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Survival and Growth Patterns among New Technology-Based Firms: Empirical Study of Cohort 2006 in Sweden

by Heikki Rannikko, Erno T. Tornikoski, Anders Isaksson, and Hans Löfsten

This study investigates the survival and growth trends in a cohort of new technology-based firms (NTBFs) established in Sweden in 2006. This cohort has faced both an economic upswing and a severe downturn, which started in 2008, and by 2014 provides 8 years of historical records. Our study makes several contributions to the current understanding of NTBF survival and growth. First, our empirical observations show that many NTBFs (72 percent) from the 2006 cohort were still operating at the end of 2014, indicating a much higher survival rate than those found in previous studies. Second, surviving firms from the 2006 cohort positively affected employment, as their annual job creation was higher than the reduction in employment caused by exiting firms. Third, very few companies experienced high-growth during their first 7 years, and employment growth and sales growth were highly correlated among high-growth firms.

Introduction

To what extent do new technology-based firms (NTBFs) benefit society? The post-founding performance of NTBFs has received an increasing amount of attention during the past decade, mainly because growing NTBFs are believed to lead to desired benefits. For example, Henrekson and Johansson's (2010) literature review found only 20 studies on high-growth firms published after 1990, whereas 4 years later, Coad et al. (2014) identified more than 100 papers in their Google Scholar search on the topic. These studies, however, tend to focus solely on growing firms. Discussing the benefits of a few high-growth firms, scholars seem to have disregarded the job destruction nature of exiting new and young firms (Shane 2009). In any given year, many NTBFs exit and, thus, destroy recently created jobs. While few studies provide valuable information about the early survival rates of new firms (Anyadike-Danes et al. 2015; Geroski, Mata, and Portugal 2010; Löfsten 2016; Macdonald 2012), most studies do not clearly define the specific patterns of NTBF exits. However, to appreciate the benefits of NTBFs, it is important to investigate both survival and exit patterns of such companies in the same frame of study.

More importantly, due to methodological choices, knowledge of the contribution of NTBFs is still limited. First, when we focus on the impact of growing new firms, we tend to consider growth only in new companies that develop over the observation period. As a

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consequence, we neglect the development of nongrowing and exiting companies. Second, few studies have analyzed growth and survival patterns of very small new firms, and many growth studies in entrepreneurship investigated larger new companies. For example, the seminal study of Delmar, Davidsson, and Gartner (2003) analyzed growth among firms with more than 20 employees. In a similar fashion, some official definitions of high-growth firms only include firms with a certain threshold size (e.g., the OECD focuses on firms with more than 10 employees).

However, Andersson and Klepper (2013) have exploited a data set to identify all new firms in the private sector in Sweden each year for the period 1993–2005, as well as new establishments created by existing firms, and a novel finding is that the larger the size of their parent, the greater the rate of employment growth in spin-offs. Ejermo and Xiao (2014) used a population of entrepreneurial firms entering the Swedish economy from 1991 to 2002, which they followed until 2007. They found that (1) NTBFs generally experience a lower hazard rate compared to other entrepreneurial firms, (2) all entrepreneurial firms follow a pro-cyclical pattern of survival likelihood over the business cycle, and (3) when comparing NTBFs with firms without self-employees, they found that NTBFs are more sensitive to business cycle fluctuations. While these approaches have advanced our knowledge of the development and growth of young firms in general, many studies focusing on "larger" small firms indicate that we still know relatively little about the early development of new firms, especially those with less than 10 employees, and that many entrepreneurial activities have been excluded from the literature. Other studies focus on firm characteristics related to firm growth (Brenner and Schimke 2015; Chan, Bhargava, and Street 2006; Davidsson et al. 2002), venture creation speed and the subsequent venture growth (Capelleras et al. 2010) and life cycle characteristics of small firms (Masurel and Van Montfort 2006).

Our study aims at improving our assessment of the impact of NTBFs. We investigate the survival and growth patterns in a cohort of NTBFs in Sweden. Since cohort analysis concentrates on the set of new firms that began operations in the same year, it is possible to investigate not only how and why some new companies can stabilize their operations and grow, but also why some others struggle and do not find their way through the critical post-founding phase. Our study provides several contributions to the literature, especially the technology entrepreneurship literature (see Ratinho, Harms, and Walsh 2015) for a description of this research field). First, the cohort approach allows us to investigate all new firms, regardless of their size. Second, while only a few studies (e.g., Coad et al. 2014) consider both the left- and right-hand tail of the growth rate distribution, we go beyond decline, mortality, and growth by analyzing why and when some new firms exit, while others remain. Third, NTBFs are believed to have the highest wealth creation potential among new companies. Interestingly, some empirical evidence indicates that NTBFs do not necessarily have higher probabilities of faster growth than other companies (Almus 2002); technology and firm size seem to increase only survival chances (Giovannetti, Ricchiuti, and Velucchi 2011). We try to shed light on these earlier empirical observations by looking at both the survival and growth patterns of a cohort of NTBFs, contributing to the policy discussion about the role of NTBFs in the creation of social benefits. The remainder of this paper is organized as follows. The "Literature Review and Research Questions" section presents the literature review and the research questions, and the "Methodology" section describes the study's empirical setting. The "Empirical Results" section presents the empirical evidence, while the "Discussion and Conclusions" section discusses the empirical findings and concludes the study.

