

1.4 Growth of new firms and public policy

As stated above, the majority of job creation appears to stem from HGFs, which underlines the importance of public policy that enables a dynamic and diverse market for entrepreneurs. In particular, the government can facilitate market entry and promote competition by adopting suitable regulation in the areas of taxation, competition and the labor market. Since firms are faced with particular challenges and market failures in this area during the start-up process, this is when public policy can have the largest impact in order to promote HGFs and their associated socioeconomic benefits (Heyman, Norbäck & Persson, 2013a). For this reason, scholars and policy-makers alike are devoting particular attention to the antecedents and timing of these firms' growth. Empirical evidence from Sweden has in fact shown that measures relating to regulation and incentives in the institutional environment are essential in promoting the emergence of HGFs and, in extension, increased aggregate economic growth (Davidsson & Henrekson, 2002). In Sweden, Vinnova,[6] Almi[7] and the Swedish Agency for Economic and Regional Growth,[8] among others, administer numerous such programs whose effects are regularly measured and evaluated by Growth Analysis. In fact, governments worldwide have established support programs that promote innovation by directly providing support and/or investing venture capital in promising start-ups (Lerner, 2009).

Yet, evaluations of these public programs have yielded ambiguous results. In general, there are two suggested explanations to the equivocal performance. One is that the "wrong" kind of firms are selected into the programs, i.e., firms that would have been successful even without public support. An alternative explanation is that the programs are not evaluated along appropriate dimensions, and uses inadequate counterfactuals. This highlights the need for additional insight into the mechanisms associated with new firm growth, as well as an improved methodology with respect to their evaluation (Growth Analysis, 2014; Lerner, 2009).

From an external (and public) perspective, it is difficult to gauge individual firms' innovativeness and potential for growth *ex ante* (Coad & Rao, 2008). Program administrators

[5] It is worth noting that studies have found that excessively high growth rates may actually hurt a firm and even account for a large share of firm failures (Pierce & Aguinis, 2013; Probst & Raisch, 2005).
[6] Vinnova is the Swedish government's innovation agency and is charged with improving the conditions for innovation in the economy and thereby promoting sustainable growth, along with providing funds for needs-driven research (Vinnova, 2014).
[7] Almi is a publicly owned firm that strives to contribute to growth by providing venture capital and advisory services to selected firms in order to commercialize innovation and encourage Swedish firms' competitiveness (Almi, 2014).
[8] The Swedish Agency for Economic and Regional Growth (Tillväxtverket) is a government agency with the objective of promoting the establishment of enterprises, their growth and competitiveness, as well as sustainable and competitive business and industry in Sweden (Swedish Agency for Economic and Regional Growth, 2014).

typically rely on conventional result measures, subjective criteria, along with the charisma and narrative of the entrepreneurs (Barkley, DiFurio & Leatherman, 2004; Hsu, 2004). This leaves decision makers with scarce selection criteria when selecting potential future "outliers" among start-ups. Thus, there is still insufficient research with respect to the growth dynamics of start-ups populations and their consequent performance (Delmar et al., 2013).

Increasing attention has been devoted to the challenges associated with policy evaluation of early-stage market interventions, among others by the OECD (Wilson & Silva, 2013) and the European Commission (1999). Previous studies indicate that early growth may in turn enable survival and consequent continued growth. Interpreting early turnover as a signal of future growth potential implies that contribution of capital could be warranted in cases where firms exhibit such a pattern but run into problems related to shortages of capital, know-how, and other constraints. These are factors that empirical work has found to constitute barriers to potential HGFs (Bottazzi, Da Rin & Hellmann, 2009; Carpenter & Petersen, 2002) and work with developing new ways of addressing this issue is ongoing (see Henrekson & Johansson, 2009; Schneider & Veugelers, 2010). As previously discussed, the firms that have managed to survive for a longer time are more likely to have established themselves on the market and therefore warrant particular attention. Thus, this study aims to contribute to the endeavor of promoting HGFs by providing insights into determinants of growth and the dynamics that moderate the interplay between growth and survival, along with how these phenomena are best studied empirically.

1.5 Research questions in brief and outline of paper

Consequently, this paper takes the following starting points:

1. growth enables firms to retain resources, which can in turn be leveraged to achieve continued growth
2. innovative new firms can only be identified retrospectively as successful firms that have been able to use generated profits to survive and grow (and in turn generate more profits)
3. additional research is needed in order to gain insights into the growth dynamics of nascent firms, along with policy implications

This leads us to the research questions that this paper addresses, namely:

- *How important is growth for new firm survival?*
- *How important is growth in the first years for the survival of a new firm?*
- *Which other factors potentially drive growth in new firms?*

The following chapter discusses the choice of data used to answer this question. It also outlines the findings in the analysis, which can be found in its entirety in the appendix. The final chapter discusses these results and draws conclusions for future research.

2 Following the 1997 cohort of start-up firms

To address the questions raised by this paper, this study will describe the development of the firms in the population and map their growth rates over a period of 14 years. The population is constituted by the 1997 cohort of Swedish start-ups, which are denoted as "new" according to Statistics Sweden's (SCB)[9] database. In this context, "new" refers to registered firms where the majority of employees were not part of a previous firm's workforce.[10] This paper will use this population of firms to describe the observed growth rates and thereafter specifically evaluate the importance of growth as an indicator of continued success in order to contribute to the current understanding of these dynamics, along with optimal public policy aimed at promoting innovation and growth.

2.1 The object of study

When tackling the topic of firm growth, the time dimension is essential. Daunfeldt and Halvarsson (2011: 9) argue that "most studies of HGFs do not examine what happens to them over time," which is held to be a "major limitation" in previous studies. For this reason, longitudinal databases are "uniquely well-suited to study these issues on an economy-wide basis" (Haltiwanger et al., 2013: 347).

This study builds on these insights and specifically assesses new firm survival from a longitudinal cohort perspective, as opposed to cross-sectional approaches or research on determinants of the overall births and deaths of firms in an economy in a given year (cf. Brown, Lambert & Florax, 2013; Singh & Whittington, 1975). Thus, this paper is conceptually closer to Box's (2008: 390) approach and we are inclined to agree that "more longitudinal research is needed … [since] issues that relate to business growth and survival commonly concern causality." In this context, cross-sectional or short panel approaches are unlikely to capture the dynamics in a satisfying way. Similarly, Macdonald (2012) uses a cohort approach to study new firm survival in the Canadian business sector. Rather than looking at macro-foundations of firm growth, however, this study examines the timing and persistence of high growth rates, with particular consideration of HGFs and their importance for firm growth and associated public policy. Like Agarwal and Audretsch (2001), among others, we then proceed to investigate the subsequent development of the surviving firms contingent on their age, i.e., those that have managed to survive the years leading up to the current one, to get a clearer picture of the growth dynamics.

2.2 Defining new firms

New firms can be defined in several ways. For instance, firms with a new administrative record may be seen as "new firms." Such a definition may however erroneously include incumbent firms that are going through a financial reconstruction or reorganization due to a merger or acquisition in the definition.

A more accurate definition, in our view, is instead based on the history of the founders and employees of the firms. Basing our categorization on the one by Andersson and Klepper (2013), this paper thus characterizes new firms along the following dimensions:

[9] Statistics Sweden is a Swedish government agency charged with producing official statistics for private and public use (Statistics Sweden, 2013).
[10] For a more detailed discussion of the definition of "new" firms, please refer to Section 2.2.

1. New firms formed by employees formerly not employed, e.g., students
2. New firms formed by employees formerly employed as researchers at a university, i.e., a spin-off from a non-profit sector
3. New firms where a majority of the employees were formerly employed by an incumbent firm but constituted less than 50 percent of the incumbent firm's employees
4. Pulled spin-offs: New firms where the incumbent firms still exist after the new firm is established
5. Pushed spin-offs: New firms where the incumbent firms go out business as the new firm is established
6. Other new firms: New firms where less than 50 percent of its employees were formerly employed by an incumbent firm, but constituted less than 50 percent of the incumbent firm's employees
7. Reconstruction ID: New firms where a majority of its employees were formerly employed by an incumbent firm, but constituted more than 50 percent of the incumbent firm's employees

The above categories could be refined further, for instance by accounting for the size of the firm, where divestitures are certain to differ considerably from founder start-ups (self-employed entrepreneurs) in terms of resources. Another aspect is the establishment of a new branch by an incumbent firm, as opposed to the establishment of an entirely new firm (i.e., distinguishing between expansion and diversification).

While these aspects certainly warrant consideration, doing so is beyond the scope of this paper. We delimit our population of study by focusing on start-ups founded as limited companies.[11] The act of incorporation is interpreted as a signal of intent to grow in the long run. Proprietorships, foundations or partnerships, on the other hand, are oftentimes established for reasons other than long-term growth aspirations. Of course, there are exceptions to this rule, and other types of organizations may well exhibit high growth rates, generate employment, and have other desirable effects on the economy in which they operate. Conversely, limited companies may be formed for tax reasons or other purposes than striving for increased turnover, employment and growing beyond a certain threshold.

Secondly, as has been done in previous studies of firm growth (e.g., Coad, 2007), we are studying organic growth, which excludes growth affiliated with corporate actions such as spin-offs, mergers and acquisitions. While these firms seize to exist in the data set, they do not exit the market due to adverse performance. For the purposes of this study, we therefore choose to treat firms affected by such restructurings as survivors, rather than closures or "failures."

Thirdly, we will not include start-ups that are the results of a spin-off from an incumbent firm. These firms are according to empirical evidence (Andersson & Klepper, 2013) expected to be the ones with the greatest growth potential in a given year. However, they have likely already reached a certain degree of market maturity when they are established. We see this as an indication that they will differ from more "genuine" start-ups in terms of

[11] The Swedish incorporated business entity "aktiebolag" (AB) - most often referred to as a "limited company" or "joint stock company" - may be private or public, similar to corporations in the U.S. or private limited companies in the U.K.

needs and challenges, and what specific role public support can play in helping them survive and grow.

