Stockholm School of Economics Course 5350: Master's Thesis in Economics

Growth Patterns of Start-Up Firms - A Cohort Study with a Quantile Regression Approach

January 7th, 2014

Abstract

Using panel data for the cohort of Swedish limited companies established in 1997, this study analyzes the patterns and distributions of the firms' growth rates. After characterizing the growth patterns, we test the hypothesis that firm growth is essentially stochastic; a theory originating from Gibrat (1931). The firms with the highest cumulative growth rates for the examined time frame experienced the bulk of this growth in the years immediately following their inception. The same period was characterized by the highest hazard rate in terms of firm closure. Contrary to the notion of normally distributed growth rates, this study finds a skewed and fat-tailed distribution. The Laplace distribution proposed by previous studies constitutes a better fit, although the observed skewness appears to be even more extreme. After generating simulated data to alleviate bias constituted by panel attrition, a quantile regression approach is used to estimate whether causal links can be found. However, growth rates are shown to lack serial correlation, with estimates of previously proposed determinants of growth being statistically and/or economically insignificant. Furthermore, we provide robust evidence of low explanatory power from the model, which leads us to the conclusion that firm growth remains a largely random and complex process.

JEL Codes	C16, D20, L11, L25, M13
Keywords	Firm Growth Rates, Monte Carlo Simulation, Quantile Regression

Author	Sebastian Krakowski*
Supervisor	Jan Eklöf, Associate Professor
Discussant	Arne Hosemann
Examiner	Paul S. Segerstrom, Professor
Presentation	January 14th, 2014 at the Stockholm School of Economics Sveavägen 65, 113 50 Stockholm, Sweden

* 21940@student.hhs.se

Acknowledgements

This thesis was written with considerable support from the Swedish Agency for Growth Policy Analysis ("Myndigheten för tillväxtpolitiska utvärderingar och analyser", or "Tillväxtanalys"). In particular, I am indebted to Lars Bager-Sjögren for his kind and inspiring guidance.

I would furthermore like to extend my sincerest gratitude to Prof. Jan Eklöf for providing me with professional supervision and insightful comments. I also owe many thanks to Prof. Örjan Sjöberg and Daniel Halvarsson for very knowledgeable suggestions and feedback.

I additionally want to thank Dr. Annika Steiber and Gustav Radell for their valuable insights. Prof. Andrew D. Henderson, Lars-Gunnar Larsson and Göran Andersson were also kind enough to share their thoughts on the subject.

Finally, I am very appreciative of the support I received from Jan Andersson, Dr. Andreas Poldahl, Dr. Fredrik Andersson, Martin Andersson, Dr. Lise Aaboen and Prof. Hans Lööf.

Contents

1 Introduction

1.1 Background

As Amaral, Buldyrev, Havlin, Maass, et al. (1997) point out, interest in a given subject is oftentimes twofold, namely practical as well as theoretical, and that in this respect firm growth rates and their statistical distributions are no exception. From a practical standpoint, estimating a given firm's likely growth path is advantageous in order to maximize the returns from investing in that company. Analysis of financial markets has questioned the "dogma" that stock prices follow a random walk and sought to develop models that foresee market development, or at least reduce the uncertainty in such estimates (e.g. Lévy, Lévy, & Solomon, 1994; Mandelbrot, 1965; Samuelson, 2007). For instance, when analyzing price changes in security and commodity markets, Mandelbrot (1963) stated that the empirical distributions were too "peaked" to be considered random, and instead called for a "radically new approach" in financial modeling. In short, gaining explanatory power with respect to company growth patterns is seen as worthwhile in order to make more informed financial decisions (Coad & Hölzl, 2010).

These practical issues also extend to public policy. In this context, optimal allocation of public resources aimed at promoting innovation, job creation and growth are oftentimes the focus of analysis (Coad & Hölzl, 2010; Hyytinen & Toivanen, 2005). The primary objective of these kinds of programs are mostly not mere profit maximization, but in many cases, public actors are faced with similar kinds of challenges as those of their private-sector counterparts (e.g. venture capitalists) (Lerner, 1999). Insight into firm growth can thus also be seen as essential in promoting small enterprises, particularly since they are seen as drivers of economic growth and regional development by way of investment and innovation (Erlingsson, Alfarano, Raberto, & Stefánsson, 2012; Henrekson & Johansson, 2008b). In particular, small and fast-growing firms, often referred to as "high-growth firms" ("HGFs") or "Gazelles",[1] are seen as particularly important, as evidence suggests that they account for a disproportionally large share of new job creation (Birch, 1979; Daunfeldt & Halvarsson, 2012; Henrekson & Johansson, 2008a). Since the European Commission has implemented a large number of programs aimed at promoting the establishment and survival of HGFs and Gazelles (Hölzl & Friesenbichler, 2006), the issue of optimal resource allocation and program design is both international and contemporary in its nature.

From a theoretical viewpoint, on the other hand, different theories of the firm convey respective frameworks on why firms exist, what their objectives are and how these are

[1] The definition commonly used for HGFs and Gazelles is a firm achieving a given growth rate (e.g. 20%) for a certain number of consecutive years, but this criteria has been criticized as being inadequate. This topic is beyond the scope of this study, but the interested reader is referred to (Daunfeldt & Halvarsson, 2012) for a discussion on the intricacies of the matter.

pursued. Such theories include perspectives such as the Transactions Cost Theory, the Evolutionary Theory and the Neoclassical Theory, among others (see Kantarelis, 2007). By incorporating insights from a dynamic analysis that follows the same entities over time, findings may enrich these theories and contribute to work on corporate learning processes, as well as R&D and investments in capital (see Amaral, Buldyrev, Havlin, Maass, et al., 1997).

In summation, firm growth studies have generated interest from practitioners and theoreticians alike, both from the perspectives of business administration and public policy. Characterizing high-performing firms' growth rates in order to get a better grasp of their nature and behavior as well as identifying factors that contribute to their emergence are likely to make considerable contributions to all the aforementioned fields. Before moving onto the operationalization of this subject matter, we will outline the findings of previous research.

1.2 Previous Research

One of the earliest empirical studies on firm growth distributions is that of Ashton (1926), where he concludes that in their growth, the textile businesses in the Oldham District of Manchester, United Kingdom "obey no one law". In his seminal work on the subject, French economist Robert Gibrat formulated the "Law of Proportional Effect", later referred to as "Gibrat's Law", which states that a given firm's size and growth rate are proportional (Gibrat, 1931; Sutton, 1997). This implies that firm growth rates follow a log-normal, or Gaussian, distribution without serial correlation. Expressed differently, this means that a firm's ensuing growth rate is independent of its antecedent size and is thus, in effect, stochastic. A straightforward derivation of the conclusion is borrowed from Sutton (1997) and restated below.

Defining x_t as the size of a firm at time t, and the independent random variable ϵ as the proportional growth rate between times $(t-1)$ and t, we have

$$x_t - x_{t-1} = \epsilon_t \cdot x_{t-1} \tag{1}$$

where

$$x_t = (1+\epsilon_t) \cdot x_{t-1} = x_0 \cdot (1+\epsilon_1)(1+\epsilon_2)\dots(1+\epsilon_t) \tag{2}$$

Looking at a sufficiently short time period, ϵ_t can be considered small enough to justify $log(1 + \epsilon_t) \simeq \epsilon_t$. By logarithmizing Equation (2), we consequently arrive at:

$$log(x_t) \simeq log(x_0) + \epsilon_1 + \epsilon_2 + \ldots + \epsilon_t \quad (3)$$

Hereby, the independently distributed variates ϵ_t have the mean m and variance σ^2, and the letting t approach infinity ($t \to \infty$), $log(x_0)$ will be small as compared to $log(x_t)$. Finally, this leads to the conclusion that $log(x_t)$ approximatively follows a normal distribution, with the mean $m \cdot t$ and variance $\sigma^2 \cdot t$.