Literature Review and Research Questions

Introduction

Firm creation is widely embraced because new firms seem to contribute to overall economic health (Gallagher and Stewart 1986). While new firms have high mortality rates (Audretsch 1995; Dunne, Roberts, and Samuelson 1988), only a small minority of surviving firms want to grow, and finally achieve enough growth to have a positive social impact (Brüder and Preisendörfer 2000; Napier et al. 2012; Storey 1994). Consequently, policymakers and entrepreneurship researchers focus on these remaining firms, especially the high-growth firms. To analyze this mounting interest in firm growth, we looked at some recent studies from the Scopus research database using the search term "growth AND firm" in all social sciences articles from 2011. Since this resulted in over 4,000 results, we further restricted the search to

the 10 most popular entrepreneurship or innovation journals. In descending order, these were: *Small Business Economics* (75 hits), *Research Policy* (38 hits), *Industrial and Corporate Change* (37 hits), *Journal of Small Business and Enterprise Development* (32 hits), *International Journal of Entrepreneurship and Small Business* (29 hits), *International Small Business Journal* (29 hits), *Journal of Business Venturing* (16 hits), *International Journal of Entrepreneurial Behavior and Research* (15 hits), *Journal of Small Business Management* (14 hits), and *Entrepreneurship and Regional Development* (13 hits). The publication years show the rising interest; there were 11 articles published in 2012, 11 in 2013, 13 in 2014, and 14 in 2015. These figures suggest that the interest in growth studies has increased over the past few years.

Our analysis of sampling strategies among the 45 studies selected (which were required to be empirical analyses on firm growth) suggests three different approaches in recent growth studies. First, some scholars use a data set containing an entire population of (active) firms for a given timeframe across industries or in chosen industries. About 20 percent of the identified studies used this approach. For example, Peric and Vitezic (2016) studied firm survival and growth among all Croatian firms in manufacturing and hospitality during 2008–2014. Second, instead of studying the entire population of new firms, a large majority of past growth studies (around 70 percent) use a sampling strategy resulting in either representative or nonrepresentative samples. These studies are based on varying numbers of observations. For example, Lechner et al.'s (2016) study contained only 65 observations, while that of Lee (2014) was based on 4,858 firms. Third, some rare studies (around 10 percent) focus on one cohort or multiple cohorts of firms and follow their development over a number of years. For example, Anyadike-Danes et al. (2015) studied a cohort of start-ups created in 1998 in multiple countries. Box (2008) investigated the life spans of nearly 2,200 firms in seven birth cohorts of Swedish joint-stock companies, founded in seven separate years between 1899 and 1950. Employing a cohort approach, the studies relate firm survival to firm age and size, as well as to the effect of cohort affiliation and environmental change over time. Cohort affiliation and environmental forces, in other words, period effects, may explain differences in death rates among different firm populations.

However, while cohort studies automatically also consider small firms, in population-level and sample-based studies, new or small firms are excluded from the analyses. From the 45 studies reviewed, 13 studies impose a clear age limit, and 13 studies impose a clear size limit. For example, Duschl and Peng (2015) exclude firms with fewer than five employees because "the growth process of micro-firms tends to be rather noisy." There was clearly no age limit in 15 of the identified studies, and no size restriction in 10 studies. Capasso et al.'s (2015) study had both these properties. In addition, the role of age (in 17 studies) and size (in 23 studies) in the sampling was unclear, or the results did not contain descriptive statistics. For example, a study by García-Manjón and Romero-Merino (2012) investigating the relationship between research and development (R&D) and growth reports the nominal sales statistics for the sample companies but does not discuss firm age or the number of employees, which makes it difficult to position the results among similar studies. Among recent growth studies, the most popular measure of growth seems to be the log difference of sales, though some cases use additional measures, such as employment change.

These shortcomings should be a motivation to anyone who wishes to investigate new firm developments from their establishment onwards. That is, it would be important for knowledge creation to approach the firm's survival and growth through detailed analyses of a representative sample, and investigate what happens to each firm (exit/survival/growth) during their early years. Criscuolo, Gal, and Menon (2014) use micro-aggregated data in their analysis of employment growth in 18 countries for the sake of harmonization. Geroski (1995) states that entry seems to be relatively common in most industries, but that small-scale, *de novo* entrants generally have a rather short life expectancy, and concludes entry appears to be relatively easy, but survival is not. Caves (1998) analyzes how structural entry barriers affect the behavior of actual entrants, and find that gross entry is substantial in most industries because it is much larger than net entry, due to high rates of infant firm mortality.

While these studies provide valuable information about the post entry performance of new firms, we believe it is important to address the gaps caused by micro-aggregation to continue advancing our knowledge about new firm survival and growth patterns. Thus, to advance

our understanding of new firms' early development, we conduct a detailed firm-level analysis on both the survival and growth of a cohort of NTBFs. To guide our analysis, we formally pose three specific research questions.

Survival and Exit Patterns among NTBFs

Academic research has shown that survival rates range from 30 percent to 55 percent among new firms, depending on the time frame and industry in question. In the 1980s, Portuguese companies showed survival rates between 32 percent and 36 percent after 8 years of existence (Geroski, Mata, and Portugal 2010), similar to Canadian firms founded in 2002 (Macdonald 2012). Macdonald (2012) observed a survival rate of 38 percent among companies in the "Professional, scientific, and technical services" sector. Disney, Haskel, and Heden (2003) observed survival rates between 33 percent and 52 percent among 7-year-old firms in the United Kingdom, the United States, Canada, Portugal, France, and Italy. The 5-year survival rate of European firms founded in 2005 and still operating in 2010 is around 46.4 percent (Eurostat 2013). As a general rule, Santarelli and Vivarelli (2007) state that more than 50 percent of new firms exit the market within the first 5 years of activity. So far, the highest survival rates have been presented by Löfsten (2016), who observed that the survival rate among NTBFs was 55 percent (between 2005 and 2014). A high survival rate of NTBFs may relate to being part of technology or innovation systems, which increase survival chances, but may also limit growth opportunities within the system (Autio 1997). Therefore, we would expect a survival rate higher than 50 percent among NTBFs within 8 years of their founding.

