New-Firm Survival in Sweden: New Methods and Results

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Abstract

We analyze firm survival and focus on several levels of analysis and study the impact from founding conditions as well as from current, post-entry environmental variation. A prospective longitudinal dataset, recorded at the firm-level and covering nine complete entry cohorts of Swedish companies, is employed. The companies were founded between 1899 and 1992, and each firm is followed over nearly a decade. We adopt the semi-parametric complementary log-log (cloglog) model and find a proportionally lower hazard for exit for larger firms, entering in manufacturing and during economic booms. More importantly, our results show that, over time, increases in GDP growth and in the interest rate would push down hazard rates, while increasing inflation slightly increases the hazard. Since the impact from various factors is much more complicated than the simple model would suggest, we partially relax the assumption of proportionality. We find that smaller firms that enter during recessions display higher hazards, while the hazard is lower for larger firms. As firms age, increases in inflation would increase the hazard for small entrants but reduce the hazard for large start-ups. Additionally, GDP growth and the interest rate would reduce the hazard rates for all kinds of combinations, but at different extents. In essence, our study shows how different factor dynamically interact; furthermore, our methodology and prospective longitudinal data provides shows the possibility for dynamic analyses.

Keywords: firm entry; survival; founding conditions; contemporaneous conditions; Sweden

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Introduction

This article analyzes the linkages between new-firm survival, founding conditions and post-entry conditions. Research that use short observation periods, cross-sectional approaches, or that focus on individual-focused factors, are often unable to analyze competing and complementary explanations (Gartner, 1988; Landström and Lohrke, 2010). In particular, it becomes problematic to study the impact from environmental and exogenous conditions. Less attention has been given to the function of the context and environment, and scholars maintaint that research should elaborate on temporal dimensions and on transition and change, on multiple levels, and on context (Davidsson and Henrekson, 2002; Davidsson, 2016; Martinez, Yang and Aldrich, 2011). Data availability has often been a limiting factor – much data cover short periods, or is often reported at quite aggregate levels (Ahmad and Hoffman, 2007; Bartelsman et al., 2005), and the comparative paucity of appropriate data may partly explain this relative unbalance in previous research (Gartner and Shane, 1995; Manjón-Antolín and Arauzo-Carod, 2008).

One way to evade commonly encountered methodological problems in longitudinal research is to employ 'alternative' methodological approaches and empirical sources. In the present study we analyze firm survival in Sweden across a very long period, 1899-1999. By making use of contemporary data as well as of archives and historical sources (Martinez et al. 2011), we have generated prospective longitudinal data, consisting of several complete heterogeneous entry cohorts of firms. The firms in the different cohorts were founded under very dissimilar environmental conditions. Thus, our approach presents an opportunity for dynamic analyses of the linkages between survival, initial founding (macro) conditions and time-varying factors. These issues have received relatively less research attention: in several cases, founding and subsequent conditions can be similar, and the failure to account for the effect of contemporaneous conditions may lead to misleading conclusions – for instance that observed variation in firm performance is dependent of founding conditions (Geroski, Mata and Portugal, 2010). In the present article, we attempt to make these factors visible.

In the entrepreneurship literature, essentially two major streams of research use demographic and quantitative approaches on the link between entrepreneurial activity and exogenous conditions. Large-scale international programs, such as GEM (e.g., Bosma and Levie, 2010) and other large-scale projects, have generated extensive datasets on entreprenurial activity. This type of data is nowadays widely employed in e.g. cross-country comparative analyses that focus on either the supply- or demand-sides of entrepreneurship (Bjørnskov and Foss, 2008; Carmona, Congregado and Golpe, 2010; Carree et al. 2007; Nyström, 2008; Stenholm, Acs and Wuebker, 2013). Empirical studies have, occasionally, analyzed moderately long periods, using aggregated country-level panels or data of a (repeated) cross-sectional design.[1]

Another, multidisciplinary research stream uses micro level (or panel) data on firm dynamics. Even if there are exceptions, the studied periods/intervals are of short- to medium-length. Short intervals or cross sectional designs make environmental variations challenging to include. Yet, a relatively smaller number of studies in this tradition has elaborated on macro-environmental effects on firm performance, commonly analyzing entry cohorts. Of these, some have asked whether both founding conditions and conditions in the environment over time – current conditions – would affect firm performance. We set out from this second multidisciplinary research stream and follow the approaches of recent studies that have elaborated on the linkages between firm performance and intitial and current (exogenous) conditions (e.g., Geroski et al., 2010; Ejermo and Xiao, 2014; Manjón-Antolín and Arauzo-Carod, 2008).

[1] GEM has produced global series from 1999 (see Bosma and Levie, 2010). Another international database is Compendia, covering OECD economies from the 1970s and onwards (Van Stel, 2005). Some resarch has used longitudinal data that consists of aggregate time-series for individual economies, often measured over several decades (e.g., Lindh and Ohlsson, 1998; Shane, 1996; Steinmetz and Wright, 1989).

Following these studies and in particular the (eclectic) spirit of Geroski et al. (2010), we set out from findings and established regularities in the Industrial Organization (IO) and Organizational Ecology (OE) literatures. These two literatures, although significantly different in theoretical assumptions, have generated a substantial amount of empirical research and 'stylized facts' on organizational behavior (Geroski, 2001); furthermore, past research and recent findings thus indicate that firms' responses to the dynamic relationships between founding conditions and time-varying factors may be dissimilar if the entry cohort is heterogeneous. Firms may respond differently to these conditions, and in the article we attempt to employ analytical techniques for assessing these types of responses.

In our analysis, we use a prospective longitudinal empirical dataset which covers complete heterogeneous entry (birth) cohorts of Swedish companies. These were founded in nine separate years between 1899 and 1992: in 1899, 1909, 1912, 1921, 1930, 1942, 1950, 1987 and 1992. In total, the dataset records the life-histories of more than 37,000 companies of all different entry sizes, entering in all types of industries. The firms entered under very different conditions; these long intervals between observations imply that we, different from the majority of previous studies, generally have non-overlapping cohorts. This improves the possibility to distinguish whether different founding conditions – at different levels – and post-entry macroenvironmental variation would affect firm survival (c.f., Geroski et al., 2010).

Background and hypotheses

The core premise in the present article is that macro- and micro-explanations to firm survival should be regarded as complementary. Our research strategy corresponds to previously identified needs for research advancements – specifically the analysis of causal events and the integration of several levels of analysis. 'Ideal-type' research designs include all units that are subjected to transition over time. However, in practice, several empirical populations are often incomplete, making it difficult to analyze transition and change, as well as complementary and competing explanations (Aldrich and Ruef, 2006; Carre and Thurik, 2008; Davidsson and Wiklund, 2001; Davidsson 2008, 2016). Environmental variation has often remained absent in much past empirical research, or has often been problematical to operationalize (Manjón-Antolin and Arauzo-Carod, 2008). Recently, Martinez et al. (2011) have concluded that researchers seem to be more comfortable measuring environmental variations across space than across time. However, longer perspectives on the conditions for enterprising activity can better make us understand current developments and they may add new insights (Aldrich, 2009; Shane, 1996).

A substantial number of studies find that survival and mortality rates fluctuate with change and transition in the external economic, social and institutional environment. Particularly amongst economists, it has often been commonplace to assume that changes in the conditions for entrepreneurship vary with changes in the macro economy. Several studies that employ aggregate indicators have tested for, and regularly discovered, a dependency on macroeconomic conditions (e.g., Blanchflower, 2000; Bögenhold and Staber, 1991; Lindh and Ohlsson, 1998; Shane, 1996; Steinmetz and Wright, 1989; Wennekers et al., 2005). More importantly, several contributions on firm dynamics are found in the traditions of IO and OE. The two literatures differ substantially in several theoretical assumptions but also share common conceptions of regularities (for comprehensive overviews and discussions, see Frech, 2002, and, in particular, Geroski, 2001).

In the spirit of research that specifically addresses how time-varying, macroeconomic conditions would affect survival performance from entry (e.g., Audretsch et al., 2000; Huyn et al., 2012; Mata et al., 1995) and, in particular, recent research that has aimed at studying the roles of both initial founding conditions and contemporaneous exogenous variation (see for instance Disney, Haskel and Heden, 2003; Geroski et al., 2010), the overarching aim of our study is to analyze new-firm survival in relation to both intitial founding conditions and contemporaneous conditions at the firm-, industry- and macro-levels. Firstly, our research problem sets out from a number of established empirical regularities that have been well-covered in past research (c.f., Caves, 1998): does increasing firm age reduce the risk for exit; will a larger (initial) start-up size increase the probability for survival, and, finally, are there any sectoral/industry differences in survival? Furthermore, the specific research problem in our study draws on recent findings and discussion in the literature on organizational performance (e.g., Disney et al., 2003; Geroski et al., 2010) – specifically, we ask (*a*) if contemporaneous (time-varying) macroeconomic conditions would affect firm survival, and (*b*) whether macroeconomic conditions at the time of founding have effects on the likelihood for survival. Furthermore, (*c*) we ask if there is a *dynamic relationship* at hand: specifically, we ask whether there is a dynamic relationship between survival and conditions at different levels of analysis.