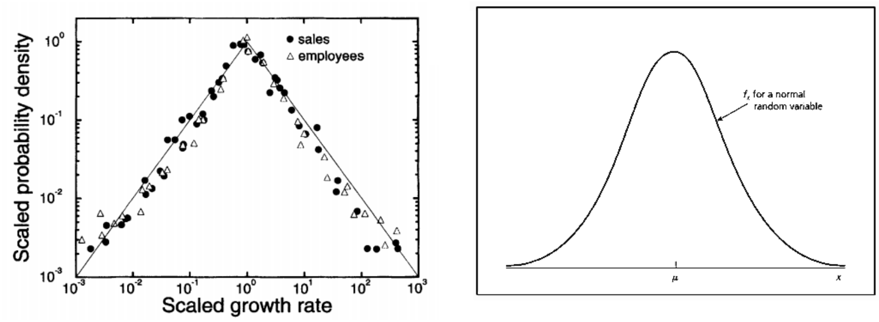
The framework has been applied to analyze not only the sizes of firms, but of cities as well as countries (González-Val & Sanso-Navarro, 2008). Since its formulation, however, empirical testing has only managed to reach somewhat ambiguous results regarding the validity of Gibrat's Law, and whether firm growth rates are in deed random (Audretsch, Klomp, & Thurik, 2002). While early work has tended to confirm the law, later studies have generally only found support for it among large companies, with smaller ones exhibiting a negative relationship between size and growth, i.e. smaller (and particularly younger) firms generally growing faster than larger ones (Lotti, Santarelli, & Vivarelli, 2007).

Influential work from the field of econophysics[2] by Stanley et al. (1996)[3] found the growth rates of U.S. manufacturing firms to follow a "tent-shaped" distribution with significantly fatter tails than those of the Gaussian distribution. For reference, the empirical "tent-shape" is juxtapositioned with a stylized Gaussian distribution in Figure 1.

[2] "Econophysics" has been defined as "the activities of physicists who are working on economics problems to test a variety of new conceptual approaches deriving from the physical sciences". Often, this work relates to empirical problems involving non-Gaussian distributions, commonly referred to as distributions with "fat tails" (Mantegna & Stanley, 2000; Rosser, 2008).

[3] See also (Amaral, Buldyrev, Havlin, Leschhorn, et al., 1997), (Buldyrev et al., 1997) and (Amaral, Buldyrev, Havlin, Maass, et al., 1997).

Figure 1 **Empirical Tent-Shaped Distribution Alongside a Stylized Gaussian Distribution**



Graphs taken from Stanley et al. (1996) (empirical “tent-shaped” distribution, left) and Wooldridge (2009) (Gaussian/normal distribution, right).

Later empirical studies have largely corroborated this finding, both across countries (Bottazzi, Coad, Jacoby, and Secchi (2011) and Bottazzi, Cefis, Dosi, and Secchi (2003) for French and Italian manufacturing companies), international industries (Bottazzi and Secchi (2003b) for pharmaceutical companies), and different levels of aggregation (Bottazzi and Secchi (2003a) for aggregated and disaggregated data). The findings have also been replicated for Icelandic (Erlingsson, Alfarano, Raberto, & Stefánsson, 2012), Danish (Reichstein & Jensen, 2005) and U.K. (Dunne & Hughes, 1994) firms from varying industries. Likewise, Heshmati (2001) rejects Gibrat’s Law when analyzing Swedish micro- and small-sized firms. Daunfeldt and Elert (2013) come to the same conclusion for Swedish firms, but find that industry-specific aspects play a role in whether the law holds or not.

Rather than a Gaussian distribution, empirical findings have been described as following a Laplace distribution (also called a “double-exponential” or “symmetric exponential” distribution), a conclusion characterized as “remarkably robust” (Coad, 2009). Taking a more general stance, Bottazzi, Cefis, and Dosi (2002) introduced models relying on the Subbotin family of statistical distributions, of which the Gaussian and Laplace distributions are two special cases (which are attained by adjusting the shape parameter that changes the “fatness” of the tails). Lastly on the note of distribution modeling, Fu et al. (2005) have suggested that another refinement is necessary. Specifically, small firms follow a Pareto function rather than a Laplace distribution, since the tails are even fatter than those of the latter distribution. Other generalizations of the Laplace distribution, such as the Linnik distribution, have also been suggested Halvarsson (2013). The Laplace distribution only describes somewhat larger companies’ growth distributions accurately, as the tails continually get smaller and approach the Gaussian distribution as firm size increases.

If it is the case that firm growth does not follow a Gaussian distribution, but rather exhibits a skewness and has non-random characteristics that consistently generates fat tails - whereby the "outliers" constituted by fast-growing firms in the right tail are of particular interest (Gladwell, 2008) - there should be patterns visible in the growth rates. In deed, researchers have sought to establish regularities among the previously mentioned HGFs and Gazelles. Yet, evidence regarding these growth patterns is inconclusive at best. Most firms do not grow at all and growth rates are notoriously volatile; a given firm that displays high growth in one period is unlikely to do so in the next one (Bottazzi, Coad, Jacoby, & Secchi, 2011). Further research is said to be needed with respect to mapping the characteristics of high-performing firms that are both rare and desirable from a public policy perspective (e.g. Daunfeldt & Halvarsson, 2012).

Along the same lines, the supposed non-random nature of growth begs the question if there are significant determinants of firm growth. Previous literature has suggested a number of factors that positively affect firm growth rates. These include innovation (Coad, 2009), R&D and technological know-how (e.g. Geroski, 1999; Nelson & Winter, 1982) and the characteristics of firms' employees, e.g. the level of human capital (Koch, Späth, & Strotmann, 2013; Minniti, Zacharakis, Spinelli, Rice, & Habbershon, 2006), among others. Geographic expansion and industry-specific characteristics are further examples of such proposed determinants (Coad, 2009; Koch, Späth, & Strotmann, 1998). Yet, the notion of "determinants of growth" is irreconcilable with Gibrat's Law, i.e. firm growth supposedly following a random walk. In fact, evidence that Gibrat's Law doesn't always appear to hold - in particular in the case of small and new firms - has only started emerging quite recently. This fact constitutes a "major obstacle" to empirical work (Coad, 2007b).

Some of the explanatory frameworks put forward don't entirely depart from the tradition in Industrial Organization studies to model firm growth as a phenomenon completely driven by exogenous, random shocks (Coad, 2009). Likewise, Daunfeldt and Halvarsson (2012) find that high firm growth is a one-shot and rare occurrence that does not tend to be sustained, and that public policy should rather aim at establishing good overall conditions for firms, rather than to attempt to "pick winners". The inherent randomness makes predictions difficult, and high-performing firms in one period are more likely than not to perform worse in consequent periods. In fact, the "stylized facts" regarding firm growth that Geroski (1999) recounts characterize firm growth as a path-dependent random walk constituted by unexpected, stochastic shocks. Furthermore, growth is idiosyncratic, i.e. does not correlate with any industry, economy or other firms, and are volatile without serial correlation. As Reichstein and Dahl (2004) point out, this leaves neither management nor public policy with any significant influence over firm growth; a quite spectacular conclusion with widespread ramifications for management theory and public policy if accepted, no doubt.