2.3 Measuring new firms

Various methods have been used to measure start-up activity in Sweden. The Swedish Companies Registration Office's statistics on start-ups are used in reports such as SCB's "Nyföretagarstatistiken"[12] and the Swedish Jobs and Society Foundation's[13] "Nyföretagar-barometern." However, these statistics include many corporate restructurings that do not constitute "genuinely" new start-ups (cf. Ullström, 2002). Growth Analysis compile statistics for new enterprises annually based on the same data but take changes in firm characteristics into account in order to derive the net number of start-ups. They also provide follow-up surveys that track surviving firms three years after their inception (see Pettersson, Ericsson & Olofsson, 2002 for this study's cohort of start-ups). Yet, none of these surveys provide the necessary longitudinal information for the purposes at hand.[14]

Instead, this paper makes use of Swedish official firm-level data provided by SCB, where the yearly survey "Structural Business Statistics" ("FEK")[15] constitutes the basis of the dataset. It follows all Swedish limited companies started in the year 1997 and their respective development until 2011. It is the only survey that makes use of the financial statements of all firms registered in Sweden. The information is complemented with balance sheet data from the Swedish Tax Agency's standardized income statements ("SRU")[16] (Swedish Tax Agency, 2013).

In order to identify and follow business entities over the course of the analyzed time frame, the information has been merged with another comprehensive SCB dataset, the "Dynamics of Firms and Establishments" register ("FAD"),[17] which tracks Swedish firms and work-places along the dimensions establishment, restructuring, closure, employees and offices. Thanks to the use of official register-based labor market statistics ("RAMS"),[18] the employees in the respective workplaces can be mapped and tracked over time. This gives a more accurate picture of how firms develop, including restructuring, labor mobility and outsourcing measures that would otherwise remain obscured (Andersson & Arvidson, 2004).

Important to note is that due to the aforementioned discrepancies in methods used with respect to the definition of "new" firms in the Swedish economy, the number of start-ups based on FAD differs from that in other reports.[19] For a more comprehensive discussion of how statistics on the Swedish industry dynamics are developed and employed – including

[12] The publications "Nyföretagandet" and "Nyföretagarstatistiken" were provided by SCB together with Institutet för Tillväxtpolitiska Studier (ITPS), Growth Analysis's predecessor, until 2009.
[13] The Swedish Jobs and Society Foundation ("NyföretagarCentrum" in Swedish) supports entrepreneurship in Sweden by providing consultation and advice to individuals contemplating starting up businesses (Swedish Jobs and Society Foundation, 2015).
[14] In these studies, start-ups with changes of business owner, legal entity or other kind of restructuring are excluded. This implies that the statistics are not identical to the ones on newly registered firms, which are produced by the Swedish Companies Registration Office ("Bolagsverket").
[15] Swedish title "Företagens ekonomi."
[16] Swedish title "Standardiserat räkenskapsutdrag."
[17] Swedish title " Företagens och arbetsställenas dynamik."
[18] Swedish title "Registerbaserad arbetsmarknadsstatistik."
[19] For a more extensive discussion on the methods and resulting differences, please consult Ullström (2002) and Pettersson et al. (2002). Please note that the publications are presently available exclusively in Swedish.

FAD, RAMS and SRU - the reader is encouraged to consult the Growth Analysis publication "Statistik över näringslivsdynamik" (Widerstedt, 2010).[20]

To categorize start-ups into the above categories, FAD makes use of two basic criteria:

Criterion A:

$$\frac{G}{T_2} > 0.5$$

Criterion B:

$$\frac{G}{T_1} > 0.5$$

where G denotes the total number of employees in a specific firm who are employed in both years 1 and 2. T_1 and T_2 signify the number of employees in the firm in year 1 and 2, respectively.

Accordingly, a start-up is considered new if neither of the criteria are met, the firm is genuinely new (or liquidated). If only criterion 2 is fulfilled, viz., $A < 0.5$ and $B > 0.5$, the new entity is due to a merger. Conversely, a new firm is designated a split if only criterion 1 is fulfilled, viz., $A > 0.5$ and $B < 0.5$. Finally, a firm is incumbent if both criteria are satisfied.[21]

Thus, this study uses the FAD definition of "new" firms, an approach used by Andersson and Klepper (2013), Andersson and Noseleit (2011) and Oreland (2012), among others. In doing so, worker flows are used to differentiate among different types of start-ups, such as genuinely new firms as opposed to mergers and spin-offs (e.g., Andersson & Arvidsson, 2011).

2.4 The number and constitution of Swedish firms in 1997

As previously stated, this paper limits its scope of study to the non-financial, for-profit limited companies in the 1997 cohort. The number and constitution of the active firms in Sweden in 1997 is presented in Table 1. Out of the 83 842 new firms, 12 206 were founded as restructurings, i.e., mergers and splits, and are excluded from the analysis. This leaves 71 636 "genuine" start-ups, a term we use to refer to new firms that were not founded through some form of restructuring. Among these remaining firms, 19 232 limited companies form the population that constitutes the object of our study.

Table 1 Firms active in the Swedish economy in 1997

Category	**Number of Firms**
Incumbent firms	298 339
New entrants	83 842
thereof mergers	5 989
thereof splits	6 217
thereof genuine start-ups	71 636
thereof limited companies	19 232

[20] The publication is presently available exclusively in Swedish.
[21] Please consult Andersson and Arvidsson (2004; 2011) for an extensive discussion on the methods employed in FAD.

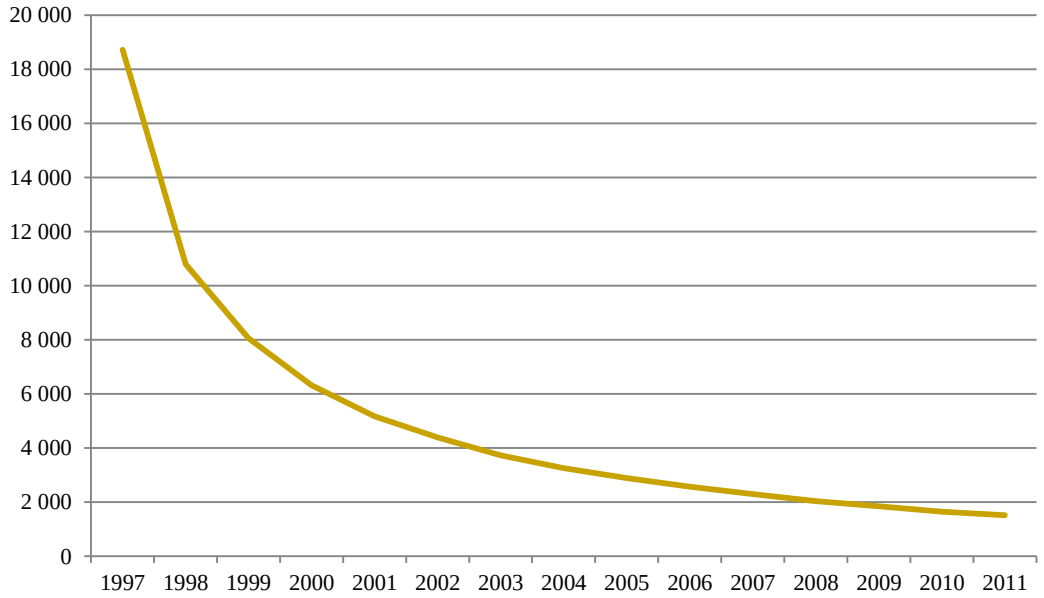
An overview of the firms' establishment and attrition rates shows that less than 8 percent of the firms in the initial 1997 cohort remain intact until 2011. Almost 75 percent were liquidated, while approximately 12 percent (mergers) and 6 percent (splits) were restructured (Table 2).

Table 2 Development of the 1997 cohort of new firms

				Closed firms			
Year	*Established*	*Closed*	*Remaining*	*Liquidations*	*Mergers*	*Splits*	*Others*
1997	19 232	509	18 723	509	0	0	0
1998		7 930	10 793	6 510	981	439	0
1999		2 741	8 052	2 142	406	193	0
2000		1 729	6 323	1 348	293	88	0
2001		1 156	5 167	897	183	76	0
2002		782	4 385	627	92	63	0
2003		660	3 725	537	65	58	0
2004		468	3 257	358	61	33	16
2005		375	2 882	292	43	40	0
2006		314	2 568	245	43	26	0
2007		270	2 298	209	43	18	0
2008		261	2 037	212	34	15	0
2009		197	1 840	174	9	14	0
2010		200	1 640	155	28	17	0
2011		123	1 517	95	14	7	7
Total	*19 232*	*17 715*	-	*14 310*	*2 295*	*1 087*	*23*

Figure 1 illustrates the development of the number of remaining (see column 4 of Table 2). The figure indicates that a firm is subject to the strongest forces of market selection and adversity in the first three or four years of its life in terms of survival chances.

Figure 1 Number of organically growing firms that remain over the analyzed period



2.5 Post-entry performance – a focus on start-up growth

Many of the factors of interest when analyzing firm growth are unobservable, such as "asset specificity" in the transaction cost view of the firm, or "core competencies" in the resource-based view (Geroski, 2000: 1-2). This paper limits the scope of study to a cohort of newly established firms as there are a number of advantages associated with this approach. The first is that including all established firms in the study alleviates the survivor bias frequently associated with simply focusing on surviving firms and disregarding "failures," i.e., the attrition (Carpenter & Lynch, 1999; Hyytinen, Pajarinen & Rouvinen, 2015). Secondly, as all firms were based and operative in Sweden, they presumably also experienced the same macroeconomic shocks over the examined time frame (see Garnsey, Stam & Heffernan, 2006). Furthermore, the entrepreneurs can be assumed to have acted in a similar environment with respect to market opportunities and constraints.

The time frame is long enough to cover several business cycles,[22] which should decrease the risk of isolated trends excessively affecting the data. As 1997 was not a year marked by extreme macroeconomic shocks or investment booms in Sweden, it is assumed to be sufficiently representative with respect to the number and nature of firms that were established.

Growth is measured in terms of changes in revenue or turnover between years, as new firms are typically assumed to be pursuing a level of turnover that is sustainable. To be sure, there are other measures of firm growth, such as the change in number of employees or in equity. Yet, these are associated with methodological issues of their own (e.g., the widespread use of temporary labor and consultants in the case of measurement using employees). Turnover was chosen because of the developing consensus that it is preferable over other kinds of measures (Davidsson & Wiklund, 2013; Sexton & Kasarda, 1992).