Hypotheses

At the *firm level*, established empirical regularities of age and size dependencies imply that new and small firms generally have a higher probability to exit. These two liabilities of newness and smallness, respectively, will diminish with increasing firm age and increasing firm size (c.f., Evans, 1987; Carroll and Hannan, 2000). Several variants of this age dependency have evolved, such as the 'liability of newness' (negative age dependence); the 'liability of adolenscence' (initially increasing mortality followed by decreasing mortality), or the 'liability of obsolecence' (positive age dependence) (Carrol and Khessina, 2005). Nonetheless, the pervading idea is that firms and organizations, irrespective of time and place, are subjected to an age-liability. Since there are several variants, we do not *a priori* hypothesize on firm age.

However, organizations entering with a larger size, or that grow, would have excess resources and advantages from both scale and scope and excess resources, meaning that they would cope with harsher times better than smaller firms (Carroll and Hannan, 2000). Firms that enter with a smaller size, or that do not grow over time, have higher persistent probabilities of exit (Geroski et al., 2010). Therefore, we formulate the following hypothesis:

> H1a. Firms entering with larger initial size will have lower probabilities for exit.
>
> H1b. Firms entering with larger initial size will have persistently lower probabilities for exit.

Furthermore, both IO and OE establish regularities of *industry-* or *population-level effects*. The most common methodology in both literatures is to count rates or some other kind of transformation in populations that are homogeneous. In IO, this equals to distinct, individual industries. More broadly, OE defines industries as 'populations', which also may represent other types of organizations (e.g., labor unions; Hannan and Freeman 1988). OE appears to have displayed a lesser general interest in innovation and technology *per se*. It could to some extent be maintained that both traditions identify that factors and processes at the industry- or population-level would affect organizational outcomes. Results in IO conclude that innovation rates, technological change, and industry life-cycle effects affect survival rates – both for incumbents and for new entrants (Agarwal and Audretsch, 2001; Klepper, 1996, 2002). In particular, industries characterized by intense competition often have higher exit rates rates, and that manufacturing industries display higher survival rates compared to sectors such as trade or services (Harhoff et al., 1998; Phillips and Kirchoff, 1989). We formulate the following hypothesis on industry and sector effects on survival:

> H2. Firms entering in manufacturing will have lower probabilities for exit than firms that enter in other sectors.

In the remainder of this section, we develop a number of hypotheses that are related to the dynamic relationship(s) between intital conditions at the firm-, industry- and macro-levels, and post-entry time-varying macro conditions. Both IO and OE assert that *environmental conditions* – macroeconomic, macro-social and institutional conditions – would have a considerable role for firm survival. OE commonly takes on a broader definition of the macro environment: 'wider' economic, political, institutional, social, and cultural phenomena – as well as particular 'real-historical' events (such as wars) – often represent the macro environment in OE analyses (e.g. Barron et al., 1994). As noted, one substantial difference is that OE holds that population ('industry') density – the number of organizations in a population at a given point in time – represents the *primary* environment for organizations, while the IO literature quite naturally sets forth from economic theory and specifically hypothesizes on the impact from both industry- and aggregate-level conditions and variation on (new) firm survival (e.g., Bhattacharjee et al., 2009; Boeri and Bellmann, 1995; Geroski et al., 2010).[2]

Although in rather different ways, the IO and OE literatures regard environmental conditions at the time of founding as an important explanation to variation in survival rates – in both the short and long terms. This effect is particularly emphasized in the OE tradition: organizations that enter into a particular population at a specific, historical point in time are 'imprinted' with the social, cultural, and technical features of that very environment. The current characteristics of any entry cohort would be revealed by both the internal and external historical conditions that prevailed at entry. Organizations founded under adverse conditions are put through a 'trial by fire'-process; those who manage to survive may have better survival prospects over time than those entering under more benign conditions (Hannan and Freeman, 1988; Swaminathan, 1996). In a similar manner, scholars in IO have theorized that firms which enter in distinctly dissimilar periods face different cyclical and macroeconomic conditions. As a consequence, both firms and different entry cohorts may display different survival patterns even in the longer term (Geroski et al., 2010).

[2] Specifically, organizational ecologists often include macroeconomic variables in empirical analyses; howver, these are generally are not considered to represent the most important, or the most theoretically interesting, environmental factors. For an exception, see Carroll and Delacroix (1982).

Starting with how current environmental conditions would affect business performance, several studies in IO find that survival rates vary with environmental change; this relationship holds for both large and established businesses (Goudie and Meeks, 1991; Bhattacharjee et al., 2002); for fairly mature firms, and for small and new firms (Carreira and Teixeira, 2011). In a similar way, empirical results in OE show that organizational mortality vary with environmental fluctuations. For example, Barron et al. (1994), Carroll et al. (1993), and Carroll et al. (1996), find long-term mortality effects from aggregate economic and financial variation (for an exception, see Carroll and Swaminathan, 1991). This view is also supported by the IO tradition (e.g., Everett and Watson, 1998; Tveterås and Eide, 2000). To the best of our knowledge, the specific approach of multiple entry ('birth') cohorts appears to have been less common in empirical OE research. However, results in OE tend to find cohort effects on organizational mortality (Barnett et al., 2003; Carroll and Delacroix, 1982).

In particular, an increasing number of studies in the IO tradition – see Audretsch and Mahmood (1995), Box (2008); Disney et al. (2003), Ejermo and Xiao (2014), Fotopolous and Lori (2000), Fritsch et al. (2006), Geroski et al. (2010), Huyhn et al. (2010), Mata et al. (1995), Strotmann (2007) and Wagner (1994) – analyze *entry cohorts*, attempting to determine the effects from external variation and shocks. Commonly, the macro environment is measured either as macroeconomic (GDP) growth, as variation in aggregate or regional employment, or as variation in industry indicators – or in financial conditions; previous studies have shown a negative effect on firm survival from changes in the interest rate burden which may cause insolvency for particularly new and small firms (Everett and Watson, 1998; Guariglia, Spaliara and Tsoukas, 2016). Furthermore, interest rates also tend to be high in inflationary circumstances, inflation being associated with business uncertainty (Parker, 2009). One main conclusion from past research is that there should be a pro-cyclical pattern of survival performance: periods of (macro) economic expansion and growth would be favorable and should depress firms' exit rates. At the same time, other macro conditions would, *a priori*, have a counter-cyclical relationship with survival: high interest rates and high inflation rates would signal worsening credit conditions and business uncertainty, while low such rates thus would be favorable. As a consequence, there is general agreement that aggregate macroeconomic conditions positively would affect firms' survival prospects. We therefore formulate the following hypothesis:

> H3a. Favorable macroeconomic current conditions will decrease the probability for firms to exit.
> H3b. Favorable macroeconomic current conditions will persistently decrease the probability for firms to exit.

However, research often – although not always – find distinct differences in survival between entry cohorts. This may be the outcome of differences in conditions both during founding and in the post entry period (i.e., current conditions). Geroski et al. (2010) note that this line of reasoning is very similar to the OE view that initial conditions matter for survival: initial conditions may leave a permanent imprint – an entry cohort that has gone through a 'trial by fire' (Swaminathan, 1996) is likely to have lower rates of failure. Thus, adverse founding conditions and immediate selection may over time be followed by *lower* exit probabilities. However, and with notable exceptcions (e.g., Barnett, 2003), OE does not theorize particularly much on entry cohorts *per se*. This is more explicit in the IO tradition: for instance, Audretsch et al. (2000), using four successive birth cohorts of firms traced over a decade, find that while the likelihood of survival is shaped by variations in the exogenous environment, no significant differences in survival *between* cohorts appear. Similarly, Mata et al. (1995) employ seven consecutively entering cohorts of firms (founded 1983 to 1989 and followed until 1990). Their results indicate that cohorts display different survival rates due to varying conditions both during and after entry. Similar conclusions are reached by Huynh et al. (2012), following successive entry cohorts.

On the other hand, Wagner (1994, 2010a, 2010b) does not find that macro-environmental conditions have any (systematical) effect on survival between successive entry cohorts.