As firm growth research to this day has neither fully abandoned the idea of firm growth as an entirely random phenomenon, nor identified a *bona fide* set of factors that qualify as determinants of growth, more evidence is needed to advance the current state of knowledge. There is consequently a "dearth" of research looking closer at high-growth firms, and in particular, disentangling randomness and genuine performance is a "central challenge" in research (Denrell, 2004). For this purpose, Henderson, Raynor, and Ahmed (2012) call for a "greater use of robust analyses that are free of distributional assumptions", referring to the skewed nature of growth rate distributions. As Coad (2009) points out, the following quote by Starbuck (1971) may be dated, yet still proves quite true in this context:

> *"The subject of organizational growth has progressed beyond abysmal darkness. It is ready for – and badly needs – solid, systematic empirical research directed toward explicit hypotheses and utilizing sophisticated statistical methods".*

1.3 Purpose and Research Questions

This thesis discusses the distributions and dynamics of start-up firm growth rates. A large share of the early work on firm growth rates, most of it derivative of Gibrat's theory (see Gibrat, 1931), contends that firm growth is essentially a stochastic process. However, in light of recent findings that have rejected the theory (e.g. Bottazzi, Coad, Jacoby, & Secchi, 2011), the evidence is contradictory with respect to whether the notion of random growth should be entirely abandoned or not. Still today, there is no consensus on how high-performing firms emerge and the patterns they follow. Nor do scholars agree whether there are indeed consistently significant determinants to be found among firm-, industry- or country-specific factors (e.g. Coad, 2007b). This study links into this discussion by following and analyzing the growth rates of a cohort of Swedish companies. The observed growth rates among these entities are used to analyze the patterns and distributions, along with a number of firm-specific variables, in order to establish whether there are any significant causal links to be found. Reasoning similar to that of Capasso, Cefis, and Frenken (2009) and Reichstein and Dahl (2004) holds that the presence of such causality would disprove Gibrat's Law, since it would refute an "absence of any structure in growth processes". Thus, from a theoretical standpoint, the evidence from this study adds to the current state of knowledge in two ways. Firstly, it contributes to the ongoing endeavor of identifying patterns among the growth rates of firms, and in particular characterize the start-up firms that exhibit the highest growth rates. Secondly, it expands on the findings relating to the randomness of the growth rates, and in addition to analyzing the observed distribution discuss the conclusions and their implications for economic and managerial science.

More specifically, emphasis is put on the high-performing companies that manage to achieve the highest increases in net turnover each year and cumulatively over the entire 14-year period (1997 to 2011). Companies may very well grow substantially in later periods than the ones that are the objective of this study (i.e. a maximum of 14 years). Yet, the widespread belief that young high-growth firms, however defined, greatly contribute to a range of socio-economic targets was found to justify the focus on growth rates in the early stages of firm development (see Henrekson & Johansson, 2008b). These companies are oftentimes of interest from a policy perspective due to their perceived benefits with respect to the ensuing generation of employment and growth. In addition to the aforementioned theoretical contributions from this study, mapping the growth patterns and examining the role of randomness can also lead to insights relevant to effective policy measures. Empirical evidence is desirable in order to make well-informed policy decisions with respect to optimal allocation of resources aimed at promoting promising start-up firms.

Lastly, the study has a methodological aspect in that the employed method is quite recent and has not reached widespread use within the scientific community; especially not with respect to cohort studies. The use of Monte Carlo-simulation to impute values for the firms that did not survive the entire time period, paired with a robust quantile regression analysis of panel data, constitutes largely uncharted territory and hopefully provides a basis for further studies that aim to continue refining the combined use of these methodological tools.

This leads us to the following research questions in this study:

1. *How can the observed growth patterns be characterized?*
2. *Can we identify factors that have a significant causal effect on the growth rates, and if so, which are they?*

1.4 Delimitation

In approaching these research questions, we are faced with a couple of necessary limitations in scope and scale. Firstly, the focus is not to attempt to identify and test all feasible determinants of growth, which would necessitate a more comprehensive dive into innovation, investments and R&D, marketing practice, along with human resources and other related aspects. This work should rather be seen as an incremental contribution to the current state of knowledge than an attempt at constructing an exhaustive model of firm growth. Here, we are merely attempting to characterize the growth patterns of a specific population, namely the Swedish cohort of limited companies founded in 1997, in order to provide additional Swedish evidence to contrast previous international academic studies of firm growth.

Another dimension that is not included in this study is that of management theory and differing views of the firm. These frameworks differ with regard to how firms should be viewed, the role they play and what how they operate in order to fulfill their objectives. Forsgren (2013) names a few of the most dominant perspectives with the respect to multinational companies, namely the "Resource-Based View" (see Penrose, 1995), the "Organizational Capability View" (e.g. Kogut & Zander, 1993), the "Dynamic Capabilities View" (see Teece, Pisano, & Shuen, 1997) and the "Evolutionary Theory of the Firm" (see Nelson & Winter, 1982).

As has been done in earlier studies of growth distributions of firms (e.g. Coad, 2007a), we are studying organic growth, which excludes growth affiliated with corporate actions such as spin-offs, mergers and acquisitions. These phenomena are also worthy of inquiry, yet fall beyond the scope of this particular study. Here, firm growth is analyzed in order to find out whether firm- and regional-specific factors appear to be systematically affecting the growth rates; specifically those of the top decile in terms of growth. Logically, identifying causal links in terms of firm growth would repudiate Gibrat's Law, at least for the cohort being analyzed. Finding such determinants of growth, such as number of employees, affiliation, and ownership structure would then be more closely examined as a possible factor contributing to growth, which, to the author's knowledge at least, has not been done before at this scale with these methods for Swedish start-ups.

Furthermore, we are not examining the distribution of the sizes of firms in the economy, which is a nearby, yet different field of study. These studies look at how the sizes of firms, measured in turnover or employees for instance, are distributed in an economy, regardless of age (e.g. Cabral & Mata, 2001; Lotti & Santarelli, 2001). Growth rate distributions are deemed more worthwhile as an object of analysis, since the area of interest here is dynamic (growth), rather that static (size).

Lastly, we are not studying models for firm growth. In the area of firm growth studies, new insights into growth distributions are oftentimes incorporated into theoretical models that seek to closely emulate real-world distributions of firm size and/or growth rates (e.g. Rossi-Hansberg & Wright, 2006). For instance, such a study could seek to find an approximate model with a number of parameters that states the balanced growth path of firms meeting a certain criteria. This is beyond the scope of this study, yet constitutes a possibly fruitful path for further research.

2 Method

2.1 Structure of the Analysis

The analysis is divided into a descriptive and inferential part. The descriptive section is dedicated to analyzing the growth rates in different years and their distribution along the dimensions industry, ownership and growth deciles. A survival analysis is also conducted by constructing a hazard rate function for the years covered by the data. As previous studies have rather consistently established that firm growth tends to follow a Laplace rather than a log-normal distribution (e.g. Amaral, Buldyrev, Havlin, Maass, et al., 1997; Bottazzi & Secchi, 2003b), simple tests of normality and a graphic comparison with the Laplace distribution are consequently also presented. They serve as "sanity checks" to see whether the cohort follows the expected distributions, before moving onto the inferential analysis.

The latter, inferential part looks for significant causal links with regard to growth. The issue of systematic attrition[4] in the population is a caveat, whereby firms that were closed over the course of the analyzed time frame cannot be disregarded without biasing the results. Firm closure is not likely to be random, and the causes for attrition may very well be correlated with variables of interest. In other words, firm closure can have many different reasons, and one of them can very well be outstanding performance (e.g. by way of acquisition by another company), which is why the inclusion in the analysis is vital to its integrity.

2.2 Characterizing Growth Rates

Finding testable aspects of firm growth is considered a challenge, as many of the factors of interest are unobservable, such as "asset specificity" in the transaction cost view of the firm, or "core competencies" in the resource-based view (Geroski, 1999). This thesis operationalizes the aforementioned purpose by limiting the object of study to a cohort of newly established Swedish firms in 1997 along with their respective growth rates until 2011. There are a number of reasons for this approach; the first one being that including all established firms in the study alleviates the survivor bias frequently associated with simply focusing on survivors and disregarding attrition (e.g. Carpenter & Lynch, 1999; Denrell, 2003). Because all firms were based and operative in Sweden, they presumably also experienced the same macroeconomic shocks over the examined time frame (Garnsey, Stam, & Heffernan, 2006). Additionally, by employing a panel regression approach, problematic aspects due to unobservable factors are at least in

[4] "Attrition" refers to the decrease in number of observations for the firms each year, as some of the firms are closed but others are not. This causes the panel to be unbalanced, along with estimates to possibly become biased and/or inconsistent (Rudolph & Jostarndt, 2007).

part eliminated from the later regressions, thereby addressing the previously mentioned caveat in firm growth studies. The time frame is long enough to cover approximately three Kitchin business cycles (Kitchin, 1993), or more than one Juglar investment cycle (Juglar, 1862), which should decrease the risk of individual trends influencing the data too much. As 1997 was not a year marked by extreme macroeconomic shocks or investment booms in Sweden, it is assumed to be representative with respect to the number and nature of companies to be established.