The survival rates observed by earlier studies suggest that these rates are relatively similar in different sectors. For example, Macdonald (2012) found surprisingly little variation across industries for Canadian firms founded in 2002. However, we would expect significant differences in firms' survival and growth rates across industries. For example, in the IT sector the app–industry is currently relatively easy to enter, but, at the same time, it provides high yields only when the firms succeed. In other words, many enter the market, but many fail, and very few achieve significant growth. Therefore, we would expect significant sector differences in survival rates among NTBFs. In addition, based on the notion of liability-of-newness (Djupdal and Westhead 2015; Stinchcombe 1965), new firms are vulnerable in the very first years after their founding. The consequence of this notion is that we should observe relatively more exits during the first few years, and fewer afterward.

Furthermore, intuitively, we tend to think about a firm exit as an involuntary act, which represents approximately 49 percent of all exits in Sweden (Wennberg et al. 2010). Coleman, Cotei, and Farhat (2013) distinguished two types of exit: closures (permanently stopped operations), and mergers or acquisitions, and found serial entrepreneurs in the service sector were more likely to exit through merger or acquisition. Coleman et al. concluded that firms with more experienced and more highly educated owners were likely to survive, and that R&D activities did not significantly improve the chances of survival because firms are riskier and thus subject to a higher failure rate.

Finally, because of the liability-of-smallness characteristic (Freeman, Carroll, and Hannan 1983) of new firms, we would expect a higher volatility among smaller NTBFs. Due to their small size, some NTBFs are more vulnerable to external shocks than larger NTBFs. As a consequence, we could expect the NTBFs that developed during the observation period to face exit less often than those NTBFs that remained small. To explore these issues, we introduce the following research question:

> *RQ1*: *What are the survival and mortality patterns of NTBFs during their early years?*

Growth Patterns among NTBFs

Achieving high growth is relatively rare. It is widely accepted that growth rate distributions of small firms are tent-shaped (Coad and Hölzl 2009), meaning that only a few companies experience extreme growth events (either positive or negative). According to the OECD, when the employment-based criterion is used, the share of high-growth firms varies between 2 percent and 6 percent (OECD 2015). When sales development is used, the proportion of high-growth companies ranges from 5 percent to 15 percent (OECD 2015). Moreover, according to past research, firms in high-technology sectors do not experience strong growth with higher probability than companies in other industries (Coad et al. 2014). Therefore, we would not expect to observe more high growth firms among

Swedish NTBFs than what is observed among start-ups in general.

Recent research has shown that companies have idiosyncratic growth patterns that are not easy to identify by looking at averages across firms (Bottazzi and Secchi 2006). It has been suggested that these growth patterns depend on two dimensions: a firm's size and its lagged growth rate (Coad 2007; Hamilton 2011). Small companies are found to experience negative autocorrelation, especially in the case of fast-growing firms, reflecting their erratic growth patterns (Coad 2007). Large companies are likely to experience positive autocorrelation, irrespective of their growth rate in the previous period (Coad 2007). Besides manufacturing, these results seem to also hold in the service sector. Concerning service industries, Coad (2009) found that for micro firms (1–9 employees), sustained growth is a very rare phenomenon (negative autocorrelation), while for small and medium-sized firms, growth episodes stretch over a longer time horizon (positive autocorrelation). In support of this view, a recent study on medium-sized firms in the United Kingdom found that gazelles have difficulty sustaining the pace of growth for periods of longer duration (Parker, Storey, and van Witteloostuijn 2010). Therefore, high-growth firms seem to be a "temporally unstable population" (Delmar, Davidsson, and Gartner 2003, p. 195). We should expect only a few companies to grow consistently over multiple years.

Small firms that grew very fast in the previous period are particularly unlikely to repeat this growth performance (Coad 2007; Coad and Hölzl 2009). Many growth studies deal with firms that are larger in size, and thereby leave out a great deal of entrepreneurial activity. For example, the "Arriving at high growth firm" article by Delmar, Davidsson, and Gartner (2003) studied growth among firms larger than 20 employees. An observation from firm growth research is that there is still confusion about how to measure firm growth. Various researchers have argued that differences in the measurement of firm growth contribute to mixed results (Davidsson and Wiklund 2000; Shepherd and Wiklund 2009; Weinzimmer, Nystrom, and Freeman 1998). To correct this situation, it has been suggested that researchers should use several different growth measures, rather than a single measure. The use of multiple growth measures would allow easier comparisons across studies, more substantial robustness checks, and qualitative investigation of the differences found between different quantitative indicators (Coad et al. 2014).

However, sales and employee growth do not always move together. According to Delmar (2006), sales and employment figures represent different phases of growth processes. Whereas sales is an intermediary variable that responds to changes in supply and demand conditions, employment is an instrumental variable planned by the entrepreneur (Delmar 2006). Changes in sales are most likely highly correlated with changes in employment, but not necessarily; by hiring new employees, an entrepreneur can adjust a firm to a new level of demand through subcontracting or improving productivity (Delmar 2006). However, instead of an internal growth strategy, a company can opt for an external growth strategy in which the firm obtains access to the resources needed to fulfill its commitments through cooperative means (Johannisson 1990). To explore these issues in the case of NTBFs, we introduce the following research question:

RQ2: What are the high growth patterns among NTBFs during their early years?

Job Creation and Destruction Patterns among NTBFs

Studies that highlight the unprecedented success of high-growth start-ups in creating new jobs generally disregard the possibility that exiting new firms could destroy more jobs than the surviving companies create (Shane 2009). Knaup's (2005) study using U.S. data and Kirchhoff (1994), Persson (2004), and Wagner's (1994) studies using European data show that each cohort of new firms employs more people in its first year than in every other year after that. Phillips and Kirchhoff (1989), using a data source developed by the U.S. Small Business Administration, found that on the average, 39.8 percent of new firms survive 6 or more years, and this is equivalent to a failure rate of three out of five, substantially lower than popularly believed. Headd and Kirchhoff (2009) found that survival rates were not affected by macroeconomic conditions. According to Shane (2009), policymakers believe a dangerous myth because they think that start-up companies are a magic bullet that will transform depressed economic regions, generate innovation, and create jobs. Shane underlines that to achieve more

economic growth through more start-ups, new firms would need to be more productive than existing companies; however, they are not. Haltiwanger, Lane, and Spletzer (1999) combined data from the U.S. Census and other sources to look at the relationship between firm productivity and firm age, and the results showed that firm productivity increases with firm age. The typical start-up makes up for its poor productivity when it gets older because the typical U.S. start-up is dead in 5 years. This pattern makes sense, because there should not be positive correlation between economic growth and the rate at which typical start-ups are formed over the long term (Shane 2009).