The strategy of a cohort approach is thus advantageous. Several, but not all, of these studies also find specific cohort differences, which may (partially) be outcomes of specific exogenous conditions that prevailed at founding. Therefore, emerging work in the IO tradition (resembling, to some extent, the OE approach) has specifically come to address the extent to which founding and current conditions, respectively, would affect firm survival: Fotopolous and Lori (2000) observe distinct differences in survival between consecutively founded cohorts: firms (cohorts) established closer to an oncoming macroeconomic recession have lower survival rates than those entering during booms; similarly, Strotmann (2007) finds (equivocal) support for distinct environmental founding effects between separate entry cohorts of firms. Furthermore, Disney et al. (2003) discover some small, indirect, variance in survival and find effects related to the economic environment at founding: the impact of cyclical shocks is reinforced, the older the establishment. Thus, as firms manage to survive and mature, there will be a stronger negative impact from economic downturns – thereby, an increasingly greater sensitivity to macro-environmental fluctuations. More importantly, Geroski et al. (2010) study ten consecutive entry cohorts and analyze both the influence from environmental founding conditions and from (contemporaneous) environmental variation over time. Geroski and colleagues find that firms' survival rates are higher in times in which the economy is growing, and lower in periods of economic decline. They also find a distinct effect from of macroeconomic founding conditions: firms born in a boom seem to have nearly permanently higher survival rates in comparison to those founded under more adverse conditions. From these studies, we formulate the following hypothesis:

H4a. Firms entering during recessions will have higher probabilities for exit.

H4b. Firms entering during recessions will have persistently higher probabilities for exit.

Finally, recent research findings on the *dynamic* relationship(s) between initial conditions, at several levels, and time-varying factors, make us formulate the following hypotheses to be tested. These hypotheses are formulated along the lines of previously generated knowledge and 'stylized facts' on organisational behavior (e.g., Caves, 1998; Hannan and Freeman, 2000) and recent findings in research that address time-varying and founding conditions (Audretsch et al., 2000; Disney et al., 2003; Geroski et al., 2010; Huynh et al., 2012; Mata et al., 1995). Thus, previously knowledge on the dynamic relationships between organizational age, entry size, founding conditions and current macro conditions make us formulate the following hypotheses:

> H5. Hypothesis H1a is valid for firms entering during both booms and recessions. However, the reduction in the probability for exit will be smaller during recessions.

Consequently, hypothesis H5 refers to the assumption that size effects would be smaller in the group of the firms that are founded during recessions compared to those entering during booms.

> H6. Hypothesis H4a is valid for firms that enter with smaller initial size. Exit probabilities will be less high for larger entrants during recessions.

Hypothesis H6 thereby predicts that recessions in general would increase the probabilities of exit both in smaller and larger start-ups; however, the increase would be smaller for larger start-ups.

> H7. Hypothesis H2 is valid for small firms. Exit probabilities will be even lower for larger firms that enter in manufacturing.

Accordingly, Hypothesis H7 states that manufacturing firms, regardless of entry size, should have lower probabilities of exit; yet, the reduction would be greater for larger entrants.

> H8. Hypothesis H2 is valid for firms entering during booms. Exit probabilities will be higher for firms entering in manufacturing during recessions.

Hypothesis H8 maintains that manufacturing firms will have lower probabilities of exit regardless if entry occurs during booms or recessions. However, the reduction in probability will be lesser among manufacturing firms founded during recessions.

> H9. Hypothesis H3a is valid for firms that enter with smaller initial size. Exit probabilities will be lower for firms that enter with larger initial size.

As can be noted, hypothesis H9 addresses the dynamic relationship between firm size at entry and current macro conditions; small firms would thus face greater sensitivity for current macroeconomic conditions.

Finally, we hypothesize that there will be a dynamic relationship between founding and current macro conditions on the probability for exit: firms established in recession would face greater sensitivity for current macroeconomic conditions.

> H10. Hypothesis H3a is valid for firms founded during both booms and recessions. However, the reduction in the probability for exit will be smaller for firms entering during recessions.

Research framework

Several recent empirical IO-studies have employed multiple-cohort strategies in order to elaborate on the impact of environmental (founding) conditions. In OE, a resembling conception is the one of historical 'imprinting' at the time of founding of an organization. Furthermore, OE commonly use populations of organizations over very long periods of time. In our view, therefore, yet another main contribution from OE is its long-term, 'real-historical' analysis along with the fact that organizational ecologists often triangulate (and generate their own) data from different records. In our own study we employ heterogeneous birth cohorts, collected from various sources. To fully employ concepts and theory from both traditions discussed above is not feasible. However, we are able to study test several hypotheses and assumptions in earlier research.

As has been discussed, recent research show a growing intention to explicitly analyze the role of (both) founding and/or current environmental conditions. However, most previous cohort studies employ consecutive cohorts (e.g., Audretsch et al. 2000; Disney et al. 2003; Geroski et al. 2010; Fotopolous and Lori 2000; Mata et al. 1995; Wagner 1994, 2010a, 2010b). Past empirical research has shown occasionally varying results. The common use of successive cohorts, founded in successive years implies that environmental founding conditions and variation in those conditions after founding may be quite similar. This could be a partial explanation for some of the inconsistencies in past research. As e.g. concluded by Wagner (2010b) in his study of four German entry cohorts, the post-entry performance of the cohorts was extraordinarily similar, which might be explained by the fact that macroeconomic conditions were quite similar.

In our own attempt, we use and compare cohorts that are different: their environments differed at the time of entry. The period of analysis covers multiple transformation phases, structural cycles, as well as a longer, general movement in the Swedish economy from a dominance of manufacturing industry to an increasing dominance of the service sectors. Conclusions from earlier studies (e.g., Wagner, 2010b) and from previously generated knowledge on long-term transformation, indicate that a research design with short time-frames and successive cohorts may be inappropriate (Schön, 2010). Thus, we have selected firms founded in very different years, and our sample covers periods of both peaks and throughs. In that respect, our overall research approach is comparative. Such an approach can either compare cases (in this article: cohorts) that are *similar* to each other – the 'Method of agreement' – or cases that are *different*, the 'Method of difference.' The Method of agreement-approach is often used to illustrate the value of a general theory or of an explicitly formulated hypothesis. Its function is thus to strengthen the argument for the usefulness of a theory by showing that it can cover several empirical cases; the empirical examples are deliberately chosen to demonstrate how well the theory works. In contrast, the Method of difference-approach, which makes use of contrasting cases in different contexts, serve the opposite purpose. Here, comparison is used to clarify the unique features of the cases studied, and to show how they affect the outcome. Comparison that contrasts of contexts fills a theory-testing function (Ragin and Zaret, 1983; Skocpol and Somers, 1980), which is one ambition with our study.

Except for a few individual years, we use mostly non-overlapping entry cohorts over a long interval of time. Our study uses demographic techniques. A demographic research strategy makes it possible to distinguish and identify particular behaviors across time and place (e.g., Hagenaars, 1990). All subjects entering in a certain period represents a birth cohort, or entry cohort. By taking the cohort concept into consideration it becomes easier to detect movements and changes that may be exclusive to that particular cohort (Glenn, 1977; Hagenaars, 1990; Menard, 1991). Naturally, our strategy would not be able to solve all issues and problems, but the long-term approach of our study – benefiting from the advantages that historical archival data is able to provide for dynamic analyses (Martinez et al. 2011) – has the potential to contribute with new insights.

Following Bandick and Görg (2010), Tsoukas (2011), Görg and Spaliara (2014) and Guariglia, Spaliara and Tsoukas (2016), we employ the complementary log-log (cloglog) model to estimate hazard rates for our analyses. To the best of our knowledge, the cloglog model has not been used previously in studies on firm survival that use a cohort approach, although Geroski et al. (2010) adopt a model in which the logarithm of hazard serves as dependent variable; this is an approximation of cloglog model. There are other discrete models available, such as the logit model. However, the cloglog model has several advantages for the purpose of the present study. First, it would be appropriate to employ a cloglog model when there are many events occurring in each time interval (Allison, 2010); the cloglog model can control unobservable heterogeneities (Hess and Persson, 2012), and this is particularly important for our cohort study. Furthermore, an attractive feature of a cloglog model is that exponentials of the coefficients provide the ratios of hazard rates directly, while, in a logit model, coeffients represent ratios of logits. Finally, by introducing age dummies into the cloglog model, we may obtain information about the baseline hazard function, which becomes an important instrument for exploring age effects.