The most commonly employed way of calculating a given firm i's growth rate at time t is using the log-differences of firm size between times t and $t-1$ (Bernard, Massari, Reyes

[22] Specifically, the time frame covers approximately three Kitchin business cycles (Kitchin, 1993), or more than one Juglar investment cycle (Juglar, 1862).

& Taglioni, 2014; Colombelli, Haned & Le Bas, 2013). This implies that growth is defined for the years in the interval [1998,1999,…,2011]. We thus get the following definition of firm growth used in this study:

Equation 1

$$\log(growth_{i,t}) = \log(size_{i,t}) - \log(size_{i,t-1})$$

2.6 How is growth distributed over time?

The table with the firms' turnover and growth rates shows how the number of observations declines as firms are closed along the studied time period.[23] With the exception of the year 1999, mean turnover[24] increases steadily each year, but the median turnover does not increase at the same rate. This already hints at the presence of a number of outliers, or at least very high-performing firms at the upper end of the distribution.

[23] Please note that the number of observations is not precisely the same as in Table 3 since there were a different number of missing or incorrectly coded observations for exits and turnover rates.
[24] Means are continuously calculated as the arithmetic average of the observed values in the dataset.

Table 3 Distribution of growth in turnover for the 1997 cohort of new firms

	Turnover [1000 SEK]			**Growth rate [percent]**		
Year	*Observations*	*Mean*	*Median*	*Observations*	*Mean*	*Median*
1997	19 232	3 885.89	1 255.00	-	-	-
1998	11 082	4 697.27	1 674.00	10 805	232.99	21.4
1999	8 175	4 499.07	1 734.00	8 093	39.65	7.1
2000	6 429	5 274.67	1 853.00	6 372	43.39	7.1
2001	5 254	5 629.97	1 892.00	5 212	27.05	4.1
2002	4 443	6 138.36	1 905.00	4 402	11.39	2.2
2003	3 784	6 810.12	1 996.50	3 751	7.74	0.7
2004	3 302	7 624.81	2 103.00	3 277	10.85	2.1
2005	2 922	8 151.55	2 181.50	2 902	40.07	2.9
2006	2 611	8 966.43	2 272.00	2 596	49.53	4.3
2007	2 327	9 569.73	2 400.00	2 312	22.51	4.2
2008	2 065	10 802.09	2 520.00	2 055	8.27	2.2
2009	1 859	13 081.73	2 539.00	1 850	7.65	- 2.7
2010	1 655	17 611.35	2 650.00	1 644	6.75	1.1
2011	1 517	22 218.31	2 829.00	1 506	15.14	2.8

It can be noted that, broadly speaking, the above pattern appears to closely follow the macroeconomic shocks that hit Sweden during this time. Allowing for lags of 1-2 years after the crisis in the early 2000s and the global recession of 2007-2008 (see, e.g., Kiander & Vartia, 2011; Reinhart & Rogoff, 2008), there is a discernable adverse effect on the growth rates.

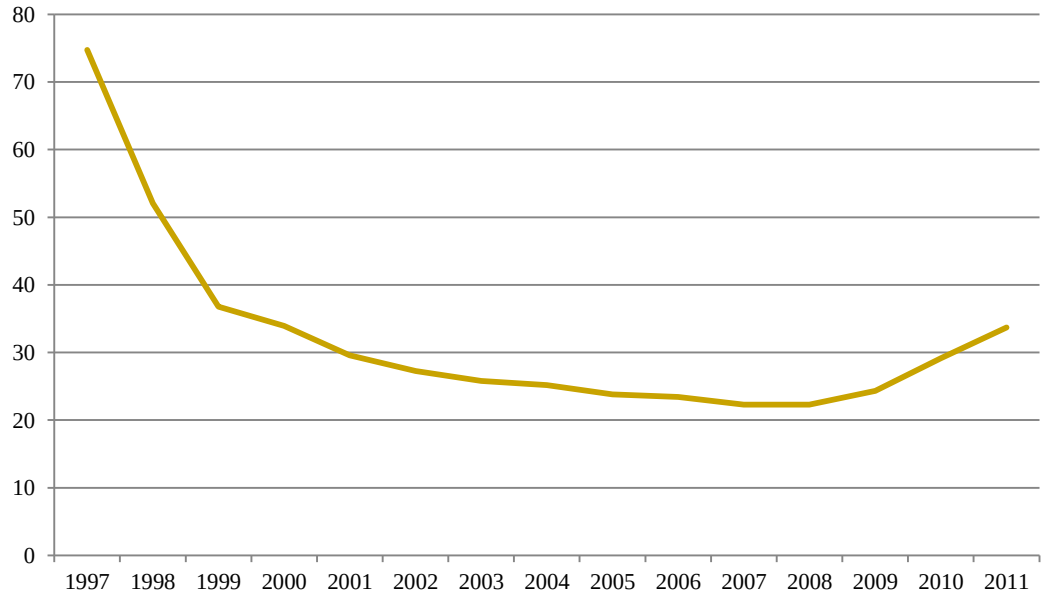
Taking a closer look at the growth rates in the first few years of the cohort's life in Table 4, we find that the firms that survived the entire period in general experienced markedly higher growth rates early on, compared to the firms that exited the market at some point. With the exception of the first year, surviving firms had a higher median growth rate in the first five years. The survivors also had a higher median growth rate seen over the entire time period. The firms that exited the market nevertheless exhibited similar or higher average growth rates for the first three years in existence, after which the pattern is reversed. This indicates that the growth paths for the exiting firms are more "volatile" than that of their surviving counterparts. Discounting the effects of outliers by focusing on median growth rates, the results nevertheless indicate that early growth is associated with increased survival for the cohort.

Table 4 Mean and median growth rates for survivors and non-survivors among the 1997 cohort of new firms

	Mean growth rate [percent]			**Median growth rate [percent]**		
Year	*Survivors*	*Exits*	*Entire cohort*	*Survivors*	*Exits*	*Entire cohort*
1997-2010	64.03	90.52	64.46	5.19	3.78	5.16
1997	226.57	220.64	226.42	21.44	24.14	21.44
1998	39.39	54.37	39.62	7.21	5.16	7.15
1999	42.62	88.98	43.39	7.19	5.45	7.14
2000	27.28	13.18	27.05	4.05	2.78	4.05
2001	62.86	10.69	11.37	2.20	-1.87	2.16

Figure 2 depicts the total turnover of the surviving firms in the cohort, calculated as the product of the number of survivors and the mean turnover. We note that total turnover stops decreasing around 2008, and steadily increases until the end of the surveyed time span. The sum still does not reach the turnover the initial year, however. In 2011, the 1 517 surviving firms exhibit a combined turnover roughly equal to that of the 6 323 active firms in 2000.

Figure 2 Sum of turnover for the 1997 cohort of new firms (in SEK, millions)



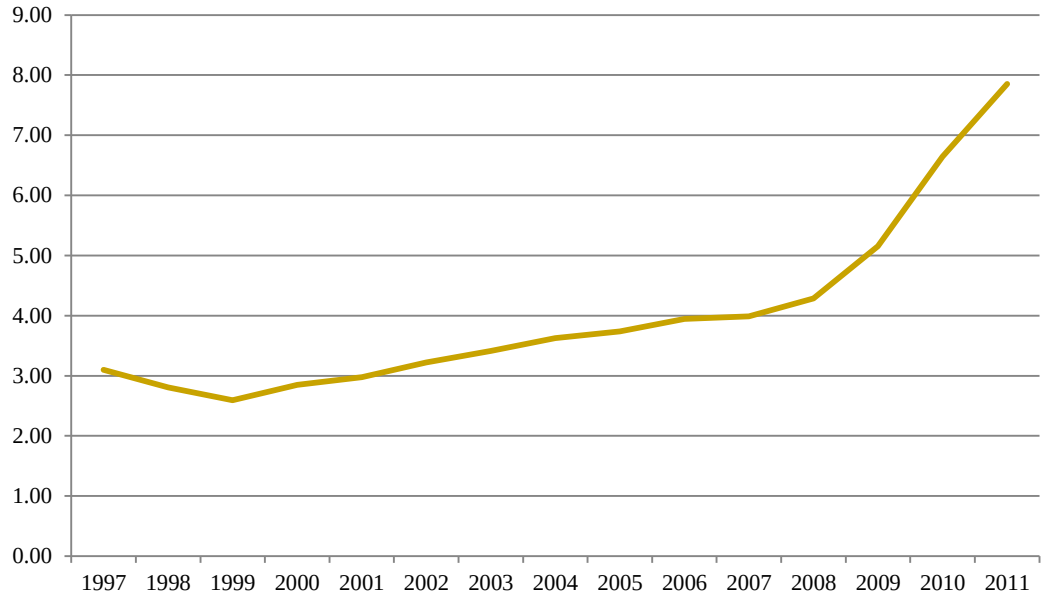
Taking a closer look at the development of turnover over time, Table 4 shows that mean growth rates are initially quite high (exceeding 200 percent in the first year). They consequently decrease steadily until the year 2003.[25] After a slight increase, mean growth again declines and reaches single-digit levels in the years 2008 through 2010.

Looking at the median growth rates, however, the numbers are somewhat more modest, indicating that a relatively small number of firms are in fact experiencing rapid growth. Below, these dynamics are illustrated in Figure 3 as the development of the ratio of the

[25] Please note, however, that a number of growth rates are missing in the dataset due to missing observations among the net turnover values in the dataset.

mean turnover to median turnover. The figure indicates that a relatively small share of the firms is able to reach high levels of growth. We thus point to the presence of a relatively low number of outliers (i.e., in the right tail of the turnover distribution) that are growing rapidly and thus disproportionately increasing the mean growth rates in the population.

Figure 3 Ratio of mean turnover to median turnover for the 1997 cohort of new firms



2.7 The analysis at a glance

This section is a non-technical discussion of the analysis that can be found in the Appendix. We conduct an econometric analysis to estimate the significance of growth in turnover with respect to new firm survival. We also explore additional potential determinants of survival. The theoretical starting point is Klofsten's (2009) framework regarding the post-entry performance of the start-up firms. This approach emphasizes the importance for small firms to possess certain key resources and capabilities. Specifically, these relate to:

- Market relations
- An operational organization
- A functioning business model

As we do not have the data for the incidence or intensity of these skills, we use available firm data as an indicator for the presence of the skills and resources necessary for growth and survival in the market. For the analysis, we employ two approaches that have emerged as preferred methods in the empirical literature on firm growth, viz., logistic analysis and duration analysis. With respect to the latter, which is also known as survival or hazards analysis, we use Cox's (1972) proportional hazards model.