A concern in recent studies regarding applying the cohort approach is the presence of a tendency toward micro-aggregation (an analysis where individual firms are not followed, but they are classified by certain criteria). Criscuolo, Gal, and Menon (2014) used micro-aggregated data in their analysis of employment growth in 18 countries for the sake of harmonization. Anyadike-Danes et al. (2015) studied the 1998 cohort in several countries by measuring firms' development at their establishment and 10 years later, using micro-aggregated data, to create a convenient data set. While these studies provide valuable information about the post-entry performance of new firms, we intend to address the gap caused by micro-aggregation, conducting a detailed firm-level empirical analysis. Based on previous research showing that technology may increase survival chances (Giovannetti, Ricchiuti, and Velucchi 2011), we would expect significant differences in the net contribution of a cohort of technology-based new firms. To explore this issue among NTBFs, we introduce the following research question:

> *RQ3: Do NTBFs make a positive or negative contribution to job creation after their establishment year?*

Methodology

Data

Our empirical setting is the Swedish population of NTBFs founded in 2006. The year 2006 is chosen because it provides (by 2014) 8 years of historical records. Furthermore, this cohort has faced both an economic upswing and a severe downturn that started in 2008, thus providing significant variation regarding contextual factors. Sweden is known for its advanced firm registration system, making it a perfect context to carry out a cohort study. We identified the companies using Retriever Business, a database of financial and legal information on all businesses in Sweden. Retriever Business contains information, such as the organization number, number of employees, branches, information regarding boards, and annual reports, dating from 2000/2001 on all types of firms in Sweden, including sole proprietorships. Many universities in Sweden have access to this database. Faculty, researchers, and students at the universities can use their university card or library card to virtually access most of the university library e-resources. We considered only firms organized as limited companies, excluding sole proprietorships and other legal forms. One reason for this limitation is that we want to avoid a sample with too many hobbies and lifestyle firms, which, in many ways, are different from limited companies.[1]

Studies of the new technology-based industry have sought to define "high technology" (Markusen, Hall, and Glasmeier 1986), and there are mainly two groups of indicators (Monck et al. 1988): measures of resource inputs to high-technology activities, such as R&D effort and R&D expenditure; and the employment of qualified personnel and measures of output or performance, such as growth, patent records, copyrights and licenses, and technological innovations. Patents are often used as an indicator of technological development, although the propensity to patent varies among sectors, firms, and countries (Taylor and Silberston 1973). Storey and Tether (1998) provide an overview of NTBFs in Europe, and the paper mainly discusses the characteristics of NTBFs and their founders. In our study, we used the Eurostat categorization of manufacturing and services industries according to technological intensity.[2] Butchart (1987) pioneered the industry approach in the United Kingdom, which was widely applied after that (e.g., Brown and Mason 2014). Based on the nomenclature of

[1]Another practical reason is that detailed annual report data is only available for businesses organized as limited companies.

[2]https://epp.eurostat.ec.europa.eu/statistics_explained/index.php/High-tech_statistics.

Table 1
High-Technology Sectors NACE Revision 2 Codes

Technology Sector	NACE Revision 2 Codes
High-technology manufacturing	21 Manufacture of basic pharmaceutical products and pharmaceutical preparations
	26 Manufacture of computer, electronic, and optical products
Medium high-technology manufacturing	20 Manufacture of chemicals and chemical products
	27–30 Manufacture of electrical equipment; Manufacture of machinery and equipment n.e.c.; Manufacture of motor vehicles, trailers, and semi-trailers; Manufacture of other transport equipment
Knowledge-intensive high-technology services	59–63 Motion picture, video, and television program production, sound recording and music publishing activities; Programming and broadcasting activities; Telecommunications.
	Computer programming, consultancy, and related activities; Information service activities
	72 Scientific research and development

economic activities, NACE revision 2 codes (NACE is derived from the French Nomenclature statistique des activités économiques dans la Communauté européenne), we concentrate on firms in high-technology, medium-high-technology, and knowledge-intensive high-technology services. We aggregated the firms at the two-digit level to minimize the chance that individual companies could be identified in the reported data. Table 1 summarizes the sector classification.

We identify 1,143 NTBFs (limited liability companies) founded in Sweden in these sectors in 2006. From this group of firms, 85 percent belong to knowledge intensive high-technology services, 12 percent to medium-high-technology manufacturing, and 3 percent to high-technology manufacturing. We define companies started in 2006 as firms registered at the Swedish Companies Registration office in 2016 that were also registered for value-added tax (VAT) and tax prepayment (corporate tax, F-skatt) that year. This procedure helps us confirm that the company started operations that year (only firms that are active can be liable for VAT and corporate tax), and filter out dormant companies, shelf companies, and other entities that are not active. We also avoid uncertainties about what year they started by using a more precise definition of start year by excluding firms where registration year and VAT/F-tax year did not match.