Data and variables

In Sweden, information on companies is public, and overall, the data originate from practically the same source: the Swedish Companies Registration Office (*Bolagsverket*), formerly the Swedish Patent and Registrations Office (*Patent- och registreringsverket*, PRV). However, the nine cohorts originate from different archives and databases. The life courses of companies in the seven oldest cohorts (1899-1950) have been manually re-constructed from original records and transcripts in the archives of PRV, more specifically PRV's chronological register on companies (*Aktiebolagsregistret*), consisting of the individual, physical records over each joint-stock company in Sweden ever to be established, 1897-1972.[3] This method for data collection is time-consuming; however, it represents the only way for collecting historical data on prospective entry cohorts in Sweden. The data on companies in the two younger birth cohorts (1987 and 1992) were generously and exclusively provided by the credit rating company *MM analys AB* in the year of 2002. Generally, this type of data is hard to access and is not easily obtained from public records. In essence, this more contemporary data resembles the information contained in the

[3] This archive is very extensive, but has vast potential for analyses over long periods. For detailed accounts, see Gratzer (1996) and Box (2005).

records on companies in the archives of PRV. There are some differences between the two main datasets. However, both sets of data uses the same systematic measure and definition of year of entry, age, industry sector and macro-environmental variation. Our data comprises around 37,000 companies and nearly 250,000 observation years. In the entire dataset, 23,761 firms (about 64%) exited – either by bankruptcy, liquidation, merger or de-registration. Here, we only analyze the first eight years from entry; firms surviving beyond this period are treated as censored observations; the youngest cohort, starting in 1992, contains only eight observation years. Furthermore, over longer intervals, cohorts are weeded out and it could be questioned if very long periods of analysis are meaningful, given the overall research problem in the present study.

In our dataset, there is generally a high ratio of firms exiting within a rather short period of time from entry. In the analyses, we employ data from previous research and statistical databases (Edvinsson 2005a, 2005b; Edvinsson, Jacobson and Waldenström, 2010). Our sample has been divided according to several criteria: cohort, start-up size, industry sector, etc. Admittedly, our approach and our definitions of a number of variables are, in several extents, quite 'crude.' For instance, the variable that measures initial macroeconomic conditions at founding is binary, and is defined as either economic expansion or recession – that is: the measure does not take into account whether the macro economy is in a recession but on the road to recovery, etc. However, the considerable advantage with our data is that it is possible to test previous assumptions and to generate new knowledge on firm survival. The following variables are used and shortly discussed in Table 1 (variable names in parentheses).

*** Insert Table 1 about here ***

Method of analysis

Basic model

We extend the cloglog model in two ways. Similar to the original Cox model (Cox, 1978), which is widely adopted for studying continuous-time duration/hazard models, the cloglog model imposes the proportional hazards (PH) assumption. This assumption has been proved to be too restrictive. The present article adopts various approaches to set up semi-proportional cloglog in order to relax this assumption. At the same time, we also include time-varying covariates in the cloglog model (in line with, e.g., Nam, Kim, Park and Lee, 2008).

The cloglog model is defined as the following. Assume that *t* represents the age of a firm. T is a random variable representing the age at which the firm exits. T is continuous in nature but spell lengths are interval-censored: the values of T can only be observed on a calendar-year basis (in terms of the age of a firm, *t*). Thus, age expressed in the calendar year-unit can be used to establish non-overlapping age intervals for the survival analysis. As noted, we consider the first eight years of each cohort. That gives 8 intervals corresponding to the age of a firm, *t* = 1, 2, …, 8. The interval hazard rate h_t is a conditional probability that a firm exits upon the condition that it has survived until the previous interval: $h_t = \Pr\,(t-1 < T < t | T \geq t-1)$. This says that the exit occurred at age T=*t*, given the condition that the firm survived at least until *t*-1. By defining the survival function $S(t) = Pr(T \geq t)$, the interval hazard rate can be expressed as $h_t = (S(t-1) - S(t))/S(t-1)$.

To estimate the interval hazard rate h_t, the cloglog model is defined as:

$$\log\{-\log[1 - h_t(X,\ Y_t)]\} = \beta_X{}'X + \beta_Y{}'Y_t + \alpha_t \qquad (1)$$

The notation of $h_t(X,\ Y_t)$ represents an interval hazard rate at age interval *t* with the specification of a function of the variables of X and Y (to be defined later); note that the intercept in (1), α_t, is sensitive to firm age. α_t represents the baseline hazard function, $h_{0t} = \exp(\alpha_t)$, defined as a hazard rate without covariates. The baseline hazard function does not only provide information on the impact from the firms' age on survival; it will determine the outline of the hazard function. There are several ways to model the baseline hazard function; here, we adopt the semi-parametric approach by skipping parametric specification with any function form of αs. Since we consider the survival of the firms up to 8 years, we set up 8 piecewise dummy variables.

(1) specifies the link to a linear function of a set of covariates where X represents a vector of age-invariant covariates: start-up size, industry, and macroeconomic founding conditions in the first year of each cohort. Y_t, represents a vector time-varying covariates: inflation, GDP growth and the interest rate; i.e., it describes contemporaneous conditions.

In detail, in (1), we define that

$$\beta_X{}'X_i \equiv \beta_{size} size_i + \beta_{ind} industry_i + \beta_{se} state - of - economy_i$$

where *size*, *industry*, and *state-of-eeconomy* are binary variables, corresponding to small or large entry size, service/trade versus manufacturing sectors, and the founding condition for each cohort: macroeconomic expansion (boom) or recession. This can be easily demonstrated by taking the anti-log on (1) and compute the ratio, for instance when the time-invariant group changes from one group to another (value of the dummy changes from 0 to 1):

$$\frac{h_t(1, Y_t)}{h_t(0, Y_t)} = \exp\,(\beta_X), \qquad (2)$$

Here, we use the approximation: $\log\,(1 - h_t) \approx -h_t$. Thus the exponential of slope β_X offers information about proportional changes in the hazard function. $\beta_X > 0$, or equivalently $\exp(\beta_X) > 1$, indicates that the hazard would be higher when X changes from the group indicated with 0, to the group indicated with 1. On the other hand, $\beta_X < 0$ or equivalently $\exp(\beta_X) < 1$ indicates that the hazard would be lower when *X* changes. Here we may test hypotheses H1a, H2, and H4a. Hypothesis H1a states that larger firms (*size*=1) would have lower probabilities to exit. This implies β_{size} should be smaller than 1. H2 indicates β_{ind} should be smaller than 1 also, since being manufacturing firms (*industry*=1) that would have lower probabilities. On the other hand, H4a suggests that the probabilities should be higher for those entering during recessions (*state-of-economy*=1). β_{se} should be larger than 1.

At the same time,

$$\beta_Y{}'Y_{it} \equiv \beta_{inflation} inflatin_{it} + \beta_{growth} growth_{it} + \beta_{rate} rate_{it},$$

where *inflation*, *growth* (GDP growth), and *rate* (interest rate) are time-varying variables. βs are coefficients representing the slopes in the regression equation (1). Here, we unify the notation for cohorts and firms with i. β_Y offers information on proportional changes in the hazard function when Y changes one unit (in the present case: one percentage point). H3a can be tested here: the coefficient(s) for favorable macroeconomic condition should be larger than 1.[4] Note that (2) is irrelevant to the values of other variables; it is due to the PH proposition that (2) captures the shifting from changes in the considered variable, while all other variables remain the same values. In order to test the rest hypotheses, we need to partially relax the PH assumption, for which there are two basic approaches (discussed in the following sub-section).

Age-effects and persistency

Recall that the age-effects can be captured by the baseline hazard function: hazard rates at the age of the firms. The PH assumption implies that age-effects would be

[4] All the variable considered here are actually ambiguous. High inflation, growth, and even interest rate can be a result of booms. But at the same time, high inflation can represent bad economic environment, high cost for productions. High growth could also lead to high wages. High interest rate may represent the high credit costs. So it is hard to make a prediction about the coefficients.

proportional across various groups. For instance, in comparisons of large and small start-up groups, hazard ratios would remain the same for all ages (H1a). At the same time, when time-varying covariates change, the impacts on hazard rates across ages of firms have to be proportional as well (H3a). The mission here is to *relax* this PH assumption by employing an approach that is in the line with panel-data models in which heterogeneity is captured by setting up different intercepts. In our terminology, we may allow the baseline hazard rates, h_{0t}, to be a function of a strata, s. The cloglog model can be expressed as

$$\log\left[1 - h_t(X,\, Y_t)\right] = -\exp\left[\beta_Z' Z + \alpha_t + \alpha_t^*(s * D_t)\right] \quad (3)$$

where Z contains all covariates but excludes the strata, s. D_t is an age dummy, taking the value 1 at the age t, but 0 otherwise. When, for example, s is *size*, Z now contains *industry*, *state-of-economy* and all time varying variants, *inflation*, *growth*, and *rate*. The hazard function for firms with small size (*size* = 0) would be captured by the baseline hazard function, $\exp(\alpha_t)$; $\exp(\alpha_t + \alpha_t^*)$ seizes the possible impact on the baseline hazard rate related to the baseline hazard function due to firms with a large start-up size (*size* = 1). α_t^* reflects the difference between baseline hazard rates at age t across the groups characterized by s the *size* here. Since α_t^* can be different across ages, the changes in hazard due to *size* (from 0 to 1) are also age-specific. To a great extent, the PH assumption is relaxed in terms of shifting the baseline hazard function; furthermore, we may test whether the impacts are persistent, in terms of whether all age-related coefficients are all above or smaller than 1. In this exercise, we consider all variables except *industry*, which is merely treated as a control variable, to be candidates of s. We estimate (3) with one variable as the element of s at the time to test H1b, H3b and H4b.