Specifically, limited companies[5] are chosen, as incorporation is interpreted as a signal of intent to grow in the long run. This as opposed to the case of proprietorships, foundations or partnerships for instance, that are oftentimes established for reasons other than long-term growth aspirations. Of course, there are exceptions to this rule, and other types of organizations may well exhibit high growth, generate employment and have other desirable effects on the economy in which they operate. Conversely, limited companies may be formed for tax reasons or other purposes than to increase turnover, employment and grow beyond a certain threshold. In summation, however, the assumption of representability is deemed justified; limited companies make up approximately 22% of all companies established in Sweden in 1997, but excluding sole proprietorships, the share increases to about 51%, and it amounts to around 94% when disregarding partnerships.[6]

Growth is measured in terms of changes in turnover between years. There are of course other measures of firm growth, such as the change in number of employees or in equity, for instance. These are, however, associated with methodological issues of their own (e.g. the widespread use of temporary labor and consultants in the case of measuring by way of employees). Turnover was chosen because of an "emerging consensus" that turnover is preferable over other measures (Davidsson & Wiklund, 2013; Sexton & Kasarda, 1992).

The most commonly employed way of calculating a given firm i's growth rate at time t is using the log-differences of firm size between times t and t_{-1} (Bernard, Massari, Reyes, & Taglioni, 2013; Coad & Hölzl, 2010; Colombelli, Haned, & Le Bas, 2011). This implies that growth is defined for the years in the interval $[1998, 1999, ..., 2011]$. We thus get the following definition of firm growth employed in this study:

$$log(growth_{i,t}) = log(size_{i,t}) – log(size_{i,t-1}) \quad (4)$$

[5] The Swedish incorporated business entity "aktiebolag" ("AB") that may be private or public - similar to corporations in the U.S.A. or the private limited company in the U.K.

[6] The figures are based on official, publicly available data from Bolagsverket, the Swedish registrar of companies (Bolagsverket, 2013).

2.3 Simulation as a Tool for Handling Attrition

To mitigate the potential bias from systematic attrition over the course of the examined period, a Monte Carlo simulation is used to impute values for the remainder of the period for firms that did not survive until 2011. The rationale for simulating their growth is that disregarding this large number of firms in the cohort would lead to a survivor bias that would cause our analysis to misjudge the causal relationships of study. Even though we are only interested in the top-performing firms, it is not unlikely that a considerable number of the liquidated firms could consequently have exhibited high growth rates in a counterfactual scenario and thus become part of our segment of interest. Additionally, the use of simulations does not make distributional assumptions for the data, and (according to the "Strong Law of Large Numbers") the mean from infinitely many simulations will converge to the true mean and enable a computationally efficient estimation (Shechter, Schaefer, Braithwaite, & Roberts, 2006).[7].

These kinds of simulations have been employed both with unbalanced panel data (Arellano & Bond, 1991), as well as in recent work concerning firm size distributions (Bottazzi, Pirino, & Tamagni, 2013) and financial forecasts (Pedersen, 2013). Firms that died in the first two years, i.e. 1997 and 1998, are excluded from the analysis, however. The reason is that they have not exhibited potential or aspiration to grow throughout the examined time frame, and thus, inclusion in the consequent analysis is not deemed relevant. One thing to note is that the fact that smaller firms have a higher propensity to exit might lead to an underestimation. However, it has been shown that this effect is quite small and does not significantly bias results (Marsili, 2001). The approach taken here thus seems to be adequate in addressing the attrition.

The companies that are part of the simulation are divided into four groups in order to get more precise imputations for their respective growth paths. The groups are constructed along the dimensions industry sector and time of closure:

Table 1 **Classification of Simulation Groups**

		Industry	
		Primary/Secondary	Tertiary
Firm closure	Early (1999-2004)	Group 1	Group 3
	Late (2005-2010)	Group 2	Group 4

[7] Of course, an infinite number of simulations cannot be conducted, but the convergence is approximated by 170 000 runs for each simulation group in this study. According to a generalization of the Strong Law of Large Numbers, namely that of a stationary, ergodic process (often referred to as the "Ergodic Theorem"), the estimator will almost surely converge to the true mean, even though the variable is not independent and identically distributed ("i.i.d.") (White, 2001)

After testing for fixed or random effects and serial correlation, which are stated to potentially affect the standard error and efficiency of the estimations (Coad, 2007b; Niefert, 2005), these groups are respectively regressed on growth throughout their period of survival in a limited panel regression model with robust standard errors in order to attain the coefficients for the simulations.

As previous studies have identified employees (Koch, Späth, & Strotmann, 2013), geographic expansion[8] (Koch, Späth, & Strotmann, 1998) and being a subsidiary (Harhoff, Stahl, & Woywode, 1998) as potential determinants of firm growth, they are used as independent variables. We reiterate here that the following model is not meant as an estimation in the conventional sense, but rather a means to attain the coefficients for the consequent simulation. Hereby, the particular variables were chosen as they were the ones most frequently encountered in previous literature.

The limited regression model thus has the following specification:

$$\begin{aligned} &log(growth)_{i,t} = \beta_0 + \beta_1 \cdot nr.of\,employees_{i,t} + \\ &\beta_2 \cdot nr.of\,offices_{i,t} + \beta_3 \cdot part\,of\,concern_{i,t} + u_{i,t} \end{aligned} \tag{5}$$

where

- i denotes firm entity,
- t denotes year,
- β_0 is the intercept,
- $\beta_j (j = 1, 2, ..., 5)$ are the respective coefficients and
- u is the error term.

Previous literature has also discussed the issue of using lags for anything from one to up to seven year lags for the explanatory variables. Diving deeper into this caveat is beyond the scope for this thesis, as the purpose is primarily to identify causal links, rather than specific determinants with respect to growth. Here, firm growth is seen as a continuous phenomenon whereby yearly changes fairly quickly have an effect on firm size. Of course, this is a simplification and more extensively exploring and comparing lag periods could provide additional insights in future studies; in particular with the case of aspects such as R&D and innovation.

For the Monte Carlo simulations, we make use of the model in Regression (5). The aforementioned coefficients from the limited regression are used along with the last known

[8] In this setup, opening another office or workplace is used as a proxy for geographic expansion.

observations for the covariates in the model in order to generate imputed data points in the panel for the years following attrition. Thus, β_t will be replaced by the coefficients and the covariates by extrapolated values. The values will vary, as an inverse normal error term is added to each calculation. Rerunning these calculations 170 000 times for each group will yield as many potential growth rates, which is the basis for the ensuing random imputation.

2.4 A Quantile Regression Approach for Establishing Causal Links

The panel is thereby balanced by adding the imputed values attained from the Monte Carlo simulations for the groups. Moving onto the main regression analysis that addresses the second research question, namely establishing causal effects among the firms, we are faced with a number of caveats.

Firstly, firm growth is to a large extent "stochastic" (Coad, 2007b) and appears to be mostly driven by "purely stochastic shocks" (Marsili, 2001). For most regressions dealing with the subject, the R^2-values appear to be quite low (Coad, 2007b; Coad & Hölzl, 2008), which is why values above a few percent are not very likely.

We are interested in examining serial correlation in the panels for two reasons, with the first being that its occurrence would indicate non-random processes in the surveyed firms' growth paths. The second reason is that if found to be present, such correlation would bias the standard errors in the regression and additionally make the results less efficient. To this end, the Stata package "xtserial" by Drukker (2003) is used to employ a Wooldridge test of serial correlation (see Wooldridge, 2002).

Regarding the actual regression techniques, commonly employed ones such ordinary least squares ("OLS") that focus on conditional means, and effects on "the average firm" in this case, are inadequate for analyzing issues of this nature. The reason is that the tails of the distribution tend to exhibit different causal relationships than the mean does (Coad & Hölzl, 2008). Instead, scholars suggest using a quantile regression approach, a method that is being increasingly implemented in econometric studies and is more suitable for studying firm growth as a phenomenon (Fornahl & Otto, 2008; Henderson, Raynor, & Ahmed, 2012; Reichstein, Dahl, Ebersberger, & Jensen, 2010).