Furthermore, to control for the heterogeneity among new firms (Davidsson 2007; Wennberg 2005), we restricted our analysis to companies that began operations as independent firms (not belonging to a business group). We thus avoid including spin-offs from existing businesses and other start-ups that are not "true" *de novo* firms. Hence, in the Retriever Database, we excluded all companies with consolidated (group) financial statement items. Formally, a firm must be included in consolidated financial statements when ownership of a firm is over 50 percent. Moreover, when ownership is between 20 percent and 50 percent, it is normally suggested that an associate company's financial statements be included in the group financial statements. However, procedures may vary, and we cannot be entirely sure that all firms in which another company's ownership ranges between 0 percent and 50 percent are excluded from our data set. We believe, however, that the firms in our sample are reasonably independent and that our definition of independence is aligned with prior research: all firms are less than 25 years old and are established by a group of individuals rather than as a subsidiary of an already established firm (Little 1979).

As a result, we were left with 976 firms founded in 2006. We limit our research to the period between 2007 and 2014. To investigate survival and exit patterns among the NTBFs (RQ1), we conduct an in-depth analysis of the

firm registry. With regard to the growth patterns of NTBFs (RQ2), we perform a growth analysis using various growth measures only for those NTBFs for which a full-time series of employment or sales is available. This is because we must be able to compare each firm's development year by year. Including firms with, for example, only 2 years' information would bias our analysis of temporal development. In one period we would have oranges, and in the other period, apples. By restricting analysis to firms with a full-time series, we are sure to compare oranges to oranges each year. This restriction causes an additional bias. Firms with trouble generating sales are more likely not to report their sales. Thus, if these firms were included in the analysis, the inclusion would push down both median and mean values of sales each year. Therefore, our reported figures are slightly positive compared to figures of a complete cohort. Finally, with regard to whether a cohort of new firms destroys or continues creating new jobs after the establishment year (RQ3), we calculate the net impact of the cohort firms on job creation.

Survival and Growth Measures

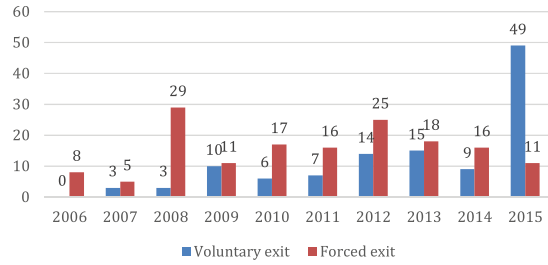
Survival. To measure survival, we utilized firm registry information. According to Swedish legislation, there are informal and formal indicators for analyzing whether business operations are being initiated. From these, we concentrate on formal indicators, which include formal registration of a company and its name, and records of the tax prepayment and value added tax registries. These notably report that a company has been founded and that it proceeds to billing customers. We see a firm surviving as long as it is tied to administrative systems through its membership in different registries.

Exit. We considered a firm to have exited the population if any of the following conditions were met: (1) the firm does not show a positive status in the company status field ("Bolagets status") of the firm registry; (2) there is a note ("Anmärkning") that the company has been liquidated or is in process of liquidation; (3) the firm is de-registered for F-tax (tax prepayment registry); (4) the firm is de-registered for value added tax; or (5) there is a de-registration date in the company registry ("Avreg. datum"). We consider a merger with another firm or deregistration from the VAT registry and/or tax prepayment registry as a voluntary exit. We count companies dealing with bankruptcy or liquidation as forced exits. Hence, our measure of exit is a proxy for an organizational exit, and not an entrepreneurial exit (Wennberg and DeTienne 2014) or business death, as Coad (2013) would phrase it.

High Growth. Some scholars suggest using several measures rather than a single measure to allow easier comparisons across studies, more substantial robustness checks, and qualitative investigations of the differences between different quantitative indicators (Shepherd and Wiklund 2009). Thus, to account for the effects of new and small firms' growth and to increase our study's reliability, we apply three different approaches to studying high growth in NTBFs. The first method is the 50 percent annual sales growth threshold (Autio, Arenius, and Wallenius 2000; Halabisky, Dreessen, and Parsley 2006), which we call the "Autio approach." The second approach is the OECD definition, according to which the measurement period begins when the firm has at least 10 employees and shows an average of 20 percent annual employee growth in a 3-year period. Since 2007 is the first year of analysis, and 2014 the last year of study, we have five 4-year periods during which a firm may qualify as a high-growth firm (2007–2010, 2008–2011, 2009–2012, 2010–2013, and 2011–2014).

To detect high-growth firms according to the OECD definition, we first calculated the annual growth rates, and then estimated the 3-year averages. If the average was greater than 20 percent, the firm was defined as a high-growth company. Third, in addition to the OECD indicator, we apply the "Kink point" approach (Clayton et al. 2013), according to which small firms with less than 10 employees are included in the group of high-growth companies according to growth at the 10-employee threshold. Thus, for a firm with 10 employees, high growth would mean 7.28 additional employees over a 3-year period. This is equivalent to average annualized growth of greater than 20 percent per year over a 3-year period (which equals the OECD rule). Consequently, for companies with less than 10 employees, a growth of eight employees or more is considered high-growth. By considering OECD and Kink point approaches together, we can include all NTBFs from the cohort in the analysis, independent of their initial size. Since we are interested in new firm growth, this seems a valuable addition.

Figure 1
Number of Exits Per Year (Voluntary and Forced, Separated) [Color figure can be viewed at wileyonlinelibrary.com]



Moreover, when analyzing high-growth companies, we observed those firms that survived until the end of 2014, and that show positive sales or employment data from 2007 to 2014. We separately analyzed firms that become group companies and those that remained independent during the observation period. For the 512 independent companies, we found complete employment time series for 293 firms, and complete sales time series for 390 firms. Similarly, for the 192 group firms, we found complete employment time series for 121 companies, and complete sales time series for 151 firms.

Empirical Results

Survival and Exit Patterns among NTBFs

From the 976 independent limited liability companies founded in 2006, by the end of 2014 (8 years after the founding year), 704 companies were still operating, which corresponds to a survival rate of 72 percent. Among these, 512 remained independent, and 192 companies became part of a business group during the observation period. A surprisingly high number of firms from the 2006 cohort were still operational at the end of 2014.