In brief, the logistic analysis finds that growth in preceding periods is associated with an increased likelihood of consequent firm survival. The duration analysis corroborates this finding and the results indicate that firms experiencing higher growth subsequently face a decreased risk of closure. Furthermore, it suggests that the initial periods after a firm's inception are the most "risky" in terms of likelihood of closure. The full modeling and analysis can be found in the Appendix.

3 Conclusion and discussion

Given their importance as job creators and engines of growth, start-up firms (and HGFs in particular) are given particular political and academic attention. Untangling the relationship between growth, profitability and survival has been the objective of numerous empirical studies in recent years (e.g., Coad et al., 2013; Delmar et al., 2013; Sleuwaegen & Onkelinx, 2014). Together with prevailing theoretical frameworks regarding entrepreneurship and new firm dynamics, studies have generally found support for the notion that profitability and growth are not only conducive, but essential to a start-up's consequent survival. Yet, there is also evidence that puts this into question. Notably, Delmar et al. (2013) instead suggest that growth may have a negative effect on new firm survival. Previous publications have highlighted issues pertaining to firm growth, such as its inherent limits and the potential dangers of excessive growth rates (Higgins, 1977; Penrose, 1959). These effects are reflected in findings for new and established firms alike (Pe'er & Vertinsky, 2006; Pierce & Aguinis, 2013; Probst & Raisch, 2005).

However, this study's findings corroborate previous findings such as those by Coad et al. (2013), Daunfeldt et al. (2010) and others, namely that growth leads to a greater likelihood of survival for new firms. This pattern has also been found in previous studies using similar methods (Ha, 2013; Hao & Naiman, 2007). More generally, aggregated industry growth seems to have a similarly beneficial effect on the hazard rate (Audretsch & Mahmood, 1995), i.e. decreasing the likelihood of firm closures. Furthermore, we present evidence supporting the notion that the early years immediately after a firm's establishment are the most risky ones (Fritsch, Brixy & Falck, 2006), and find a clear indication that higher growth rates during gestation are associated with increased survival. The observed hazard rate is also comparable to the one presented by Mata, Portugal and Guimaraes (1995) and mirrors findings presented by Coad et al. (2013) in this regard. This carries significance with respect to the early-stage financing provided by public funds and the selection of suitable recipient entrepreneurs.

Rather surprisingly, subsidiaries were found to face a significantly larger hazard of closure than independent firms, even though restructurings were treated as survivors rather than exits in the dataset. While this result may be picking up confounding factors or moderators (since theory generally suggests that firms benefit from parent firms' resources), this result has also emerged in previous literature on this topic. For instance, Audretsch and Mahmood (1995: 101) find that "the hazard rate is significantly higher for establishments which are a branch or subsidiary of an existing enterprise than for new independent enterprise." As mentioned in the introduction section, it is important to distinguish between profitability and survival in this context. For instance, Bradley, Aldrich, Shepherd and Wiklund (2011) propose a mechanism where small firm performance and survival are influenced by their relative independence. Specifically, "subsidiaries are likely to take on the characteristics, routines … and orientation of their parent organizations, thus undercutting the adaptive potential of the organization" (Bradley et al., 2011: 506). Even though subsidiaries are initially somewhat protected from competition, the fiercer pressures from selection in fact strengthen the "resourceful capability development" of the firms that manage to survive. With subsidiaries being less flexible, they would consequently face higher failure rates in the long term. Yet, as Xiao (2014: 4) points out, "acquisition may be endogenous to firm growth," which poses a methodological challenge when discussing these kinds of selection and acquisition effects.

A number of caveats are worth pointing out. Firstly, the control variables included in the setups are in no way exhaustive. Additional aspects such as employee characteristics (Gimeno, Folta, Cooper & Woo, 1997), debt structure (Audretsch, Houweling & Thurik, 2000) and additional macroeconomic factors (Acs, Armington & Zhang, 2007; Geroski, Mata & Portugal, 2010) are likely to play a role in determining firm growth and survival.

Since firm growth has been described as largely random and appears to be driven by shocks that are stochastic in nature, most regressions dealing with the subject exhibit quite low R^2-values (Coad, 2009; Hoogstra & van Dijk, 2004; Marsili, 2001). This is also the case here, where the estimations reach an R^2 of a little over 4 percent. Even though the R^2 is not the only criterion for evaluating models, it is an indication that the models only manage to explain a small share of the overall variation we observe.

In summation, however, the findings presented here lend additional support to the stylized fact that growth increases a firm's consequent chances of survival. In addition, there is tentative evidence that subsidiaries do not necessarily stand to benefit from parent firms' financial and technological support; at least not in terms of long term survival. This latter notion relates to the discussion on market selection mechanisms and whether the initially "sheltered" position of subsidiaries in fact helps or hurts the firms in the long run.

Given that public policy aims to promote the survival of firms in order to promote a range of societal benefits such as growth, job creation and tax revenues, these results imply that properly conceived support that helps small firms to grow could lead to increased survival rates in the long term. Of course, such measures should take the aforementioned market selection mechanisms into account. Hereby, the role of parent firms and large firms as acquirers is far from negligible. For instance, this study finds partial support for the theory stating that relatively independent firms which survive the initial, risky period of intense competition experience higher long-term survival. Nevertheless, the potential of "crowding out" private investment and the particularities of the specific industry and market should always be taken into account when public support programs are implemented (cf. Cumming & MacIntosh, 2006; Lerner, 2009; Lööf & Heshmati, 2004).

Possibly fruitful paths for future studies include additional studies of market selection processes and what determines long-term sustainability in firm survival. For instance, the question remains under which circumstances subsidiaries actually benefit from their parents' resources in terms of long-term survival rather than mere short-term resilience to market selection (Bradley et al., 2011). Similar to Xiao (2014), future studies could also benefit from taking the nature and motivation of acquisitions into account in order to address the endogeneity of acquisitions. Studies of firm mortality that explicitly take modes of entry and exit into account are becoming more widespread and are providing richer, more fine-grained insights into these dynamics (this study treated restructurings as right-censored observations). For instance, there is evidence that high-performing start-ups in the market are typically "selected" for acquisition by larger firms due to their higher perceived potential (Andersson & Xiao, 2014). Thus, it is possible that not only the worst- but also the best-performing start-ups exit the market due to these mechanisms.

Furthermore, the more general determinants of growth and survival were beyond the primary scope of this study but nevertheless constitute an important aspect when formulating public policy aimed at supporting the emergence, growth and survival of small firms. For instance, studies making use of patent databases may provide valuable insights into how firms use innovation and technology to compete in the market, and how this affects growth paths and survival. The capital structure and financing modes (e.g., venture

capital, debt structure) of start-ups should also be accounted for, as financial variables have been shown to have a non-negligible impact (e.g., Coad et al., 2013).

Finally, on a more methodological note, we suggest that cohort studies and quantile regression approaches are preferable to cross-sectional analyses using conventional econometric methods. As previously mentioned, analyzing firm cohorts mitigates survivor bias and inherently accounts for many unobservable confounding factors that otherwise constitute econometric challenges. Finally, quantile regression (Koenker & Bassett, 1978; Koenker & Hallock, 2001) can yield more fine-grained insights into the best-performing parts of the population, rather than simply estimating effects for the average firm. Since HGFs (as well as high-performing firms in general) are of particular interest, quantile regression can provide insights in this particular segment, and thus be more informative than studies that do not differentiate among quantiles in the data, which may be subject to differing causal relationships (Coad & Hölzl, 2009). Together with a range of other benefits (such as robustness to outliers and skewness in the distribution), the method is thus being increasingly implemented in econometric studies and is seen as particularly suitable for studying firm growth as a phenomenon (Henderson, Raynor & Ahmed, 2012; Reichstein, Dahl, Ebersberger & Jensen, 2010).

4 References

Acs, Z. J., Armington, C., & Zhang, T. 2007. The determinants of new-firm survival across regional economies: The role of human capital stock and knowledge spillover. *Papers in Regional Science,* 86(3): 367-391.

Agarwal, R., & Audretsch, D. B. 2001. Does entry size matter? The impact of the life cycle and technology on firm survival. *Journal of Industrial Economics,* 49(1): 21-43.

Almi. 2014. *About Almi,* http://www.almi.se/English/, (February 25, 2015).

Anavatan, A., & Karaöz, M. 2013. Cox regression models with time-varying covariates applied to survival success of young firms. *Journal of Economic and Social Studies,* 3(2): 53-69.

Andersson, J., & Arvidson, G. 2004. *Företagens och arbetsställenas dynamik (FAD).* Statistics Sweden (SCB).

Andersson, J., & Arvidsson, G. 2011. *Företagens och arbetsställenas dynamik (FAD).* Statistics Sweden.

Andersson, M., & Klepper, S. 2013. Characteristics and performance of new firms and spinoffs in Sweden. *Industrial and Corporate Change,* 22(1): 245-280.

Andersson, M., & Noseleit, F. 2011. Start-ups and employment dynamics within and across sectors. *Small Business Economics,* 36(4): 461-483.

Andersson, M., & Xiao, J. 2014. *Acquisitions of start-ups by incumbent businesses: A market selection process of "high-quality" entrants?*: Lund University, CIRCLE - Center for Innovation, Research and Competences in the Learning Economy.

Audretsch, D. B., Houweling, P., & Thurik, A. R. 2000. Firm survival in the Netherlands. *Review of Industrial Organization,* 16(1): 1-11.

Audretsch, D. B., & Mahmood, T. 1991. The hazard rate of new establishments: A first report. *Economics Letters,* 36(4): 409-412.

Audretsch, D. B., & Mahmood, T. 1994. Firm selection and industry evolution: The post-entry performance of new firms. *Journal of Evolutionary Economics,* 4(3): 243-260.

Audretsch, D. B., & Mahmood, T. 1995. New firm survival: New results using a hazard function. *Review of Economics and Statistics,* 77(1): 97-103.

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.

Barkley, D. L., DiFurio, F., & Leatherman, J. 2004. The role of a public venture capital program in state economic development: The case of Kansas Venture Capital, Inc. *Journal of Regional Analysis and Policy,* 34(2): 83-106.