In this case, we are interested in the top-performing firms, defined as those belonging to the top decile in terms of turnover growth over time as well as cumulatively. Quantile regression is a generalization of a conditional median estimator, as opposed to the conventional mean, that estimates the effects of covariates on given quantiles in a distribution. Whereas an OLS estimation minimizes the sum of squared error terms $\sum_i e_i^2$, a median estimation minimizes the least absolute deviations ("LAD") $\sum_i |e_i|$.

To illustrate this difference, we use the following generic model, with quantile regression application adapted from Koenker and Bassett (1978):

$$y_i = \alpha + \beta x_i + \epsilon_i \tag{6}$$

where

- i denotes entity,
- α and β are population parameters,
- ϵ is the idiosyncratic error term and
- $\hat{\beta}_0$ and $\hat{\beta}_1$ will be the corresponding parameter estimates

An OLS regression will produce estimates for β according to:

$$\hat{\beta} = \underset{\beta \in \mathbb{R}}{\arg\min} \sum\nolimits_{i=1}^{N} (y_i - \alpha - \beta x_i)^2 \tag{7}$$

A quantile regression, on the other hand, will estimate the τ^{th} quantile, with $\tau \in [0;1]$, according to:

$$\hat{\beta}_\tau = \underset{\beta \in \mathbb{R}}{\arg\min} \sum\nolimits_{i=1}^{N} \rho_\tau (y_i - \alpha - \beta x_i) \tag{8}$$

where

$$\rho_\tau(u) = (\tau - 1(u \leq 0))u \tag{9}$$

This method is more accurate when the distribution is skewed and is also more robust with respect to outliers, since it does not necessitate assumptions regarding the actual underlying distribution of the data (Hao & Naiman, 2007; Koenker & Hallock, 2001). This is particularly useful in this setting, since we are exploring the distribution of the empirical growth rates and do not wish to make excessive assumptions *a priori*.

As we are using panel data, however, the implementation of quantile regression is not straightforward. Only a few studies have combined panel or cross-sectional regressions with quantiles (e.g. Barnes & Hughes, 2002; Powell, 2010), and even fewer (if any) have combined this with Monte Carlo simulations and robust standard errors, as this study does. One paper, however, offers guidance in this regard. In order to address the unobserved effects in the panel, Canay (2011, pp. 7-9) presents a two-step estimator where predicting and differencing out the unobserved effects from the dependent variable allows for a second-stage quantile regression (in this case for the top decile). The resulting estimations are thus both consistent and asymptotically normal. By using Machado, Parente, and Santos Silva (2011)'s "qreg2"-package for Stata, the standard errors are robust as well.

When formulating the actual regression model, previous studies' findings regarding potential determinants of firm growth have provided guidance. In addition to the factors described in the previous section when outlining the limited regression model, additional variables of interest will be described here. Controlling for ownership structure (Audretsch & Mahmood, 1994; Geroski & Gugler, 2001) and employing industry-specific dummies (Coad, 2009) have proven fruitful in previous studies, although including the latter does not typically increase the explanatory power, i.e. the R^2, of the regressions. We will additionally be including controls for geographic location of the firms' headquarters in terms of county. Another previously employed control is the age and/or size of the firms, sometimes used interchangeably because of their innate link (Greiner, 1972). However, as this study is following a particular cohort of firms that will all have the same age throughout the analysis, age is not taken into consideration in this regard.

Furthermore, investment in terms of capital expenditure and acquisitions (Cabral, 1995; Maksimovic & Phillips, 2008) appears to play a key role in firms growth rates. Additionally, public programs aimed at promoting growth in selected companies by way of investments or subsidies have attracted attention from scholars due to their proliferation, not seldom attempting to alleviate start-up firms' "financing constraints" due to proposed failures in the capital market (de Meza & Webb, 1999). Yet, studies have come to diverging conclusions with respect to their legitimacy, efficacy and optimal design (Fier, Aschhoff, & Löhlein, 2007; Lerner, 2002; Shane, 2009).

Other potential determinants have certainly been proposed in earlier studies on the subject, with perhaps the most important one being "innovation" (Coad, 2009). Numerous studies have modeled and estimated the relationship between "innovativeness", R&D or technological sophistication on the one hand and growth, e.g. in terms of turnover, on the other (e.g. Geroski, 1999; Nelson & Winter, 1982). Others, such as the rate of competition among firms in the market, have been used to explain the skewed distributions of growth (Bottazzi & Secchi, 2005). Human capital, for example in terms of education among the employees, have been proposed as being conducive to success (Minniti, Zacharakis, Spinelli, Rice, & Habbershon, 2006). Due to the limitations in accessing this firms-specific data, however, these aspects cannot be included in the analysis. Later studies in a vein similar to this one, however, could stand to benefit from including them to possibly increase the explanatory power of the regressions.

The regression model will consequently have the following specification:

$$
\begin{aligned}
& log(growth)_{i,t} = \beta_0 + \beta_1 \cdot nr.\,of\,employees_{i,t} + \beta_2 \cdot nr.\,of\,offices_{i,t} + \\
& \beta_3 \cdot net\,investment_{i,t} + \beta_4 \cdot part\,of\,concern_{i,t} + \\
& \beta_5 \cdot part\,of\,public\,growth\,program_{i,t} + industry\,controls + \\
& region\,controls + ownership\,controls + u_{i,t}
\end{aligned} \tag{10}
$$

where

- i denotes firm entity,
- t denotes year,
- β_0 is the intercept,
- $\beta_j (j = 1, 2, ..., 5)$ are the respective coefficients and
- u is the error term.

Once again, we test for fixed or random effects as well as serial correlation. The predicted unobservable effects are then subtracted from the dependent variable. This leaves us with the following specification for the quantile regression, where the same independent variables are regressed on the "demeaned" dependent growth variable:

$$
\begin{aligned}
& log(growth)_{\tau,i,t} = log(growth)_{0.9,i,t} = \beta_0 + \beta_1 \cdot nr.\,of\,employees_{i,t} + \\
& \beta_2 \cdot nr.\,of\,offices_{i,t} + \beta_3 \cdot net\,investment_{i,t} + \beta_4 \cdot part\,of\,concern_{i,t} + \\
& \beta_5 \cdot part\,of\,public\,growth\,program_{i,t} + u_{i,t}
\end{aligned} \tag{11}
$$

where

- i denotes firm entity,
- t denotes year,
- τ denotes quantile,
- β_0 is the intercept,
- $\beta_j (j = 1, 2, ..., 5)$ are the respective coefficients and
- u is the error term.

As stated, this regression model is modeled after what the majority of the surveyed literature has pointed out as possible determinants of firm growth patterns. There are indubiously further models and setups discussed in other literature that may be just as applicable in this context. As the purpose is to explore causal links in general, rather than construct an accurate and parsimonious explanatory model however, this limitation is not deemed a source of great bias in this context.

Finally, as is commonly done in econometric studies today, a number of robustness checks will be included in order to relate the results to similar, yet slightly altered, estimations (Lu & White, 2014). Firstly, the overall panel regression results that were used to attain estimates of the unobservable effects will be kept as a benchmark, although the results should be viewed with caution as they only estimate effects on the average firm, rather than the top segment of firms. Thereafter, a panel regression will be run for the top cumulative decile of the firms in the balanced panel with imputed values, along with the bottom decile as a comparison case. Lastly, the same panel regression will be run for the firms that survived until 2011, i.e. without imputations. The unobservable factors will be subtracted once again, and the top (and bottom) decile will be estimated by way of quantile regression with robust standard errors. Finally, the results will be compared and discussed, whereby differing results in the regressions will indicate uncertainty and sensitivity with respect to the regression models. Similar results, however, could possibly reinforce the structural validity of the findings.