Figure 1 displays the temporal distribution of exits from the cohort between 2006 and 2014. The main observation from the statistics is that, after 2007, the annual number of exits rose to an average of 32 exits per year. This increase coincides with the financial crisis that began in 2008. There also seems to be a slight upward trend in the number of exits, with a peak in 2015. Most firms that exited the population were independent (255 companies), and only a few firms were part of a business group at the time of exit (17 firms).

Moreover, as Table A1 in the Appendix shows, there seems to be some variance in exit/survival rates by industry. However, if we focus on sectors (two-digit NACE code level) with more than 20 start-ups in 2006, the survival rate ranges from 64 percent to 74 percent, with an average of 69 percent. Thus, looking at NTBF survival in the industries with the highest levels of firm concentration, survival rates are surprisingly evenly distributed.

Regarding exit causes, it seems that an involuntary exit is more probable than a voluntary exit (Figure 1). From 2006 to 2014, around 57 percent (156) of the exits were forced, and 43 percent (116) exits were voluntary. On average, there were 12 voluntary exits and 16 forced exits per year. Looking at the firms that remained independent during the analysis period, we notice that 40 percent of such companies experienced a voluntary exit, whereas 60 percent experienced a forced exit. With regard to firms that became part of a business group, 88 percent experienced a voluntary exit and 12 percent experienced a forced exit. Therefore, with respect to RQ1, among Swedish NTBFs during 2006–2014 we observed: (1) a survival rate of 72 percent; (2) very little variance in survival rates across high-technology sectors; and (3) around 57 percent of the exits were forced exits.

Empirical Growth Patterns among NTBFs

Growth in General. The analysis of our empirical data indicates that NTBFs have grown substantially. Whereas the mean sales level of 541 firms was 8,545 TKR in 2007, it had

increased to 27,514 TKR by 2014, showing an almost 222 percent increase. During the same period, the mean level of employees of 414 firms (for which we could find full-time series of employment information) grew by 80 percent, from 5 to 9 employees. However, there were significant differences between companies that stayed independent during the observation period compared to firms that became part of a group. Independent firms remained small during the observation period, while group firms grew much more. For the 390 independent companies for which we had complete sales time series, the sales (mean) indicator increased around 60 percent between 2007 and 2014 (from 2,396 TKR to 3,847 TKR). Simultaneously, the sales (median) indicator decreased around 6 percent (from 1,399 TLR to 1,317 TKR). Among the firms that became part of a group, the sales (mean) indicator grew around 263 percent (from 24,425 TKR to 88,641 TKR), while the sales (median) indicator grew around 143 percent (from 2,887 TKR to 7,017 TKR). The increasing spread between the mean and median value of sales indicates the presence of a small group of firms that managed to grow quickly and is responsible for the overall positive development of group firms.

The employment statistics show development patterns, similar to the sales statistics. The development of the 293 independent firms for which we had complete employee time series is rather modest in terms of employment growth during the period of analysis. The average independent firm, according to its median indicator, remained a two-employee organization during the entire period, though the mean indicator increased from 2 to 3 employees. This result is in contrast with the average group firm, for which the employee (mean) indicator increased 100 percent (from 12 to 24 employees), and the employee (median) indicator increased 133 percent (from 3 to 7 employees).

High Growth. The analysis of the empirical data indicates that, regardless of the growth measure used, only a small minority of companies qualified as high-growth firms. Table 2 reports the number of high-growth firms according to two different measurement approaches in each 3-year period starting from 2007 to 2010 and ending in 2011–2014. We report high growth rates first based on the OECD definition, and then using the Kink point approach. The third approach is the Autio approach (as outlined in the "Survival and Growth Measures" section).

As the data in Table 2 demonstrates, the number of high-growth NTBFs varies considerably across periods. According to the OECD definition, we can identify between 7 and 12 high-growth NTBFs. When we combine the OECD approach with the Kink-point method, we identify between 21 and 26 high-growth NTBFs in our sample, while the number of high-growth NTBFs varies between 2 and 13 using the Autio approach. Combining all three methods, the share of high-growth NTBFs in the 2006 cohort start-ups ranges from 0.2 percent (high-growth firms according to Autio definition from 2011 to 2014) to 2 percent (high-growth companies according to combined OECD—Kink-point approach from 2007 to 2010).

Growth Persistence. The analysis of our empirical data indicates that high employment growth seems to persist, while strong sales growth does not. Between 54 percent and 77 percent of NTBFs classified as high-growth according to the joint OECD–Kink-point approach in one period are also classified as high-growth in the next period. However, this percentage falls in subsequent periods. For example, only 35 percent of high-growth NTBFs in the 2007–2010 period presented the same growth path in the 2011–2014 period. Furthermore, the results are considerably different when we use the Autio definition. Table 3 sheds light on the persistence of high growth, showing that most firms experienced only one growth phase during the observation period. This is especially true according to the Autio definition, as the number of companies that experienced more than one high-growth period differs significantly: 16 firms experienced one growth period, 3 firms experienced two growth periods, and 4 companies experienced three growth periods.