Barringer, B. R., & Greening, D. W. 1998. Small business growth through geographic expansion: A comparative case study. *Journal of Business Venturing,* 13(6): 467-492.

Bates, T. 1990. Entrepreneur human capital inputs and small business longevity. *Review of Economics and Statistics,* 72(4): 551-559.

Bates, T. 1995. Analysis of survival rates among franchise and independent small business startups. *Journal of Small Business Management,* 33(2): 26-36.

Baumol, W. J. 1959. *Business behavior, value and growth*. New York: Macmillan.

Baumol, W. J. 2002. *The free-market innovation machine: Analyzing the growth miracle of capitalism*. Princeton, NJ: Princeton University Press.

Bernard, A. B., Massari, R., Reyes, J.-D., & Taglioni, D. 2014. *Exporter dynamics, firm size and growth, and partial year effects*.

Birch, D. L. 1981. Who creates jobs? *The Public Interest,* 65: 3-14.

Bottazzi, L., Da Rin, M., & Hellmann, T. 2009. What is the role of legal systems in financial intermediation? Theory and evidence. *Journal of Financial Intermediation,* 18(4): 559-598.

Box, M. 2008. The death of firms: Exploring the effects of environment and birth cohort on firm survival in Sweden. *Small Business Economics,* 31(4): 379-393.

Bradley, S. W., Aldrich, H. E., Shepherd, D. A., & Wiklund, J. 2011. Resources, environmental change, and survival: Asymmetric paths of young independent and subsidiary organizations. *Strategic Management Journal,* 32(5): 486-509.

Brown, J. P., Lambert, D. M., & Florax, R. J. G. M. 2013. The birth, death, and persistence of firms: Creative destruction and the spatial distribution of US manufacturing establishments, 2000-2006. *Economic Geography,* 89(3): 203-226.

Brüderl, J., Preisendörfer, P., & Ziegler, R. 1992. Survival chances of newly founded business organizations. *American Sociological Review,* 57(2): 227-242.

Cader, H. A., & Leatherman, J. C. 2011. Small business survival and sample selection bias. *Small Business Economics,* 37(2): 155-165.

Carpenter, J., & Lynch, A. 1999. Survivorship bias and attrition effects in measures of performance persistence. *Journal of Financial Economics,* 54: 337-374.

Carpenter, R. E., & Petersen, B. C. 2002. Is the growth of small firms constrained by internal finance? *Review of Economics and Statistics,* 84(2): 298-309.

Cassar, G. 2004. The financing of business start-ups. *Journal of Business Venturing,* 19(2): 261-283.

Coad, A. 2007. *Firm growth: A survey*. Max Planck Institute of Economics, Evolutionary Economics Group.

Coad, A. 2009. *The growth of firms: A survey of theories and empirical evidence*. Cheltenham, United Kingdom: Edward Elgar.

Coad, A., Daunfeldt, S.-O., Johansson, D., & Wennberg, K. 2011. *Who do high-growth firms employ, and who do they hire?*: The Ratio Institute.

Coad, A., Frankish, J., Roberts, R. G., & Storey, D. J. 2013. Growth paths and survival chances: An application of Gambler's ruin theory. *Journal of Business Venturing,* 28(5): 615-632.

Coad, A., & Hölzl, W. 2009. On the autocorrelation of growth rates. *Journal of Industry, Competition and Trade,* 9(2): 139-166.

Coad, A., & Rao, R. 2008. Innovation and firm growth in high-tech sectors: A quantile regression approach. *Research Policy,* 37(4): 633-648.

Colombelli, A., Haned, N., & Le Bas, C. 2013. On firm growth and innovation: Some new empirical perspectives using French CIS (1992-2004). *Structural Change and Economic Dynamics,* 26: 14-26.

Cox, D. R. 1972. Regression models and life-tables. *Journal of the Royal Statistical Society Series B,* 34(2): 187-220.

Cumming, D. J., & MacIntosh, J. G. 2006. Crowding out private equity: Canadian evidence. *Journal of Business Venturing,* 21(5): 569-609.

Cyert, R. M., & March, J. G. 1963. *A behavioral theory of the firm*. Englewood Cliffs, NJ: Prentice-Hall.

Datta, S., Satten, G. A., & Williamson, J. M. 2000. Consistency and asymptotic normality of estimators in a proportional hazards model with interval censoring and left truncation. *Annals of the Institute of Statistical Mathematics,* 52(1): 160-172.

Daunfeldt, S.-O., Elert, N., & Johansson, D. 2010. *The economic contribution of high-growth firms: Do definitions matter?*: The Ratio Institute.

Daunfeldt, S.-O., & Halvarsson, D. 2011. *Snabbväxarnas dynamik - Är hög företagstillväxt uthållig?*: Swedish Agency for Growth Policy Analysis.

Daunfeldt, S.-O., Halvarsson, D., & Johansson, D. 2012. *A cautionary note on using the Eurostat-OECD definition of high-growth firms*. HUI Research.

Davidsson, P., & Henrekson, M. 2002. Determinants of the prevalence of start-ups and high-growth firms. *Small Business Economics,* 19(2): 81-104.

Davidsson, P., & Klofsten, M. 2003. The business platform: Developing an instrument to gauge and to assist the development of young firms. *Journal of Small Business Management,* 41(1): 1-26.

Davidsson, P., & Wiklund, J. 2013. *New perspectives on firm growth*. Cheltenham, United Kingdom: Edward Elgar.

de Wit, G., & Kok, J. 2013. Do small businesses create more jobs? New evidence for Europe. *Small Business Economics,* 42(2): 283-295.

Decker, R., Haltiwanger, J., Jarmin, R., & Miranda, J. 2014. The role of entrepreneurship in US job creation and economic dynamism. *The Journal of Economic Perspectives,* 28(3): 3-24.

Delmar, F., Davidsson, P., & Gartner, W. B. 2003. Arriving at the high-growth firm. *Journal of Business Venturing,* 18(2): 189-216.

Delmar, F., McKelvie, A., & Wennberg, K. 2013. Untangling the relationships among growth, profitability and survival in new firms. *Technovation,* 33(8): 276-291.

Esteve-Pérez, S., Sanchis-Llopis, A., & Sanchis-Llopis, J. A. 2004. The determinants of survival of Spanish manufacturing firms. *Review of Industrial Organization,* 25(3): 251-273.

European Commission. 1999. *Risk capital: Implementation of the action plan - Proposals for moving forward. Communication from the Commission to the Council and the European Parliament*. European Commission.

Falkenhall, B., & Junkka, F. 2009. *Gasellföretag - Kännetecken och utvecklingsmönster*. Growth Analysis.

Fox, J. 2002. Cox proportional-hazard regression for survival data. In J. Fox (Ed.), *An R and S-plus companion to applied regression*. Thousand Oaks, CA: Sage.

Fritsch, M., Brixy, U., & Falck, O. 2006. The effect of industry, region, and time on new business survival - A multi-dimensional analysis. *Review of Industrial Organization,* 28(3): 285-306.

Gabe, T. M., & Kraybill, D. S. 2003. Passive firm learning and employment projection error. *Small Business Economics,* 21(1): 19-26.

Gagliardi, F. 2010. *Firm performance and institutional context: A theoretical exploration with evidence from the Italian cooperative sector*. PhD Thesis, University of Hertfordshire, http://hdl.handle.net/2299/4819.

Garnsey, E., Stam, E., & Heffernan, P. 2006. New firm growth: Exploring processes and paths. *Industry and Innovation,* 13(1): 1-20.

Gepp, A., & Kumar, K. 2008. The role of survival analysis in financial distress prediction. *International Research Journal of Finance and Economics,* 16: 13-34.

Geroski, P. A. 1995. What do we know about entry? *International Journal of Industrial Organization,* 13(4): 421-440.

Geroski, P. A. 2000. The growth of firms in theory and in practice. In N. Foss and V. Mahnke (Eds.), *Competence, governance, and entrepreneurship: Advances in economic strategy research*. Oxford, United Kingdom: Oxford University Press.

Geroski, P. A., Mata, J., & Portugal, P. 2010. Founding conditions and the survival of new firms. *Strategic Management Journal,* 31(5): 510-529.

Geroski, P. A., Van Reenen, J. M., & Walters, C. F. 1997. How persistently do firms innovate? *Research Policy,* 26(1): 33-48.

Gibrat, R. 1931. *Les inégalités économiques*. Paris: Recueil Sirey.

Gimeno, J., Folta, T. B., Cooper, A. C., & Woo, C. Y. 1997. Survival of the fittest? Entrepreneurial human capital and the persistence of underperforming firms. *Administrative Science Quarterly,* 42(4): 750-783.

Giovannetti, G., Ricchiuti, G., & Velucchi, M. 2011. Size, innovation and internationalization: A survival analysis of Italian firms. *Applied Economics,* 43(12): 1511-1520.

González-Hermosillo, B. 1999. *Determinants of ex-ante banking system distress: A macro-micro empirical exploration of some recent episodes*. Washington, DC: International Monetary Fund.

Greene, W. H. 2012. *Econometric analysis* (7th ed.). Upper Saddle River, NJ: Prentice Hall.

Growth Analysis. 2014. *Företagsstöd till innovativa små och medelstora företag: En kontrafaktisk effektutvärdering*. Growth Analysis,.

Ha, N. M. 2013. The effects of firm's growth on firm survival in Vietnam. *International Business Research,* 6(5): 142-156.

Haltiwanger, J., Jarmin, R. S., & Miranda, J. 2013. Who creates jobs? Small versus large versus young. *Review of Economics and Statistics,* 95(2): 347-361.

Halvarsson, D. 2013. *Identifying high-growth firms*. The Ratio Institute.

Hao, L., & Naiman, D. Q. 2007. *Quantile regression*. Thousand Oaks, CA: Sage.

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.

Henderson, A. D., Raynor, M. E., & Ahmed, M. 2012. How long must a firm be great to rule out chance? Benchmarking sustained superior performance without being fooled by randomness. *Strategic Management Journal,* 33(4): 387-406.

Henrekson, M., & Johansson, D. 2009. Competencies and institutions fostering high-growth firms. *Foundations and Trends in Entrepreneurship,* 5(1): 1-80.