3 Data

The study makes use of Swedish official firm-level data provided by Statistics Sweden ("SCB") which is a Swedish government agency with the task of producing official statistics for private and public use (SCB, 2013). The yearly survey "Structural Business Statistics" ("FEK")[9] constitutes the basis of the dataset that follows all Swedish limited companies started in the year 1997 and their respective development until 2011. It is the only survey that makes use of the financial statements of all companies registered in Sweden. The information is complemented with balance sheet data from the Swedish Tax Agency's standardized income statements ("SRU")[10] (Skatteverket, 2013).

In order to identify and follow business entities over the course of the analyzed time frame, the information has been merged with another comprehensive SCB dataset that tracks Swedish companies and workplaces along the dimensions establishment, restructuring, closure, employees and offices.[11] Thanks to the use of official labor registry data,[12] the employees in the respective workplaces can be mapped and tracked over time. This gives a more accurate picture of how companies develop, including restructuring, labor mobility and outsourcing measures that would otherwise remain obscured (Andersson & Arvidson, 2004).

Beyond the above sources, a registry of companies participating in public agency programs was provided by The Swedish Agency for Growth Policy Analysis.[13] The programs contained in the data comprise those implemented by the Swedish innovation agency Vinnova and aim at promoting growth and innovation processes by investing in selected companies (Vinnova, 2011). To be sure, these are not the only investments being made in the Swedish economy. Placements made by private sector actors such as venture capital firms and business angels certainly appear worthy of inquiry in the context of firm growth (e.g. Davila, Foster, & Gupta, 2003; De Clercq, Meuleman, & Wright, 2012). For the purpose of limitations of scope, however, this analytical dimension is left out of this study, yet is deemed a promising area for further research.

Important to point out is that the data itself brings with it some limitations. Although the source (Statistics Sweden) to a degree guarantees the integrity of the data and methods used in collecting it, there have been changes in industry categorization along the studied time frame (see Appendix B), and the human factor is always present,

[9] Original Swedish title "Företagens Ekonomi".

[10] In Swedish denoted "Standardiserat Räkenskapsutdrag".

[11] The dataset is denoted "Företagens och Arbetsställenas Dynamik" ("FAD"), which roughly translates to "The Dynamics of Companies and Workplaces" (the author's own translation).

[12] In Swedish denoted "Registerbaserad Arbetsmarknadsstatistik" ("RAMS").

[13] The Swedish Agency for Growth Policy Analysis (in Swedish: "Myndigheten för tillväxtpolitiska utvärderingar och analyser", or simply "Tillväxtanalys") is a government agency that conducts evaluation and analysis of Swedish growth policy and gathers related intelligence from abroad (Tillväxtanalys, 2012).

regardless of which entity that handles data and its dissemination. The author's own manipulations of the data also constitute a risk and are inevitably based on assumptions, although the steps taken have been described as thoroughly as possible for the sake of transparency and replicability.

In addition, as mentioned in the Method section, access to more control variables would have been preferable in order to control for as many confounding factors as possible, but this is a limitation that is likely to be present in the vast majority of quantitative studies of this nature. The generally low R^2-levels from previous academic studies indeed signal many unobservable and random forces at work when it comes to firm growth.

The relevant variables included in the dataset are given in Table 2:

Table 2 **Description of Variables in Dataset**

Variable	Description	Units
year	Year	-
companyid	Unique firm identifier	-
netturnover	Net turnover	kSEK
turnovergrowth	Growth in net turnover	%
ln_turnovergrowth	Logarithmized turnover growth	-
lag_ln_turnovergrowth	Lagged logarithmized turnover growth (by one year)	-
cumul_turnovergrowth	Cumulative turnover growth	-
established	Firm established in present year	dummy variable
survivor	Firm survived since last year	dummy variable
survivor_2011	Firm survived entire period of analysis	dummy variable
closure	Firm closed current year	dummy variable
closure_merger	Firm closed current year due to merger	dummy variable
closure_split	Firm closed current year due to split	dummy variable
closure_liquidation	Firm closed current year due to liquidation	dummy variable
closure_other	Firm closed current year due to other reasons	dummy variable
partconcern	Firm is part of a concern	dummy variable
employees	Number of employees	-
offices	Number of firm offices	-
legalform	Form of enterprise	-
sector	Registered sector of the firm	-
ownership	Form of ownership	-
snicode	Registered industry code	-
snigroup[1]	Industry group	-
netinvestment	Total net investments in present year	kSEK
publicprogram	Firm was part of public growth or innovation program	dummy variable
region	County in which firm is registered in present year	-

[1]The variable "snigroup" was created by the author by grouping together industry codes on single-digit level. As previously mentioned, the groups can be found in Appendix A. Additionally, a description of the categorization process is available in Appendix B.

In Table 3 on the next page, an overview of the companies' establishment and attrition rates is given. Here we see how, after 1997 when 19 232 limited companies were established, roughly 50% of the cohort has closed or been restructured within the first three years. At the end of the analyzed time period merely 1 517 companies, i.e. less than 8% of the cohort, remains. Looking closer at the nature of this attrition, the vast majority (roughly 80%) is constituted by outright liquidations where there is no indication that the business has continued operating. The rest of the closures are due to mergers, splits and other unspecified restructuring measures, out of which mergers constitute the largest fraction of the total attrition in the cohort (approx. 13%), followed by splits (about 6%). As previously stated, restructured companies may constitute an interesting field of growth studies in and out of themselves, yet is beyond the scope of this study.

Table 3 **Firm Count and Attrition**

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

The companies' turnover and growth rates are illustrated in Table 4. The number of observations declines as companies are closed along the studied time period. With the exception of the year 1999, mean turnover[14] increases steadily each year, but the median turnover does not increase at the same rate. This already hints at the presence of a number of outliers, or at least very high-performing firms, at the upper end of the distribution.

Looking at the growth rates, however, the pattern is not as one-directional.[15] Initially showing high levels of mean growth rates, particularly in the first year with an average in excess of 200%, they show a decrease until the year 2003. Here, they once again take off only to start decreasing towards single-digit mean growth in the years 2008 to 2010. In the final year of analysis, they again start to increase, reaching approximately 15%, a level comparable to those in the years 2002 and 2004. Looking at median growth rates, however, the picture is somewhat more modest, presumably due to a small number of rapidly growing firms in the dataset. In fact, after exceeding 20% in the first year of analysis, the median growth rates never reach double-digit levels. Following the same patterns as those outlined for the mean growth rates, median growth nearly stagnates in 2003 (i.e. reaching barely 1%), and actually reaches negative levels in 2009 (-2.7%).

Although speculative, these patterns (allowing for lags of 1-2 years) seem to closely follow the macroeconomic shocks that hit Sweden in the 1990s and 2007-2008. The first of the crises was what is commonly referred to as the dot-com bubble, where overvaluation and speculation in the Internet-sector contributed to an investment bubble in the late 1990s. The bursting of the bubble adversely affected stock prices, growth and investment in Sweden the following years (Maican, 2012). In the dataset, mean and median growth rates start declining around this time, thus making the empirics fit well with this narrative.

The second crisis is the global recession of 2007-2008 associated with subprime mortgages, stock-market downturns and debt crises around the world. The crisis also affected Sweden due to worldwide financial interconnectivity, and consequently caused declining growth and increasing unemployment (Wilkinson, Spong, & Christensson, 2010). With observed growth rates declining from 2008 onwards and reaching negative median levels in 2009, it is fully conceivable that at least part of this pattern is attributable to the global financial crisis.