Impacts across various groups

Further questions in the present article relate to whether age-invariant impacts would be the same across different groups, i.e., hypotheses H5 to H8. For instance, would start-up size have the same impact on hazards across the groups of firms established during booms or recessions, respectively? Furthermore, and following the research problem in our article, we are interested in whether current macroeconomic conditions, hypotheses H9 and H10, would have the same impacts on hazards across different start-up sizes and initial states, respectively. These questions relate to the PH assumption *across various groups*. In order to relax this type of PH assumption, our study considers an alternative approach, in line with the Cox proportional model, in which the 'baseline' hazard ratio is assumed to be a constant across different strata, s. It is referred to as the semi-proportional Cox model (Eide, Omenaas and Gulsvik 1996; Tveterås and Eide 2000). Interaction of s with the rest of the variables provides information of possible non-proportional shifts associated with various s, although the hazards remain proportional within each strata. This approach is reasonable for setting up time-invariant strata only, namely across various groups. In this paper, we only consider two types of groups, *size* and *state-of-economy*, since *industry* mainly serves as a control. In detail we formulate

$$\log\left[1 - h_t(X, Y_t)\right] = -h_{0t}\exp[\beta'_{X'}X' + \beta'_Y Y_t + s(\beta^*_s + \beta^{*\prime}_{X'}X' + \beta^{*\prime}_Y Y_t)], \qquad (4)$$

where X' is a vector of the subset of X by excluding the age-invariant strata s. In (4), h_{0t} is still the baseline hazard rate at t and $\exp(\beta^*_s)$ is the 'baseline' hazard ratio when $s = 1$ against $s = 0$ with all other covariates taking value of zero. This is similar to the one from the previous approach. However, an important feature is that this ratio is *age-invariant*.

Moreover, $\exp(\beta_{X'})$ indicate proportional changes in the hazard function within the group classified with $s = 0$,

$$\frac{h_t(s{=}0\ \&\ X'{=}1)}{h_t(s{=}0\ \&\ X'{=}0)}.$$

On the hand, $\exp(\beta_{X'} + \beta^*_{X'})$ represents within the group characterized by s=1 when *X'*=1 changed from *X'*=0,

$$\frac{h_t(s{=}1\ \&\ X'{=}1)}{h_t(s{=}1\ \&\ X'{=}0)}.$$

Thus, a significant exp $(\beta^*_{X'})$ represents a significant difference in the hazard ratios across different groups characterized by s. Using s=*size* to illustrate, *X'* now contains *state-of-economy* (H6) and *industry* (H7). $\exp(\beta^*_{size})$ provides the 'baseline' hazard rate in the large start-up group, s=*size*=1. $\exp(\beta_{se})$ is the hazard ratio of small start-ups established during recessions (*size*=0 and *se*=1) against small firms established in booms (*size*=0, *se*=0). This is the first half of hypothesis H6 which is the validity of H4a in the group of small start-ups. If $\exp(\beta_{se}) > 1$, the hazard rate for the small start-ups established in recessions would be greater than that of small start-ups established in booms (H4a is valid for the group of small firms). On the other hand, $\exp(\beta_{se} + \beta^*_{se})$ signifies the hazard ratio of large firms established during recessions (*size*=1, *se*=1) compared to large firms established during *booms* (*size*=1, *se*=0). Since large firms usually have lower probabilities to exit, the hypothesis 6 (H6) predicts $\beta^*_{se} < 1$. Similarly, $exp(\beta_{ind})$ illustrates the hazard ratio of manufacturing firms (*ind*=1) against service/trading firms (*ind*=0), in the group of small start-ups (H2 in the group of small firms that is the first half of H7). On the other hand, $\exp(\beta_{ind} + \beta^*_{ind})$ signifies the hazard ratio of large manufacturing firms (*size*=1, *ind*=1) in comparison to large firms in the services/trades sectors (*size*=1, *ind*=0). Since this would be even lower, hypothesis H7 predicts that β^*_{ind}<1.

Analogously, if s=*state-of-economy*, $\exp(\beta^*_{se})$ reflects the baseline hazard rates in the group that the start-ups were established during recessions. $\exp(\beta_{size})$ reflects the hazard ratio of large firms against small firms in the group of firms established during booms (H1a is valid in booms). At the same time, $\exp(\beta_{size} + \beta_{size}^{*})$ shows the same hazard ratio in the group of firms established during recessions. Since recessions usually make probabilities of exit higher, the hypothesis 5 (H5) predicts $\beta_{size}^{*} > 1.$ On the other hand, $\exp(\beta_{ind})$ reflects the hazard ratio of manufacturing firms against other firms in the group that is established during booms (the first half of H8), while $\exp(\beta_{ind} + \beta_{ind}^{*})$ shows the same hazard ratio for the group of firms that enters in recessions. The hypothesis predicts $\beta_{ind}^{*} > 1.$

Returning to (4), $\exp(\beta_{Y'})$ and $\exp(\beta_{Y'} + \beta_{Y'}^{*})$ reflect the hazard ratios when a time-varying variable increases one unit in each group characterized by the strata, respectively (hypotheses H9 and H10). For example, using *s=size* again, $\exp(\beta_{inflation})$ shows the hazard ratio when inflation increases one percentage point in the group of small start-ups, whereas $\exp(\beta_{inflation} + \beta_{inflation}^{*})$ displays the hazard ratio when inflation increases by one percentage point in the group of large start-ups. A significant $\exp(\beta_{inflation}^{*})$ indicates that two hazard ratios across the groups are significantly different.

Results

Basic facts on survival and hazards

Figure 1 consists of four graphs. In the upper-left panel, aggregated survival is plotted and in the upper-right position, survival according to individual cohorts is presented. We can observe a considerable heterogeneity: firms established in the cohorts 1942 and 1950 have high survival probabilities, while the cohorts from 1909, 1912, 1921 and 1992 demonstrate low survival rates at the end of their respective 8-year period. Intuitively, it seems as firms established during recessions, represented by the latter group of cohorts, have lower rates of survival. This is confirmed when observing survival rates according to initial macroeconomic conditions (Edvinsson, 2005a). This is plotted in the lower-right position of Figure 1: the survival function of firms established during booms is located above the one corresponding to firms established during recessions. The lower-left panel, finally, shows the survival functions according to initial start-up size. It can be observed that large start-ups differ substantially from small ones in survival, while the differences are rather small if we group the firms according initial macroeconomic conditions.

*** Insert Figure 1 about here ***

Despite that Figure 1 provides intuitive images on survival and hazards, we may not be able to identify whether the differences are statistically significant. Thus, regression exercises according to the cloglog models, discussed in the previous section, is carried out.

Main regression findings

We report our estimations in Table 2. We first run a basic model (1), which assumes the PH assumption and designed to test hypotheses H1a, H2, H3a, and H4a. We refer to this model as the *base* model and report the result in the first column in Table 2. The 8 piecewise intercepts, representing baseline hazard rates, are all statistically significant. The baseline hazard rates start roughly at the level of 1.16% when new firms are aged 1 year and rise steadily towards the top-most, about 26% (at age 6). Thereafter, the hazard rates decline quickly to 2.89% at age 8. In other words, the risk for exit is intensified year by year until the sixth year, and drops afterwards. Consequently, in our data, firms surviving beyond six years face rather low exit risks, and our result is consistent to previous studies which finds clear evidence of positive duration dependence followed by negative duration dependence (Holmes et al., 2010).

*** Insert Table 2 about here ***

In the BASE model, all slopes are significant (at 1%, except for inflation which is significant at 5%). The slopes of *size* and *industry* are less than 1, indicating that hazard rates of large start-ups would be 87% (1-0.13) of the one for small start-ups. This result provides a positive evidence for hypothesis H1a, and is consistent with previous findings (Geroski et al., 2010; Holmes et al., 2010). Furthermore, the hazard rates for manufacturing firms is only 35% of that of firms starting in the services/trades sectors; thus our result is for the hypothesis H2 and confirms the finding in several past studies, e.g., Harhoff et al. (1998); Phillips and Kirchhoff (1989). The slope of *state-of-economy* is 1.70, indicating that firms established during recessions would have an increased hazard rate by 70% in comparison to firms established in booms. This also confirms the hypothesis H4a. At the same time, we note that this is in line with the findings by, e.g., Fotopolous and Lori (2000) and Huynh et al. (2012). Notice that all changes discussed above are irrelevant to firm age. This implies that hazard functions would be proportional.