Henrekson, M., & Johansson, D. 2010. Gazelles as job creators: A survey and interpretation of the evidence. *Small Business Economics,* 35(2): 227-244.

Heyman, F., Norbäck, P.-J., & Persson, L. 2013a. *Jobbdynamiken i svenskt näringsliv 1990 till 2009: Teori och empiri*. Institutet för Näringslivsforskning.

Heyman, F., Norbäck, P.-J., & Persson, L. 2013b. *Var skapas jobben? En ESO-rapport om dynamiken i svenskt näringsliv 1990 till 2009*. Expertgruppen för Studier i Offentlig Ekonomi, Swedish Ministry of Finance.

Higgins, R. C. 1977. How much growth can a firm afford? *Financial Management,* 6(3): 7-16.

Hoogstra, G., & van Dijk, J. 2004. Explaining firm employment growth: Does location matter? *Small Business Economics,* 22(3-4): 179-192.

Horowitz, J. L., & Savin, N. E. 2001. Binary response models: Logits, probits and semiparametrics. *The Journal of Economic Perspectives,* 15(4): 43-56.

Hsu, D. H. 2004. What do entrepreneurs pay for venture capital affiliation? *The Journal of Finance,* 59(4): 1805-1844.

Hyytinen, A., Pajarinen, M., & Rouvinen, P. 2015. Does innovativeness reduce startup survival rates? *Journal of Business Venturing,* 30(4): 564-581.

Jovanovic, B. 1982. Selection and the evolution of industry. *Econometrica,* 50(3): 649-670.

Juglar, C. 1862. *Des crises commerciales et de leur retour périodique en france, en angleterre, et aux états-unis*. Paris, France: Guillaumin.

Kanjilal, A. 2009. Distance to event vs. propensity of event - A survival analysis vs. logistic regression approach. *Spring 2009 DMA Analytics Annual Journal*: 23-30.

Kiander, J., & Vartia, P. 2011. Lessons from the crisis in Finland and Sweden in the 1990s. *Empirica,* 38(1): 53-69.

Kitchin, J. 1993. Cycles and trends in economic factors. *Review of Economics and Statistics,* 5(1): 10-16.

Klofsten, M. 2009. *Affärsplattformen: Entreprenören och företagets första år (3rd ed.)*. Stockholm, Sweden: SNS Förlag.

Koch, A., Späth, J., & Strotmann, H. 2013. The role of employees for post-entry firm growth. *Small Business Economics,* 41(3): 733-755.

Koenker, R., & Bassett, G. 1978. Regression quantiles. *Econometrica,* 46(1): 33-50.

Koenker, R., & Hallock, K. F. 2001. Quantile regression. *Journal of Economic Perspectives,* 15(4): 143-156.

Konstandina, N. V. 2007. *Measuring efficiency and explaining failures in banking: Application to the Russian banking sector*. PhD Thesis, Oregon State University, http://hdl.handle.net/1957/5963.

Lennox, C. 1999. Identifying failing companies: A re-evaluation of the logit, probit and DA approaches. *Journal of Economics and Business,* 51(4): 347-364.

Lerner, J. 2009. *Boulevard of broken dreams: Why public efforts to boost entrepreneurship and venture capital have failed - And what to do about it*. Princeton, NJ: Princeton University Press.

Lin, P.-C., & Huang, D.-S. 2008. Technological regimes and firm survival: Evidence across sectors and over time. *Small Business Economics,* 30(2): 175-186.

Lööf, H., & Heshmati, A. 2004. *The impact of public funding on private R&d investment: New evidence from a firm level innovation study*. Royal Institute of Technology, CESIS.

Macdonald, R. 2012. *Firm dynamics: The death of new Canadian firms - A survival analysis of the 2002 cohort of entrants to the business sector*. Statistics Canada, Economic Analysis.

Marris, R. 1964. *The economic theory of managerial capitalism*. Toronto: Palgrave Macmillan.

Marsili, O. 2001. *The anatomy and evolution of industries: Technological change and industrial dynamics*. Cheltenham, United Kingdom: Edward Elgar.

Mata, J., Portugal, P., & Guimaraes, P. 1995. The survival of new plants: Start-up conditions and post-entry evolution. *International Journal of Industrial Organization,* 13(4): 459-481.

OECD. 2014. *Entrepreneurship at a glance 2014*. Paris, France: OECD Publishing.

Oreland, C. 2012. *Snabbväxande företag i sverige - En jobbskapande sprintstafett*. Nationalekonomiska Föreningen.

Pe'er, A., & Vertinsky, I. 2006. The survival value of clusters for de novo entrants. *Academy of Management Proceedings,* 2006(1): N1-N6.

Penrose, E. T. 1959. *The theory of the growth of the firm*. Oxford, United Kingdom: Blackwell.

Persson, H. 2004. The survival and growth of new establishments in Sweden, 1987-1995. *Small Business Economics,* 23(5): 423-440.

Pettersson, K., Ericsson, T., & Olofsson, J. 2002. *Uppföljning av 1997 års nystartade företag - Tre år efter start*. SCB & ITPS.

Pierce, J. R., & Aguinis, H. 2013. The too-much-of-a-good-thing effect in management. *Journal of Management,* 39(2): 313-338.

Probst, G., & Raisch, S. 2005. Organizational crisis: The logic of failure. *Academy of Management Executive,* 19(1): 90-105.

Reichstein, T., Dahl, M., Ebersberger, B., & Jensen, M. 2010. The devil dwells in the tails - A quantile regression approach to firm growth. *Journal of Evolutionary Economics,* 20(2): 219-231.

Reinhart, C. M., & Rogoff, K. S. 2008. Is the 2007 US sub-prime financial crisis so different? An international historical comparison. *American Economic Review,* 98(2): 339-344.

Reynolds, P., & Miller, B. 1992. New firm gestation: Conception, birth, and implications for research. *Journal of Business Venturing,* 7(5): 405-417.

Robinson, C., O'Leary, B., & Rincon, A. 2006. *Business start-ups, closures and economic churn: A review of the literature*. London.

Santarelli, E., & Vivarelli, M. 2007. Entrepreneurship and the process of firms' entry, survival and growth. *Industrial and Corporate Change,* 16(3): 455-488.

Schneider, C., & Veugelers, R. 2010. On young highly innovative companies: Why they matter and how (not) to policy support them. *Industrial and Corporate Change,* 19(4): 969-1007.

Sexton, D. L., & Kasarda, J. D. 1992. *The state of the art of entrepreneurship*. Boston, MA: PWS.

Shen, P.-s. 2011. Estimation in the Cox proportional hazards model with doubly censored and truncated data. *Journal of Statistical Computation & Simulation,* 81(11): 1717-1725.

Singh, A., & Whittington, G. 1975. The size and growth of firms. *Review of Economic Studies,* 42(1): 15-26.

Sleuwaegen, L., & Onkelinx, J. 2014. International commitment, post-entry growth and survival of international new ventures. *Journal of Business Venturing,* 29(1): 106-120.

Statistics Sweden. 2013. *Statistics Sweden: Your source for knowledge*. Statistics Sweden.

Suárez, F. F., & Utterback, J. M. 1995. Dominant designs and the survival of firms. *Strategic Management Journal,* 16(6): 415-430.

Swedish Agency for Economic and Regional Growth. 2014. *Tillväxtverkets uppdrag,* http://www.tillvaxtverket.se/huvudmeny/insatserfortillvaxt/naringslivsutveckling/entreprenorskapihogreutbildning/tillvaxtverketsuppdrag.4.3453fc5214836a9a4726ea3c.html, (February 25, 2015).

Swedish Jobs and Society Foundation. 2015. *About Swedish jobs and society,* http://www.nyforetagarcentrum.com/Startsida/In_English/About_Swedish_Jobs_and_Society/, (October 15, 2015).

Swedish Tax Agency. 2013. *E-filing income statements: A technical description - Income year 2013 (Edition 3, Version 1.0),* https://www.skatteverket.se/download/18.8dcbbe4142d38302d755a4/1387385701189/260B03.pdf, (June 4, 2015).

Tveterås, R., & Eide, G. E. 2000. Survival of new plants in different industry environments in Norwegian manufacturing: A semi-proportional Cox model approach. *Small Business Economics,* 14(1): 65-82.

Ullström, J. 2002. *Det svenska nyföretagandet 1986-1997: Förändringar i företagsstrukturer och sysselsättningseffekter*. Vinnova.

Widerstedt, B. 2010. *Statistik över näringslivsdynamik*. Growth Analysis.

Wilson, K. E., & Silva, F. 2013. *Policies for seed and early stage finance: Findings from the 2012 OECD financing questionnaire*.

Vinnova. 2014. *About Vinnova,* http://www.vinnova.se/en/About-VINNOVA/, (February 25, 2015).

Xiao, J. 2014. *Ownership change, multinationals, and growth of new technology-based firms*. Lund University, CIRCLE - Center for Innovation, Research and Competences in the Learning Economy.

Appendix: Modeling and analysis

Our theoretical point of departure explaining the post-entry performance among new firms is the framework proposed by Klofsten (2009). It comprises of a collection of skills that a new firm needs to possess; either through a single person or commonly in the entrepreneurial team. To establish itself on the market and start a path towards growth, a business needs to:

- have a functioning product or service offering (that is often also new to the market)
- possess skills to communicate the benefits of its offering to the market
- possess skills to organize its business in a cost-effective way

The firm also needs the capacity to learn in order to adapt to unanticipated market conditions. Additionally, when the firm eventually grows, it needs to learn to manage the business in a more sophisticated way.

Judging by the data, most firms in the cohort do not seem to possess these necessary skills. As shown in the descriptive section, as many as 44 percent of the businesses have failed by the end of the first year following their inception. In the second year, an additional 14 percent of the initial cohort exit the market.