[14] Means are continuously calculated as the arithmetic average of the observed values in the dataset.
[15] A number of growth rates are missing due to missing observations among the net turnover values in the dataset

Table 4 **Firm Turnover and Growth**

	Turnover [1000 SEK]			**Growth rate [%]**		
Year	**Observations**	**Mean**	**Median**	**Observations**	**Mean**	**Median**
1997	19 232	3 885.89	1 255.0	-	-	-
1998	11 082	4 697.27	1 674.0	10 805	232.99	21.4
1999	8 175	4 499.07	1 734.0	8 093	39.65	7.1
2000	6 429	5 274.67	1 853.0	6 372	43.39	7.1
2001	5 254	5 629.97	1 892.0	5 212	27.05	4.1
2002	4 443	6 138.36	1 905.0	4 402	11.39	2.2
2003	3 784	6 810.12	1 996.5	3 751	7.74	0.7
2004	3 302	7 624.81	2 103.0	3 277	10.85	2.1
2005	2 922	8 151.55	2 181.5	2 902	40.07	2.9
2006	2 611	8 966.43	2 272.0	2 596	49.53	4.3
2007	2 327	9 569.73	2 400.0	2 312	22.51	4.2
2008	2 065	10 802.09	2 520.0	2 055	8.27	2.2
2009	1 859	13 081.73	2 539.0	1 850	7.65	-2.7
2010	1 655	17 611.35	2 650.0	1 644	6.75	1.1
2011	1 517	22 218.31	2 829.0	1 506	15.14	2.8

On the following page, Table 5 shows the companies broken down by sector (a more detailed listing of number of firms by industry is given in Appendix A), along with attrition associated with each sector.

In the first year, the majority of firms (approximately 80%) are registered in the tertiary (also known as the service) sector, such as financial services, real estate and retail sales. The rest are split between the secondary (also known as manufacturing) and primary (e.g. agriculture and mineral extraction) sectors, constituting roughly 17% and 3%, respectively.

The attrition rates are fairly similar across the groups, amounting to 92% (tertiary), 91% (secondary) and 89% (primary) in the different sectors.

Table 5 **Breakdown and Attrition by Sector**

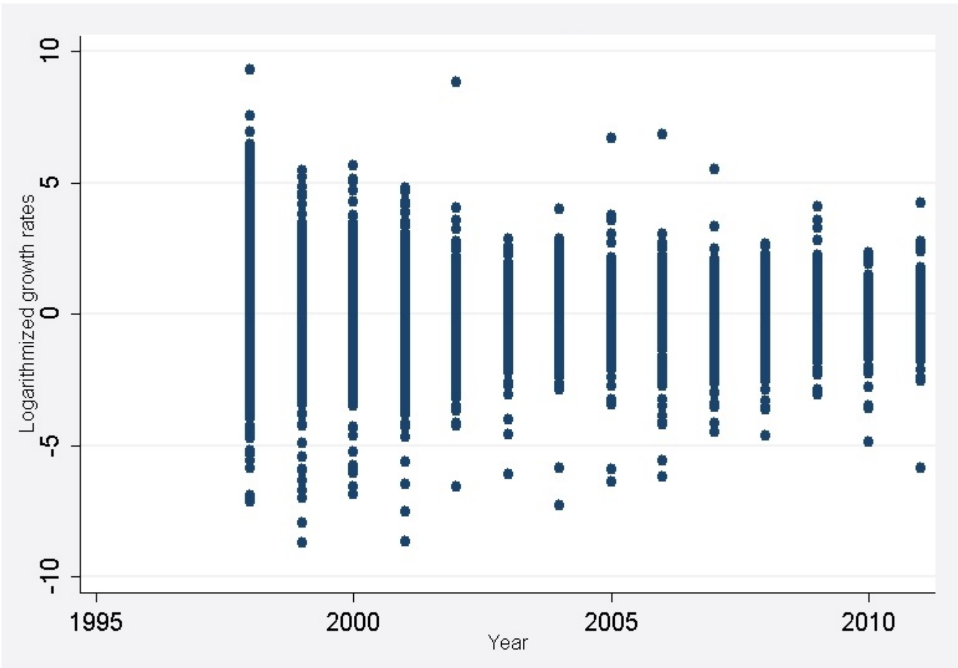
Year	**Primary sector**	**Secondary sector**	**Tertiary sector**	**Remaining**
Established 1997	506	3 347	15 379	19 232
1997	14	93	402	18 723
1998	185	1 337	6 408	10 793
1999	72	474	2 195	8 052
2000	37	292	1 400	6 323
2001	41	196	919	5 167
2002	22	141	619	4 385
2003	21	105	534	3 725
2004	16	83	369	3 257
2005	4	61	310	2 882
2006	14	54	246	2 568
2007	6	59	205	2 298
2008	9	42	210	2 037
2009	2	50	145	1 840
2010	4	43	153	1 640
2011	3	19	101	1 517

4 Analysis

4.1 Descriptive Analysis

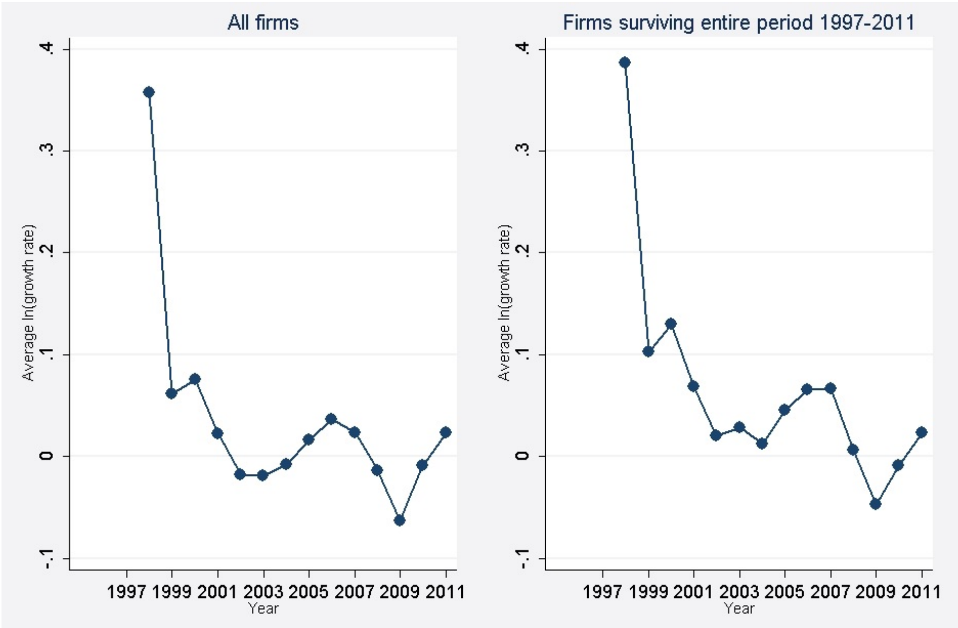
The scatterplot shown in Figure 2 illustrates the spread of the growth rates in the data. As time progresses, there is a tendency for extreme growth rates to diminish. However, outliers are present throughout the time period, albeit not as pronounced as in the first few years. The range of growth rates steadily decreases as well, particularly after the first four years.

Figure 2 **Growth Rates by Year**



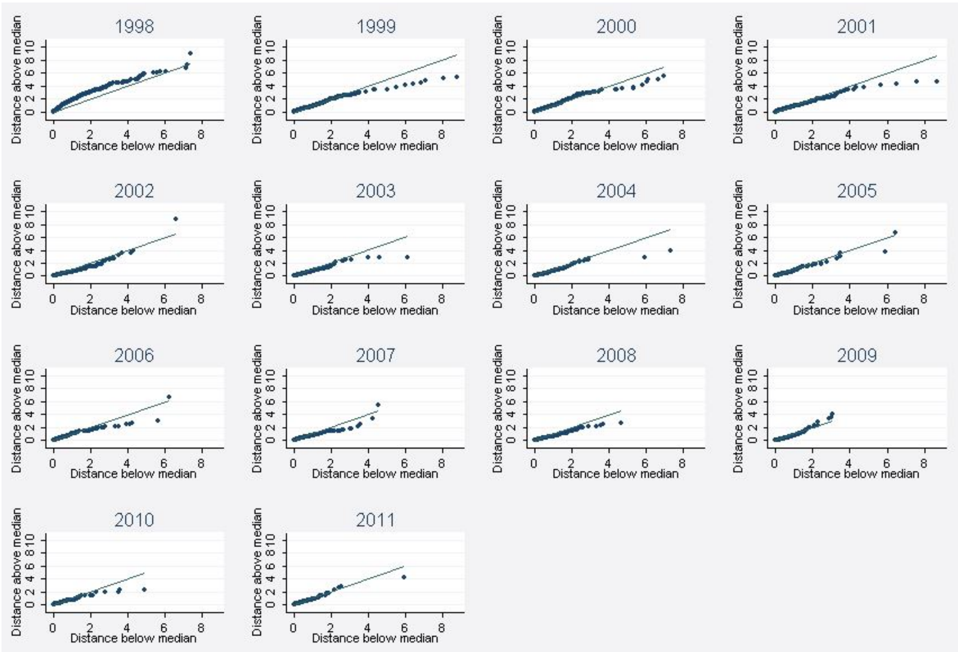
Looking at the average growth rates over time presented in Figure 3, a sharp decline is apparent in the initial years. Although the overall pattern is similar when comparing all firms with only the surviving ones, the latter group continuously outperforms former one.