The Coexistence of Sales and Employee Growth. The analysis of our empirical data indicates that the relationship between sales and employment growth is surprisingly stable for high-growth NTBFs, especially when high-growth is measured using the combined OECD-Kink point approach. We observed a positive and stable correlation between the sales (median) and employment (median) indicators. Based on our observation, sales and employment seem to develop at almost the same rate. The cross-

Table 2
Number of High-Growth Firms among the 2006 Cohort of Swedish NTBFs According to Different Measures

OECD approach	Number of HGFs		
	Group	Independent	Sum
High-growth firm according to OECD definition 2007–2010	7	0	7
High-growth firm according to OECD definition 2008–2011	7	1	8
High-growth firm according to OECD definition 2009–2012	7	0	7
High-growth firm according to OECD definition 2010–2013	10	2	12
High-growth firm according to OECD definition 2011–2014	9	2	11

KINK point approach	Number of HGFs		
	Group	Independent	Sum
High-growth firm according to KINK point definition 2007–2010	15	4	19
High-growth firm according to KINK point definition 2008–2011	10	6	16
High-growth firm according to KINK point definition 2009–2012	10	5	15
High-growth firm according to KINK point definition 2010–2013	9	3	12
High-growth firm according to KINK point definition 2011–2014	8	2	10

Autio approach	Number of HGFs		
	Group	Independent	Sum
High-growth firm according to Autio definition 2007–2010	7	6	13
High-growth firm according to Autio definition 2008–2011	6	4	10
High-growth firm according to Autio definition 2009–2012	3	5	8
High-growth firm according to Autio definition 2010–2013	4	2	6
High-growth firm according to Autio definition 2011–2014	1	1	2

Table 3
Number of High Growth Periods among the 2006 Cohort of Swedish NTBFs According to Different Measures

Number of HG Periods	Number of Firms According OECD Approach	Number of Firms According to KINK Point Approach	Number of Firms According to Autio Approach
1	11	16	16
2	5	13	3
3	5	7	4
4	1	1	0
5	1	0	1
Sum	23	37	24

Table 4
Employment Creation by the 2006 Cohort of Swedish NTBFs

	2007	2008	2009	2010	2011	2012	2013	2014
Employees in surviving firms	2459	2714	2894	3000	3206	3476	3824	4135
Employment created in comparison to previous year	2459	255	180	106	206	270	348	311
Number of firms	703	702	704	704	704	704	702	703
Employment destroyed (compared to previous year)	−8	−60	−24	−42	−91	−130	−25	−26
Number of exiting firms	−8	−32	−21	−23	−23	−39	−33	−24
Annual surplus to employment	2451	195	156	64	115	140	323	285

correlations for both pairs of time series is 0.99. When using the Autio approach, the relationships become less smooth. Especially in terms of median development, employment changes seem to drive changes in sales. This is also apparent from the cross-correlations, which are 0.98 for the relationship between the means, and 0.79 for the relationship between the medians.

Finally, we looked at the mean and median developments of sales and employment among NTBFs that do not classify as high-growth by any definition used here. For this group, the observed relationships are not nearly as consistent as for the high-growth NTBFs. Especially in terms of median development, employment changes seem to have no association with sales changes. This also appears in the cross-correlation, which is 0.70 for the relationship between the means, while no correlation exists for the relationship between the medians.

To answer RQ2, among Swedish NTBFs during 2006–2014, we observed: (1) independent new firms stayed small, while those that became part of groups grew much more; (2) around 0.2 percent–2 percent of the NTBFs qualified as high-growth firms, depending on the definition of high growth; (3) while two-thirds of the NTBFs achieved high growth in two subsequent periods, less than one third were able to sustain high growth over three periods; (4) sales and employment growth seem to move together in high-growth NTBFs, while this relationship is less clear among non-high-growth NTBFs.

Empirical Job Creation Patterns

The analysis of our empirical data indicates that the 2006 cohort had a positive impact on employment from 2007 to 2014. Table 4 reports the statistics for 976 NTBFs that were independent at the time of establishment according to Eurostat industry classifications. Table 4 shows the annual increase in employment of the cohort compared to the previous year, as well as annual employment destroyed by exiting firms. The NTBFs founded in 2006 had a total of 2,451 employees in 2007 (1 year after establishment). After the founding year, the net job creation ranged between 64 and 323 employees. As an answer to RQ3, the cohort of Swedish NTBFs considered in the study made a positive contribution to job creation after their establishment year. The surviving NTBFs had a positive and significant impact on job creation even when we consider the jobs destroyed by exiting NTBFs.

Discussion and Conclusions

Our empirical exploration of survival and growth patterns among a cohort of Swedish NTBFs between 2007 and 2014 provides several interesting insights. First, survival rates were unusually high among the sampled NTBFs. Second, a very small number of NTBFs achieved high growth, and the number of high-growth NTBFs varied substantially, depending on the definition of high growth. Third, NTBFs seemed to be net job creators after their establishment year.

Survival and Exit Patterns among NTBFs

We found that a surprisingly high number of firms from the 2006 cohort were still operational at the end of 2014 (72 percent). As pointed out in our literature review, we expected the survival rates to range between 30 percent and 55

percent. Why do our observations of Swedish NTBFs indicate a much higher survival rate? Is it because we investigate survival rates in Sweden, or because we focused on NTBFs? Was our study period particularly safe for firms? One explanation for our higher survival rate (compared to other studies) might be that we filtered out firms that never actually started any operations, and thus were also more likely to exit (e.g., due to the financial and administrative costs of maintaining a non-active firm). This also highlights the need for future studies to elaborate more on the issue of how a firm's entry is measured. We encourage future research to focus on other contexts to establish whether the survival and exit patterns we observed are usual or unusual. According to Ejermo and Xiao (2014), NTBFs generally experience a lower hazard rate compared to other entrepreneurial firms, which is interpreted as a sign of their high "quality." Ejermo and Xiao report a significantly negative coefficient at the 1 percent level, which means that NTBFs have a lower logit hazard than other entrepreneurial firms. This also implies a lower hazard rate for NTBFs than for other entrepreneurial firms.

Furthermore, we observed that the high survival rates are similar across different technology sectors, and are nearly in line with some earlier studies. In comparison, Coleman, Cotei, and Farhat (2013) found that, after 5 years of operation, the survival rate for the weighted sample was 56.0 percent, and their findings also revealed industry differences in terms of exit. Löfsten (2016) observed the survival rate among NTBFs, which was 55 percent (between 2005 and 2014). Macdonald (2012) found surprisingly little variation across industries when investigating survival rates among Canadian firms founded in 2002. Also, our observation reveals rather constant exit rates among NTBFs, in contrast with the notion of liability-of-newness. We do not find NTBFs to have higher casualty rates in the first years after the founding. Instead, it seems that the mortality rate is equally distributed during the first 7 years. These observations could indicate that NTBFs are less impacted by liability-of-newness, which is a conclusion that scholars could integrate into theoretical models in future studies.