We assume that the aforementioned skills can be aggregated into an index.[26] When the index passes a certain threshold, the skills can be characterized as being sufficient for the survival of the firm. Making use of index function models, which are commonly employed in discrete choice modeling, we assume an index y^* such that:

$$y_{it}^* = x_{it}\beta + \varepsilon_{it} \qquad i = 1, \dots, N;\ t = 1, \dots, T$$

The variables are defined as:

y_{it}^*: skill index (unobserved) for firm i in the year t

x: explanatory variables (includes an intercept)

β: parameters (to be estimated)

ε: error term, i.e., stochastic, unobserved elements - follows a distribution with a mean of zero and a variance of one (whereby the variance can be set to σ^2 by multiplying the coefficients with σ^2)

The index y^* is non-observable and we only observe the presence, i.e., the survival, of a firm ($y = 1$) when the index is above a certain threshold (which is set to 0, without loss of generality). If the index is below this threshold, the firm does not possess the necessary skills and therefore exits the market ($y = 0$). Formally, this implies the following relationship:

$$y_{it} = 1 \; if \; y_{it}^* > 0$$
$$y_{it} = 0 \; if \; y_{it}^* \leq 0$$

[26] We base our approach on Greene (2012: 686-687). For previous empirical analyses employing a similar approach we refer to Gagliardi (2010), González-Hermosillo (1999) and Konstandina (2007).

Equivalently, this implies the following probabilities for a firm to survive or exit the market, given its skills index and corresponding index function:

$$p(survival) = 1 \; if \; y_{it}^{*} > 0$$

$$p(exit) = 1 \; if \; y_{it}^{*} \leq 0$$

Since we do not have access to data on these essential skills, we cannot test their relevance directly. Instead we rely on the development of the revenue and other accessible firm data and assume that this can be used as an indicator of the presence of sufficient skills and resources for new firm growth and survival. In order to proceed with the estimation of the aforementioned parameters, we still need to assume a suitable distribution function to relate the outcomes with the index function. The distribution must limit the outcomes in the domain [0,1]. This is most commonly done by using a logit or probit estimations, as well as semiparametric approaches (Horowitz & Savin, 2001). In the next section we will discuss the methodology more in detail and present our modeling approaches.

Modeling the probability of survival

To be sure, there are several approaches available for statistically analyzing the survival of firms. Here, "discriminant and logit analyses have been the most popular approaches," but there are quite a few other approaches available, such as survival analysis and hybrid models (Gepp & Kumar, 2008: 13). This study will use two approaches that show considerable promise. Firstly, we will make use of the widespread (Lin & Huang, 2008) logistic approach since it, along with probit models, has been shown to "identify failing firms more accurately than discriminant analysis" (Lennox, 1999: 347).

In addition to the logistic analysis we will perform a duration analysis (also known as survival or hazards analysis), which is a widespread practice in the literature on firm survival (see Cader & Leatherman, 2011; Giovannetti, Ricchiuti & Velucchi, 2011; Suárez & Utterback, 1995). Compared to binary choice models like logit and probit analyses, duration analyses have the advantage that they account for right-censoring in the data (i.e., firms that survive the entire period of analysis) as well as the duration of the firms' survival (Esteve-Pérez, Sanchis-Llopis & Sanchis-Llopis, 2004; Geroski et al., 2010). This means that they also account for explanatory variables that are time dependent. Put differently, it estimates the conditional probability that a firm will survive a given period $t + \Delta t$.[27]

Specifically, this study will employ a semi-parametric duration model, namely Cox's (1972) proportional hazards model, since it is the one that is most prevalent in analyses of business survival (Anavatan & Karaöz, 2013).[28] It offers the advantage of not imposing distributional assumptions and being able to address censoring and truncation in the data (Datta, Satten & Williamson, 2000; Shen, 2011; Tveterås & Eide, 2000).[29]

[27] See Kanjilal (2009) for a more elaborate discussion on the difference between logistic regression and survival analysis.
[28] Its use for analyzing firm survival was pioneered by Audretsch and Mahmood (1991, 1994).
[29] The method is not without its drawbacks. Besides the risk of the proportionality assumption being violated, there is a tendency for it to "overfit" models since it focuses on determining "effects … on the life of businesses," rather than to aim for prediction (Gepp & Kumar, 2008). Nevertheless, it constitutes a quite feasible and commonly employed approach that can serve as a robustness check for the findings in our logistic regression.

Binary choice model – logistic analysis

Analogously to previous studies (e.g., Audretsch et al., 2000; Bates, 1990), our multivariate logit regression model uses a binary coding for the dependent variable - it is set to equal one if a firm is still operative in the present year and otherwise takes the value zero. Building on Geroski's (1995) stylized facts on firm entry, survival analyses typically control for firm and industry characteristics. Besides the lagged growth rates (1- and 2-year lags), which are the variables of interest, we control for additional dimensions that include firm size (Audretsch et al., 2000; Giovannetti et al., 2011), the number of employees (Koch, Späth & Strotmann, 2013), geographic expansion (Barringer & Greening, 1998), investment and innovation (Coad, 2009; Delmar et al., 2013) and being a subsidiary (Harhoff, Stahl & Woywode, 1998).

We consequently arrive at the following regression model:

Equation 2

$$survival_{i,t} = log\left(\frac{p}{1-p}\right) = \alpha + \beta_1 growth_{i,t-1} + \beta_2 growth_{i,t-2} + \beta_3 age_{i,t-1} + \beta_4 employees_{i,t-1} + \beta_5 expansion_{i,t-1} + \beta_6 innovation_{i,t-1} + \beta_7 investment_{i,t-1} + \beta_8 subsidiary_{i,t-1} + \delta_t + \varepsilon_{i,t}$$

The variables are defined as follows:

$survival_{i,t}$: dependent variable for survival of firm i in the year t

α: intercept

$growth_{i,t-1}$ / $growth_{i,t-2}$: corresponding growth rates with one- and two-year lags

age: the firm's age in years

$employees$: number of employees

$expansion$: geographic expansion of the firm, proxied by the number of physical offices as an indication of the firm's presence

$innovation$: innovativeness, measured through R&D expenditures

$investment$: total firm investments

$subsidiary$: dummy variable indicating daughter firms

β: respective coefficients

ε: error term

Unless otherwise noted, all variables are lagged by one year. Finally, δ denotes the industry-, geography- and year-dummies included as additional control variables (see Coad, 2009).

The odds ratios attained from the logit model estimation described above are as follows:

Table 5 Output from logit regression

	survival (log-odds)	**survival** (odds ratios)	**p-value**
growth (1-year lag)	0.4649*** (0.0338)	1.5919*** (0.0537)	0.000
growth (2-year lag)	0.2291*** (0.0978)	1.2575*** (0.0384)	0.000
age	0.0982*** (0.0100)	1.1032*** (0.0111)	0.000
employees	0.1068*** (0.0160)	1.1127*** (0.0175)	0.000
expansion	0.0373 (0.1276)	1.0380 (0.1325)	0.770
innovation	- (omitted)	- (omitted)	-
investment	0.00003** (9.97e-06)	1.0000** (9.97e-06)	0.004
subsidiary	-0.2124*** (0.0442)	0.8086*** (0.0357)	0.000
constant	1.1953*** (0.1645)	3.3047*** (0.5435)	0.000
Wald chi^2 (55)	973.49		
Prob > chi^2	0.0000		
Dummy variables for year, industry and region are included in the estimation.			
(robust standard errors in parentheses)			
* p < 0.05			
** p < 0.01			
*** p < 0.001			

Given the model specification, growth does indeed appear to be positive and highly significant for firm survival while including the previously discussed control variables. In other words, the results suggest that growth in the preceding year is associated with a higher likelihood of survival in the current year.

The interpretation of the coefficients is quickly exemplified here. Holding the other independent variables constant, a one-unit increase in the logarithmized growth rate (as defined in this study) in year $t-1$ is likely to lead to a an increase in the odds of survival by 59.19 percent in the following year t.

A test of the joint significance of the lagged growth rates results in a sound rejection of the zero-hypothesis that the coefficients would both be equal to zero. This further indicates that growth appears to be playing a role in determining the firms' survival:

Table 6 Joint significance in logit model

(1)	**growth (1-year lag) = 0**
(2)	growth (2-year lag) = 0
chi2(2)	204.83
Prob > chi2	0.0000

Among the control variables, age, employees, investment and being a subsidiary are significant, even though the magnitude for the investment variable is very small and the others are only half as large as the 2-year lagged growth variable. Contrary to what theory suggests, the sign for the subsidiary variable is negative, indicating that being a daughter firm seems to decrease the likelihood of survival.

Conditioning on history – duration analysis

Illustration of the hazard function

The hazard function states the conditional probability that a firm will not survive the current period (viz., year), given that it has survived until that period. Specifically, it is given by:

Equation 3

$$\lambda(t) = lim_{dt \to 0} \frac{Pr\{t < T \leq t + dt \mid T > t\}}{dt}$$

where:

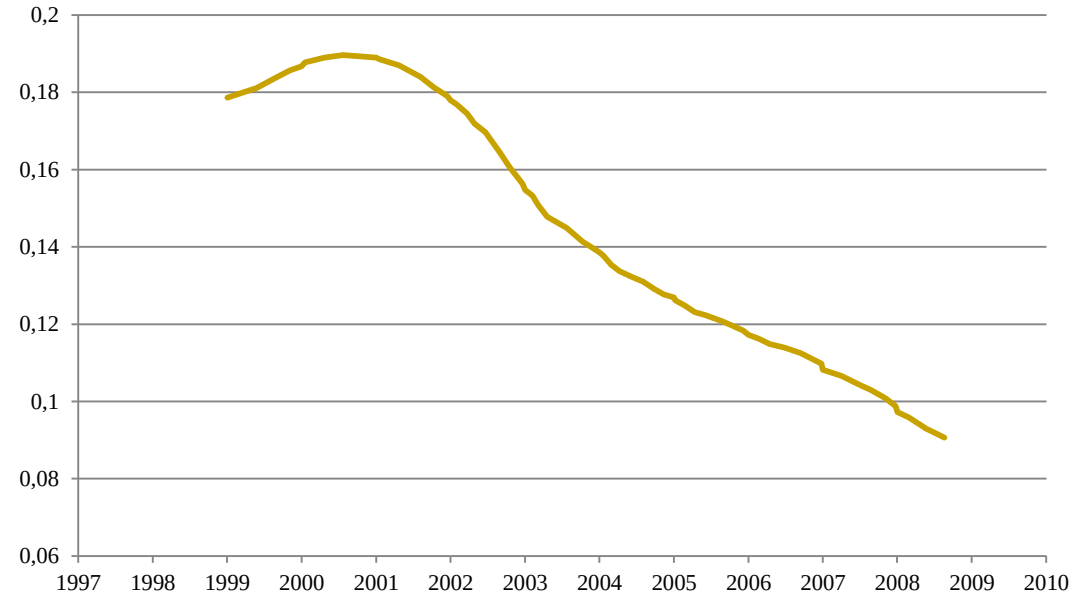
T is a non-negative continuous random variable that denotes the time until a firm exits

$[t, t + dt]$ is a time interval

dt is the width of the interval

An illustration of the hazard function for the cohort shows the mortality of the firms in the dataset:

Figure 4 Smoothed hazard function



The figure bears a considerable resemblance to that found in previous studies (e.g., Coad et al., 2013; Mata et al., 1995). It shows how the hazard rate increases initially after the firms' inception, indicating a rather "risky" time period of shortly after a firm has been established. Thereafter, the rate gradually and monotonically declines, showing how firms are more likely to survive the longer they manage to avoid closure. Towards the end of the time

period, the rate has significantly dropped, indicating a small share of firms closing by this stage.