The *base* model reported in Table 2 also reveals how current conditions would affect the hazard function. The slope coefficient of *inflation* is 1.009 (significant at 5%). This means that a one-percentage point increase in the rate of inflation is likely to increase the hazards by 0.9%; a very marginal rise. The coefficients for both *growth*, 0.95, and (interest) *rate*, 0.97, on the other hand, are smaller than 1, indicating that the baseline hazard function would be shifted downwards. Quantitatively, one percentage point increase in (GDP) *growth* would make the hazard rates 5% smaller; analogously, one percentage point rise in (interest) *rate* would cause a reduction of the hazard rates by 3%. This result is interesting, since there is a common conception that credit conditions would be significant for young firms: the higher the interest rate, the tougher the conditions; Guariglia et al. (2016) identify such a significant effect. However, our result indicates the opposite. How can this be interpreted? It might be reasonable to consider that, in the long run, the nominal interest rate usually reflects the state of the economy: high interest rates are often accompanied with strong aggregate demand (e.g., Parker, 2009). Thus, one cautious interpretation is that our results give evidence for that *aggregate demand* is a key determinant for performance. According to hypothesis H3a, GDP growth and the interest rate can be regarded as favorable macroeconomic conditions, since increases in the two variables would make the probabilities of exit to fall. On the other hand, high inflation seems to make the probability of exit to increase.

Firm age-effects and persistency

Remaining columns in Table 2 report estimations based on two types of grouping criteria in line of the strata model (3), which enables to investigate persistency of the impacts discussed above. The model named *size* sets up the stratum according to the initial size of firms, *s=size*. According to (3), the baseline hazard rates are estimated. Now the coefficients $\exp(age_i)$ correspond to, α_t, the age-effects for small start-ups. As the *base* model, the baseline hazard function has an inverted U-shape: the hazard rates reach the maximum at the age of 6. All coefficients of $size * age_i$ in Table 2 are all (except age 8) significantly smaller than 1, indicating the larger start-ups would persistently (at all ages) reduce the probabilities of exit. This provides positive evidence for hypothesis H1b. The actual hazard rates for large start-ups can be obtained by $\exp(size * age_i) * \exp(age_i)$: 0.0067, 0.0170, 0.0216, 0.0175, 0.0225, 0.0173, and 0.0181, respectively. It is not a smooth inverted U-shape, but it could be imagined that the hazard function for large start-ups is located below the one for small start-ups.

Next, we set stratum *s=state-of-economy* in (3), and denote the model as *state-of-economy.* This exercise can be used for testing hypothesis H4b. The hazard rates for firms established during booms (*se*=0) are reported as $\exp(age_i)$, and it is not a smoothed inverted U-shape. The estimates for $\exp(state-of-economy * age_i)$ are not consistently smaller than 1 (at age 1 and age 5). This means that firms established during recessions would, generally, have higher hazard rates, except at the ages of 1 and 5. Furthermore note that, at the age of 8, the coefficient is very large, but insignificant. This is because that no firms established during booms exited at the age 8 in our dataset. The baseline hazard rates for firms established in recessions can be calculated through $\exp(state-of-economy * age_i) * \exp(age_i)$: 0.0479, 0.0652, 0.1038, 0.1120, 0.1090, 0.3309, 0.1788, 0.000. The hazard functions have similar shapes but, clearly, they are not parallel. Consequently, we have a mixed testing result for hypothesis H4b: impacts due to the initial state of economy are not perfectly persistent.

Table 3 turns to changes in the hazard rates due to time-varying covariates at each firm age. This is designed to test hypothesis H3b. Note that we only consider inflation and the interest rate. The reason is that once we allow either *inflation* or *rate* to influence the probabilities at year-by-year basis, *growth* becomes insignificant. It seems that the two are better proxies for macroeconomic conditions. In the model *Inflation,* inflation would in general not increase the hazard significantly (except at the age of 5, during which the hazard rate will be increased by 9% when inflation rises by one percentage point). To begin with, this result is somehow different from the corresponding one in the *base* model, where high inflation would increase the probabilities of exit. Here, it seems that when inflation is allowed to influence the hazard rates according to firm age, it replaces the roles of GDP growth and the nominal interest rate, respectively, to represent aggregate demand. Interestingly, in this model the interest rate now would represent credit costs and actually increase the hazard rates proportionally. In the model in which *rate* is allowed to influence hazard rate at yearly basis, *inflation* still reduces the hazard rates. The variable (interest) *rate* makes, at most ages, the hazard rates to increase or not to change. A summary of the analyses with time-varying covariates (hypothesis H3b) gives the following: when we relax the PH assumption with time-varying covariates, inflation in general persistently reduces the hazard rates and the interest rate increases the probabilities of exit. Thus, inflation and the interest rate can be regarded to represent aggregate demand (a favorable macroeconomic condition) and credit conditions (an unfavorable macroeconomic condition), respectively. Furthermore, different from other results (Disney et al., 2003), we find no trend – firms became neither more nor less sensitive to exogenous variation.

*** Insert Table 3 about here ***

Grouping according to founding conditions

The final exercise is to estimate (4). Table 4 reports estimations when *s=size* and *state-of-economy*, respectively. The model *size_s* corresponds to *s=size*. The coefficients of *industry*, *state-of-economy*, *inflation*, *growth*, and *rate* provide information of hazard ratios for small start-ups. For instance, exp(β_{ind}) is 0.62, implying that small manufacturing firms have a 38% lower risk than small start-ups in other sectors. This result confirms that hypothesis H2 is valid for the group of small start-ups and therefore confirms the first half of hypothesis H7. What is new here is the coefficient of exp(β^*_{ind}), which is denoted by *size*industry* in Table 4. The value is 1.23 and highly significant. A significant value indicates that the hazard ratio would be significantly different in the group of large start-ups; since we know the hazard in the small start-up group, 0.65, we may calculate the hazard ratio of large manufacturing firms against the other large firms by 1.23*0.65= 0.80; i.e., large manufacturing firms reduce the risk of failure of other large firms by only 20%. Hypothesis H7 predicts that the hazard ratio could be further reduced in the group of larger start-ups. However, our results cannot confirm this. In sum, manufacturing firms would have lower probabilities of exit. But the reduction of probabilities is less for larger firms in comparison with smaller firms (20% reduction vs. 38%).

In the same model, exp(β_{se}) = 1.87 confirms that hypothesis H4a is valid for small start-ups. The probabilities of exit are 87% higher for small start-ups established during recessions than that established in booms. The coefficient of *size*state-of-economy*, exp(β^*_{se}), is 0.30 and highly significant. This implies the hazard ratio would be different in the group of large start-ups. Again, the hazard ratio in the group of large start-ups is given by 1.87*0.30 = 0.56; thus, the probabilities of exit for larger firms established during recessions would be 44% smaller than that (large start-ups) established during economic booms. In other words, firms established during recessions and during booms would change the hazard ratios in different directions, according to their start-up size. This result is different to what predicted in hypothesis H6. However, this result is understandable: larger initial size would reduce the probabilities for exit; on the other hand, entry during a recession would increase the probabilities for exit. The *net impact* due to being larger firms established in recession is determined by these two competing effects. Our result indicate that the effect from start-up size dominates.

*** Insert Table 4 about here ***

The coefficients of the time varying covariates share the same interpretation: increasing *inflation* by one percentage point would increase the probabilities of exit for small start-ups by 1.2%. At the same time, a one percentage point increase in *growth* and in (interest) *rate* would reduce the risk for small start-ups by 5% and 2%, respectively. The coefficient of *size*output* is not significant, meaning that impact due to output in the group of large start-ups would be indifferent to that in the group of small start-ups. The coefficients of *size*inflation* and *size*rate* are significant. Thus impacts would be different. Impacts from *inflation* on large start-ups are given by 1.012*0.97=0.98: a one percentage point increase in the rate of inflation reduces the probabilities of exit by 2%. Hence, the rate of inflation seems to play different roles in the two groups: an unfavorable macroeconomic condition for small entrants, but a favorable condition for larger entrants. This might be because larger firms have greater resources for meeting price changes. Furthermore, for large start-ups, a one percentage point increase in (the interest) *rate* would reduce the probabilities by 26% (=1-0.98*0.92). *Rate* represents aggregate demand here; both small but particularly large entrants would benefit from increases in *rate*. In summary, we have a mixed result (mainly related to inflation) for hypothesis H9.

The second column in Table 4 studies the *state-of-economy_s* model, when *s=state-of-economy* – that is, when grouping firms according to initial macro founding conditions (expansion or recession) corresponding to hypotheses, H5 (the size effect), H8 (the industry effect), and H10 (macroeconomic conditions). Starting with H5, the hazard for large start-ups that are established during booms, relative to small start-ups, is given by $\exp(\beta_{size})$=0.21. It is significant and indicates that the hazard rate would be reduced by 79%. That hazard ratio would be *further* reduced for firms that are founded during recessions: 0.09 (=0.21*0.44). This means that large start-ups would have their probabilities reduced by 91%, compared to small entrants established during recessions. Hence, the size effect would be larger in the group of firms established in recessions. This evidence argues against hypothesis H5, which expects that the size effect would be smaller during recessions.