Finally, we observed that, among the studied NTBFs, there were slightly more involuntary exits (57 percent) than voluntary exits (43 percent). Intuitively, we think about exits as involuntary acts. We consider a merger with another company or deregistration from the VAT registry and/or tax prepayment registry as voluntary exits, and we count firms dealing with bankruptcy or liquidation as forced exits. In studying a sample of Swedish firms founded in 1995, Wennberg et al. (2010) found that 66 percent had experienced an exit by 2002, for the following reasons: harvest liquidation (26 percent), distress liquidation (25 percent), harvest sale (8 percent), and distress sale (6 percent). If we consider harvest liquidation and harvest sale as voluntary exits, and distress liquidation and distress sale as an involuntary exist, we identify 51 percent voluntary exits and 49 percent involuntary exits. However, as our definitions are not compatible with those employed by Wennberg et al., this should be considered with caution.

Growth Patterns among NTBFs

We observed that, regardless of the growth measure used, only a small minority of firms qualified as high-growth companies. This observation echoes earlier findings in the literature, as not all firms attempt to grow or can grow; in fact, few start-ups wish to grow (Storey 1994). Previous findings indicate that company growth rates follow a Laplace distribution with its characteristic "tent-shape" (Bottazzi and Secchi 2006), meaning that most firms are not growing at all and only a few companies experience high growth. In the 2006 cohort of Swedish NTBFs, we found that between 0.2 percent and 2 percent of firms are classified as high-growth companies. In comparison, the OECD reports that, in Sweden, the rate of high-growth enterprises varied between 4 percent and 6 percent (OECD 2015). However, the OECD's rate of high-growth firms estimates the number of high-growth companies as a percentage of the population of companies with 10 or more employees. In this study, we estimated the share of all high-growth firms in a cohort.

We further observed that sales growth and employment growth among high-growth firms seem to be correlated, especially when using the employment-based growth measure. This observation is in contrast with some previous findings. For example, Shepherd and Wiklund's (2009) study on correlations between different growth measures showed that employment and sales growth were only modestly correlated.

Job Creation and Destruction Patterns among NTBFs

We found that the 2006 cohort had a positive impact on employment from 2007 to 2014. This observation also contradicts some earlier findings. For example, Shane (2009) claims that cohort studies on new companies show that new firms provoke net job destruction after the year of their establishment. That is, the jobs created by surviving and growing new firms do not exceed the number of jobs lost by new companies exiting the market. There are two assumptions in our analysis. First, new firms do not displace (or generate) jobs in other existing companies. Second, all growth is internal (no acquisitions). It is very hard to measure the extent to which these two phenomena affect the actual job creation of NTBFs. In the 2006 cohort of Swedish NTBFs, job creation exceeds job destruction in each year of the observation period, and ranges between 64 and 323 employees. This finding, in addition to the high survival rates, indicates the importance of NTBFs for the Swedish economy, in contrast with Brown and Mason's (2014) conclusion on the NTBF sector in Scotland, where "the economic significance of TBFs is arguably not so great as commonly assumed."

Our findings might be partly explained by our more precise measures of start year and exit. While most previous studies based on firm register data use the company's registration date as the start date, we use the tax registration (VAT) date. Since only firms that are active can be liable for VAT and corporate tax (F-tax), dormant companies, shelf companies, and other entities that are not active are excluded from our data set. Therefore, we believe that our data set is free of statistical noise. In addition, our measure of exit is based on a proxy for organizational exit, where the company ceases to exist. This should not be confused with other forms of exits that are considered in the literature, such as entrepreneurial or individual exit (Wennberg and DeTienne 2014), since there might be an entrepreneurial exit without an organizational exit. As in all research, the design of this study has several limitations, which also offer promising avenues for future research. Our data were based on only one cohort and we therefore encourage future studies to replicate and extend our study by investigating several cohorts at the same time. In addition, we encourage future scholarly work to investigate the potential benefits, and drawbacks, of NTBFs on our societies in a more general sense. For example, while NTBFs seem to create net jobs in our study, what happens at the side of existing firms in the industry: do they destroy jobs because of new entrants?

Conclusions

Our study contributes to the current understanding of NTBF growth in several ways. First, we find a surprisingly high survival rate (72 percent) for the 2006 cohort of NTBFs as of the end of 2014. This rate is higher than those reported in previous studies. In addition, we find that very few firms experience high-growth during their first 7 years (0.2 percent–2 percent for the cohort), and that, among the high-growth firms, employment growth and sales growth are highly correlated. We also find that, in the 2006 cohort of Swedish NTBFs, job generation exceeds job destruction for each year observed. Our empirical results seem to suggest that new firms operating in high-technology sectors rarely achieve high growth, but they seem to have much higher survival rates compared to the traditional belief of high mortality rates among new companies.

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Appendix

Table A1
Survival Rates in Different NACE Two-Digit Categories

Nace 2 Digit	Founded in 2006	Exit by Year 2016		Sum	Survival Percentage (percent)
		No group	Group		
20	10	4	0	4	60
21	6	0	0	0	100
25	1	0	0	0	100
26	25	9	0	9	64
27	19	5	1	6	68
28	42	15	0	15	64
29	21	7	0	7	67
30	4	0	0	0	100
32	16	5	0	5	69
59	144	36	0	36	75
60	1	1	0	1	0
61	14	6	1	7	50
62	533	130	10	140	74
63	59	17	2	19	68
72	81	20	3	23	72
	976	255	17	272	