Cox proportional hazards regression

The second analysis employs the Cox proportional hazards model. As explained by Fox (2002), a parametric model that is based on an exponential distribution typically takes the following form (see also the logit model in the previous section):

Equation 4

$$log\ h_i(t) = \alpha + \beta_1 x_{i1} + \beta_2 x_{ik} + \cdots + \beta_k x_{ik}$$

which is equivalent to:

Equation 5

$$h_i(t) = \exp(\alpha + \beta_1 x_{i1} + \beta_2 x_{ik} + \cdots + \beta_k x_{ik})$$

where:

i is the observation identifier

x are the independent variables

α is the baseline hazard, or intercept, i.e., the value attained when all independent variables are equal to 0

In the case of the semi-parametric Cox regression, however, this baseline function $\alpha(t) = log\ h_i(t)$ is unspecified, which leaves us with:

Equation 6

$$log\ h_i(t) = \alpha(t) + \beta_1 x_{i1} + \beta_2 x_{ik} + \cdots + \beta_k x_{ik}$$

or:

Equation 7

$$h_i(t) = h_0(t)\exp(\beta_1 x_{i1} + \beta_2 x_{ik} + \cdots + \beta_k x_{ik})$$

Thus, analogously to Giovannetti et al. (2011), the hazard function for a given firm i in our case is as follows:

Equation 8

$$h_i(t) = h(t, x_i) = h_0(t)\exp(x_i'\beta)$$

where

$h_0(t)$ is an unspecified baseline hazard function denoting the likelihood of a firm being liquidated, given that it has survived until the current period t

x_i is a vector of independent variables for firm i (identical to those stated in the logit section)

β represents the respective coefficients

Including the covariates used in the previous logit regression thus yields the Cox model employed here:

Equation 9

$$h_i(t) = h(t, x_i) = h_0(t)\exp(\beta_1 growth_{i,t-1} + \beta_2 growth_{i,t-2} + \beta_3 age_{i,t-1} + \beta_4 employees_{i,t-1} + \beta_5 expansion_{i,t-1} + \beta_6 innovation_{i,t-1} + \beta_7 investment_{i,t-1} + \beta_8 innovation_{i,t-1} + \delta_t)$$

Unlike the logit's odds ratios, the Cox model yields hazard ratios. They are presented below, along with the corresponding coefficients. As described by Fox (2002), the hazard ratio in the Cox model can be defined as follows. Take the case of two observations:

Equation 10

$$\eta_i = \beta_1 x_{i1} + \beta_2 x_{ik} + \cdots + \beta_k x_{ik}$$

Equation 11

$$\eta_{i'} = \beta_1 x_{i'1} + \beta_2 x_{i'k} + \cdots + \beta_k x_{i'k}$$

For these observations, the hazard ratio is defined as:

Equation 12

$$\frac{\mathrm{h_i}(t)}{\mathrm{h_{i'}}(t)} = \frac{\mathrm{h_0}(t)e^{\eta_\mathrm{i}}}{\mathrm{h_0}(t)e^{\eta_\mathrm{i'}}} = \frac{e^{\eta_\mathrm{i}}}{e^{\eta_\mathrm{i'}}}$$

Moving on to the output from the Cox regression, the results again indicate that growth is significantly associated with decreased risk of closure (or conversely, it seems to increase the likelihood of survival):

Table 7 Output from survival analysis

	closure (hazard ratio)	**p-value**
growth (1-year lag)	0.7256*** (0.0139)	0.000
growth (2-year lag)	0.8447*** (0.0191)	0.000
employees	0.9062*** (0.0070)	0.000
expansion	0.9652 (0.1413)	0.809
innovation	0.9684 (803.2255)	1.000
investment	0.99999* (5.84e-06)	0.012
subsidiary	1.1903*** (0.0472)	0.000
LR chi2 (45)	747.46	
Prob > chi2	0.0000	
(robust standard errors in parentheses)		
* p < 0.05		
** p < 0.01		
*** p < 0.001		

As in the case of the logit regression, growth in the previous year has approximately twice the effect of growth in the preceding year.

Like in the previous section, the interpretation of the model output is illustrated with an example here. The hazard ratio indicates how the hazard increases or decreases following a one-unit change in the respective variables. For instance, the results indicate that following a one-unit increase in the logarithmized growth rate in the year t, the risk (or hazard) of closure for a given firm would decrease to 72.56 percent of its initial value (i.e., decrease by 27.44 percent) in the following year $t - 1$, keeping the other covariates constant.

Testing for joint significance also shows that growth appears to have a significant effect on the firms' survival rates:

Table 8 Joint significance in Cox model

(1)	**growth (1-year lag) = 0**
(2)	growth (2-year lag) = 0
chi2(2)	308.24
Prob > chi2	0.0000

The pattern for the control variables is largely the same as in the logit regression. The number of employees, investment expenditures and being a subsidiary are significant, but the subsidiary variable is the only one with a magnitude comparative to the growth covariates. Just like in the previous regression, being a daughter firm seems to negatively affect survival by roughly the same magnitude as the positive 2-year lag growth variable. The age variable cannot be estimated in this setup due to collinearity (again, age does not vary between firms since the study follows a single cohort).

Does growth increase the likelihood of survival?

In general, the results from the Cox regression seem to corroborate the findings in the logistic setup, namely that growth has a positive, significant and non-negligible effect on firm survival. Yet, the results attained from the Cox model are slightly more modest in terms of magnitude. For the 1-year and 2-year lagged growth variables, the Cox coefficients are roughly twice and 1.5 times the size of those attained from the logit model, respectively. Regarding the remaining covariates, the estimated magnitudes are more comparable, with the difference ranging from 20 percent to near equality.

Returning to the primary objective of this study, the results indicate that growth in two consecutive years independently and jointly have a significant positive effect on a firm's survival chances in the following year. Specifically, the effect is roughly twice as strong for the 1-year lagged growth variable as for the 2-year lagged one. This finding is corroborated by similar results being attained in both models presented here, and the effect is also robust to altercations in model specifications.

The logistic regression showed that the firms' likelihood of survival tends to increase with age. This pattern also emerges in the illustration of the hazard function, which shows how the risk of closure first increases slightly in the short term but then steadily decreases over the remainder of the period. Seeing the early stages of a firm's life cycle as a market selection process, Andersson and Xiao (2014: 13) propose that "age can be regarded as a quality indicator." Hereby, they build on Jovanovic's (1982) model of "passive learning," which proposes that firms observe noisy signals that indicate their respective cost-efficiency in the market (i.e., their *ex-ante* efficiency characteristics). As suggested by Cyert and March (1963) and stated in their widely influential Behavioral Theory of the Firm, firms interpret these signals that they receive in the market and draw conclusions regarding their performance, which in turn determines their consequent behavior. According to Jovanovic, the firms consequently expand or scale down their operations (and in the case of consistently unfavorable performance eventually exit the market). In extension, this model suggests that the rates of failure and growth diminish with a firm's age, which has also been shown in previous empirical work (Gabe & Kraybill, 2003; Santarelli & Vivarelli, 2007).

Also mirroring results from previous studies of new firm survival, our results imply that firms with a higher number of employees stand a higher chance of surviving (Bates, 1995; Brüderl, Preisendörfer & Ziegler, 1992). There was however no evidence supporting the notion that geographic expansion, as measured by the number of offices opened, has a significant effect in this setup. Innovation (here proxied by R&D expenditures) was omitted and highly insignificant in the respective setups due to insufficient observations of the variable, while the effect of investments was positive and significant, but negligible in terms of magnitude. Finally, and perhaps most surprisingly, the analysis yielded a negative estimate for the subsidiary variable. Specifically, both models yielded nearly identical results implying that belonging to a concern and significantly decreased the firms' likelihood of survival.

www.growthanalysis.se

The Swedish Agency for Growth Policy Analysis (Growth Analysis) is a cross-border organisation with 60 employees. The main office is located in Östersund, Sweden, but activities are also conducted in Stockholm, Brasilia, New Delhi, Beijing, Tokyo and Washington, D.C.

Growth Analysis is responsible for growth policy evaluations and analyses and thereby contributes to:

- stronger Swedish competitiveness and the establishment of conditions for job creation in more and growing companies
- development capacity throughout Sweden with stronger local and regional competitiveness, sustainable growth and sustainable regional development.

The premise is to form a policy where growth and sustainable development go hand in hand. The primary mission is specified in the Government directives and appropriations documents. These state that the Agency shall:

- work with market awareness and policy intelligence and spread knowledge regarding trends and growth policy
- conduct analyses and evaluations that contribute to removing barriers to growth
- conduct system evaluations that facilitate prioritisation and efficiency enhancement of the emphasis and design of growth policy
- be responsible for the production, development and distribution of official statistics, facts from databases and accessibility analyses.

About the Memorandum series: some examples of publications in the series are method reasoning, interim reports and evidential reports.

Other series:
Report series – Growth Analysis' main channels for publications.
reasoning, interim reports and evidential reports.
Statistics series – continuous statistical production.
Svar Direkt [Direct Response] – assignments that are to be presented on short notice.
PM [Memorandum series] – some examples of publications in the series are method reasoning, interim reports and evidential reports.

Tillväxtanalys Studentplan 3, 831 40 Östersund
Telefon: 010 447 44 00 | info@tillvaxtanalys.se | www.tillvaxtanalys.se