As for hypothesis H8, the hazard ratio of manufacturing firms, relative to other firms, established during booms is given by $\exp(\beta_{ind})$=0.31. The coefficient is significant and indicates that manufacturing firms entering during booms would have significantly reduced hazard rates (69%) compared to other firms established under the same initial macro conditions: $\exp(\beta_{se})$* $\exp(\beta^*_{ind})$=0.31*3.17=0.98. This reduction would only be 2% for firms established during recessions. This result is consistent with hypothesis H8, which predicts that industry effects would be smaller during recessions. Hypothesis H10 states that firms entering during recessions should have higher exit probabilities. However, our results are mixed: inflation would make firms established during recessions more likely to exit, while (GDP) growth and (the interest) rate would make firms entering during recession less likely to exit. In detail, the hazard rate would be increased by 17% (1.17=0.99*1.18) when inflation rises with one percentage point. The hazard would instead be reduced by 17% (0.83=0.996*0.83) when the (interest) rate rises by one percentage point. Finally, a one percentage point increase in growth reduces the hazard rate by 5% for firms established during booms and by 15% (0.85=0.95*0.89) for firms established during recessions. Hypothesis H10 thus receives some, yet weak, support.

Conclusions and discussion

A substantial number of studies demonstrate that several factors at multiple levels affect post-entry performance: the liabilities of age and size; industry; founding conditions, as well as variations in the macroeconomic environment after entry. Furthermore, several other factors that have not been investigated here (or possible to study) in the present article are highly probable to influence organizational performance, such as individual-oriented factors. Our study has attempted to identify evidence on how some initial and time-varying conditions would firm survival in Sweden, using a multiple cohort approach and employing the semi-parametric complementary log-log (cloglog) model to estimate hazard rates. As far as we know, this is the first time the model is applied for analyses of survival amongst multiple entry cohorts of firms. One substantial advantage in using the cloglog model is the ability to control for heterogeneity, which is particularly important in a cohort study. As other discrete hazard models, the cloglog model is subjected to the proportional hazards (PH) assumption – here, however, we adopted two approaches for relaxing the PH assumption, studying possible differences in (new-firm) survival of 37,000 Swedish firms across different groups and over time, respectively. Our study has thus moved further to investigate two hitherto less covered issues: first, the impacts from factors *at each firm age*, and secondly, to allow for non-proportionality *across various groups*.

The reason for this methodological approach – including our use of non-overlapping entry cohorts, aiming at distinctly separating founding conditions and time-varying conditions after entry – has been that past theory and research in the wide literature on organizational performance has discussed and elaborated on the dynamic relationship(s) between factors at several levels and between prevailing conditions at founding and current macro conditions (c.f., Barnett et al., 2003; Carroll and Delacroix, 1982; Disney et al., 2010; Geroski et al., 2010, Huyn et al., 2012;

Wagner, 2010a). One important conclusion from past studies is that may be non-proportional hazards at hand.

Thus, in our study, we set up five hypotheses as well as five additional hypotheses to test a set of propositions in line with particularly recent studies that have asked if founding and contemporaneous conditions would affect new-firm performance (e.g., Disney et al., 2010; Geroski et al., 2010, Huyn et al., 2012). Generally, several of our hypotheses could be confirmed in our article, and several of the article's results are largely consistent with previous findings on business performance in other economies – specifically, firm age plays a crucial role for survival, for which we could observe a positive duration dependence followed by negative duration dependence (supporting the view of a 'liability of adolenscence;' Carroll and Khessina, 2006). Furthermore, our results show that a larger start-up size, establishing in the manufacturing sector, entry during booms, and favorable macroeconomic current conditions would, in general, push down the firms' hazard rates. Evidently, these relationships appear to valid across both time and place: studies on several different economies and time-periods validate these assumptions.

However, and more importantly, our results also provide new insights. In particular, an impact from initial macro (and firm-level) conditions could be confirmed: entry during a recession would increase the probability of exit, and this effect was almost persistent over time. By relaxing the PH assumption we further confirmed this effect for the group of small entrants – i.e., a firm-level founding condition – that were founded during recessions. In the group of large entrants, we could observe two competing impacts: lower probabilities due to the size effect, and higher probabilities due to the effect from unfavorable initial macro conditions at entry. Our result therefore show that entry during recessions would have totally different impacts on probabilities of exit: increasing probabilities for small firms but reducing probabilities for large firms. As far as we are aware, this is a novel result, obtained by partially relaxing the PH assumption.

In our article, we also checked for impacts from current (varying) macroeconomic conditions. With rising inflation, probabilities of exit would generally increase but not persistently. In sum, inflation proved to be harmful for small firm but not for larger entrants. GDP growth is a traditional proxy for aggregate demand. However, the impact from GDP growth became insignificant, since the PH assumption was relaxed for either inflation or the interest rate; thus, we decided to skip the tests for GDP growth persistency in our analysis. On the one hand, the interest rate represents credit costs. On the other hand, the interest rate also reflects aggregate demand: when demand is high, the interest rate level usually rises – our study showed that higher interest rate would reduce the probabilities of exit. However, when relaxing the PH assumption, we found other patterns: here, the interest rate represent credit costs and increasing hazards. In essence, our results indicate a dynamic effect from the relationship between initial conditions at the firm-, industry- and macro-analytical levels. Our results are in several extents consistent with particular Geroski et al.'s (2010) findings (see, however, also Audretsch et al. 2000; Carroll and Delacroix 1982; Disney et al. 2003; Geroski et al. 2010; Huyn et al. 2010). In our study, a larger start-up size had not only a *general* effect on hazard; it also had a lasting – *persisting* – effect. Similarly, firms entering in a period of economic expansion and booms had, in our study, consistently lower hazards; furthermore, current conditions were also significantly influential – period of increasing aggregate demand lowered the hazard.

Overall, this implies that both founding and contemporaneous conditions are important to include if we should understand how and why new firms survive. In particular, and by relaxing assumptions of proportionality and by allowing for different impacts across different firm ages and groups, we could formally and statistically show that there is a dynamic difference in survival between, as an example, a small entrant during a boom and a large entrant in a recession. As also found by Geroski et al. (2010), we cannot conclude that firms that enter in a 'trial-by-fire' have higher survival rates in the longer term. In that respect, favorable macro conditions will, generally, lower the hazard for firms. Studies in both IO (Disney et al., 2003; Geroski et al., 2010; Huyn et al., 2012) and OE (e.g., Hannan and Freeman, 1988; Swaminathan, 1996) maintain that the current characteristics of any entry cohort would be revealed by the (historical) conditions that prevailed at entry. Our article shows that so would be the case: after taking current and time-varying conditions into account, founding conditions will furthermore add substantially to explain the causes of variation new-firm survival. When relaxing the assumption(s) of proportionality, there is clear evidence for the assumption that firms entering under particular conditions will have very different hazards compared to those that enter under other conditions. More importantly, factors at the firm- and industry-levels would mediate these effects.

Environmental variation has often remained absent in much past empirical research, or has often been problematical to operationalize; furthermore, initial founding conditions have been viewed as crucial for explaining organizational performance over time in several research traditions. In this effort, it is clear that there is an advantage using prospective longitudinal data and non-overlapping entry cohorts. It is evident that our measurements and definitions of phenomena such as 'founding macroeconomic conditions' or firm entry size could be substantially refined; however, with this article we have demonstrated the possibility for temporal analyses on the influence from both initial and post-entry conditions. Our approach and findings thus show one fruitful way for researchers to address and to further develop methods for analyses of this significant research problem.

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Figure 1. Survival estimates.

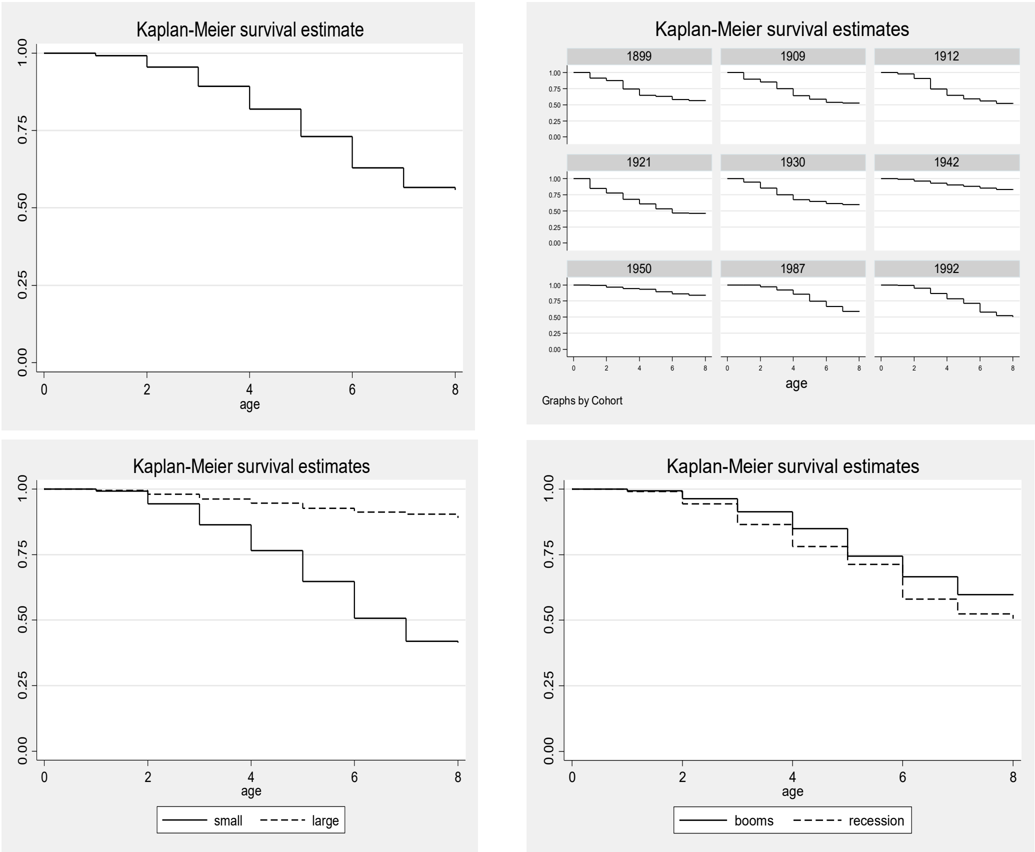

Table 1. Variables.

Dependent variable	Survival (*survival*). Binary (0 = survival; 1 = exit). The bankruptcy has been the most obvious and dramatic way of terminating a business, and this form of closure has received most research attention. Our knowledge of how typical or atypical bankruptcies have been, as a way of terminating businesses, historically is still scarce. If other ways of terminating business are not controlled for, it is impossible to detect underlying, hidden, structural changes in the pattern of firm exits (Gratzer, 2000). We consider *total* business mortality and analyze both bankrutpcies, liquidations (voluntary and involuntary), mergers and de-registrations.
Independent variables	*Firm age* (*age*). 1-8 years. Time-varying. *Firm size* (*size*). Start-up size individual firms firm. Binary: small (0)/large (1). Due to differences in the source materials, the 1899-1950 cohorts use the size of the initial stock capital (in Swedish *Kronor*). The 1987-1992 cohorts record the initial number of employees, grouped into nine different size-classes (0 to 500+ employees, according to Statistics Sweden's Business Database classification. In all cohorts, most entrants are small, typically starting with the minimum required stock capital (5,000 Kronor), or with 0 or 1-4 employees; very few firms enter with a larger size. From the size distributions, the largest 1/3 of firms in each cohort are coded as as 'large' firms (1) and the remaining 2/3 are coded 'small' (0).* *Industry sector* (*industry*). Binary: services/trade (0)/manufacturing (1). Entrants in the 1899-1950 cohorts have been classified as being in either manufacturing, trade or service sectors (no other classifications or codes have been available in the historical records; c.f., Gratzer, 1996). Detailed industry codes (SNI) are available for the 1987-1992 cohort; however we use the one-digit sector codes (manufacturing, trade or service sectors). *Macro conditions at founding* (*state-of-economy*). Binary: expansion (1); recession (0) (Edvinsson, 2005a).** *Inflation* (*inflation*). Time-varying. Annual inflation rate in Sweden (percent) (Edvinsson, Jacobson and Waldenström, 2010). *GDP growth* (*growth*). Time-varying. Annual GDP growth in Sweden (percent); Edvinsson (2005b). *Interest rate* (*rate*). Time-varying. Annual nominal interest rate in Sweden (Edvinsson, Jacobson and Waldenström, 2010).

* Admittedly, this is a crude way of measuring entry size. Furthermore, we are aware of that the variable has different definitions in our dataset. However, earlier research has found that different size indicators often are highly correlated; see e.g. Agarwal (1979); Box (2005).
** See Edvinsson's (2005a) classification of macroeconomic expansions and recessions in Sweden, 1842-2001. For a discussion on business cycles and economic growth, see e.g. Edvinsson (2005b).

Table 2. Age-effects across various sizes and booms/recessions.

	base	*size*	*state-of-economy*
age 1	0.0116***	0.0097***	0.0066***
age 2	0.0610***	0.0584***	0.0329***
age 3	0.1062***	0.1051***	0.0564***
age 4	0.1285***	0.1322***	0.0927***
age 5	0.1741***	0.1787***	0.1754***
age 6	0.2626***	0.2815***	0.0626***
age 7	0.2167***	0.2365***	0.1545***
age 8	0.0289***	0.0148***	0.0000
inflation	1.0090**	1.0086**	0.8995***
growth	0.9517***	0.9531***	0.9725***
rate	0.9734***	0.9716***	1.0863***
size	0.1303***		0.1287***
industry	0.6488***	0.6477***	0.6532***
state-of-economy	1.7019***	1.6794***	
*size***age* 1		0.6886***	
*size***age* 2		0.2907***	
*size***age* 3		0.2055***	
*size***age* 4		0.1326***	
*size***age* 5		0.1257***	
*size***age* 6		0.0616***	
*size***age* 7		0.0427***	
*size***age* 8		1.2229*	
*state-of-economy***age* 1			0.7264**
*state-of-economy***age* 2			1.9803***
*state-of-economy***age* 3			1.8412***
*state-of-economy***age* 4			1.2080***
*state-of-economy***age* 5			0.6213***
*state-of-economy***age* 6			5.2864***
*state-of-economy***age* 7			1.1573***
*state-of-economy***age* 8			1.99e+08
AIC	102784	102004	101486
SIC	102929	102223	101705
log likelihood	-51378	-50981	-50722

Legend: * $p<0.1$; ** $p<0.05$; *** $p<0.01$.

Table 3. Age-effects of changes in inflation and interest rate.

	inflation	*interest rate*
age 1	0.0074***	0.0508***
age 2	0.0419***	0.0485***
age 3	0.0736***	0.0575***
age 4	0.0716***	0.0318***
age 5	0.0678***	0.0165***
age 6	0.1994***	0.1906 ***
age 7	0.1136***	0. 0490***
age 8	0.2622***	0.9312
size	0.1288***	0.1294***
industry	0.6475***	0.6527***
state-of-economy	1.7557***	1.8156***
inflation		0.9176***
growth	1.0168	1.0226*
rate	1.0297***	
*inflation*age* 1	0.8487***	
*inflation*age* 2	0.9348***	
*inflation*age* 3	0.9285***	
*inflation*age* 4	0.9998	
*inflation*age* 5	1.0874***	
*inflation*age* 6	0.7968***	
*inflation*age* 7	1.0119*	
*inflation*age* 8	0.0198***	
*rate*age* 1		0.8590***
*rate*age* 2		1.0173
*rate*age* 3		1.0600***
*rate*age* 4		1.1626***
*rate*age* 5		1.3253***
*rate*age* 6		1.0102
*rate*age* 7		1.2085***
*rate*age* 8		0.3574***
AIC	101335	101364
SIC	101573	101582
log likelihood	-50657	-50660

Legend: * p<0.1; ** p<0.05; *** p<0.01.

Table 4. Relative hazard ratios.

	size_s	*state-of-economy_s*
age 1	0.0102***	0.0137***
age 2	0.0542***	0.0512***
age 3	0.0948***	0.0954***
age 4	0.1143***	0.1131***
age 5	0.1558***	0.1579***
age 6	0.2361***	0.1977***
age 7	0.1944***	0.1929***
age 8	0.0257***	0.0218***
size	0.5364***	0.2061***
industry	0.6239***	0.3129***
state-of-economy	1.8731***	6.4225***
inflation	1.0122***	0.9945
growth	0.9530***	0.9545***
rate	0.9795***	0.9955
*size*industry*	1.2291***	
*size*state-of-economy*	0.2981***	0.4365***
*size*inflation*	0.9729**	
*size*growth*	0.9791	
*size*rate*	0.9199***	
*state-of-economy*industry*		3.1664***
*state-of-economy*inflation*		1.1804***
*state-of-economy*growth*		0.8919***
*state-of-economy*interest-rate*		0.8262***
AIC	102580	102106
SIC	102778	102304
log likelihood	-51271	-51034

Legend: * p<0.1; ** p<0.05; *** p<0.01.