Figure 3 **Comparison of Average Growth Rates by Year**



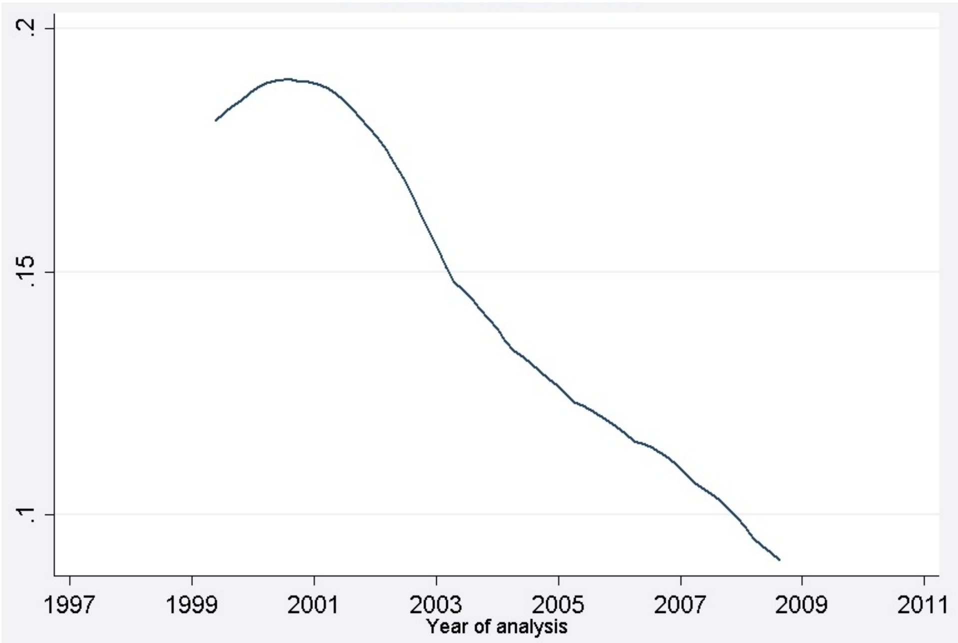
The symmetry plots in Figure 4 illustrate how centered the growth rates are around the mean, graphing the distance between the median and the points above the median against corresponding points that are below the median. Intuitively, a 45 degree line (identical or parallel to the one in the graphs) would thus signify perfectly symmetrical data. Looking closer at the plots shows us that the growth rates initially are quite symmetrical with the exception of a few firms that branch off towards the positive side of the median. Rather quickly however, we see a clear divergence that (perhaps with the exception of the years 2009 and 2011 with more modest divergence) indicates quite skewed growth rates among the firms.

Figure 4 **Symmetry Plots of Growth Rates by Year**



The survival analysis, illustrated by a hazard function in Figure 5, illustrates the mortality of the firms in the dataset.

Figure 5 **Smoothed Hazard Function**



A hazard function, also called a hazard rate, failure rate or force of mortality, applied to the case of firm survival, states the conditional probability that a firm will not survive the current period (i.e. year), given that it has survived until that period (Cox & Oakes, 1984). The hazard function is given by:

$$\lambda(t) = \lim_{dt \to 0} \frac{Pr\{t<T \leq t+dt \mid T>t\}}{dt} \tag{12}$$

where

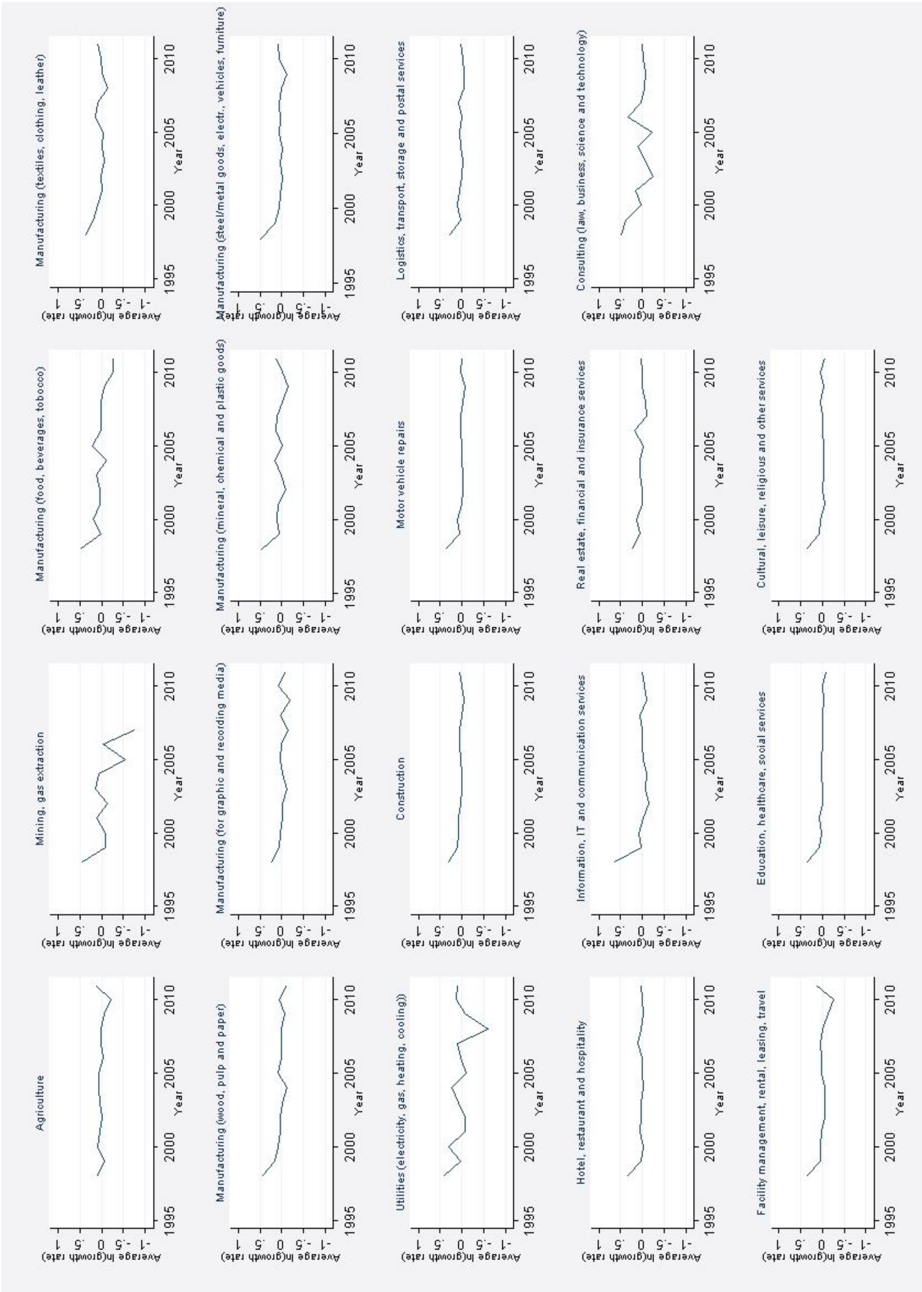
- T is a non-negative continuous random variable that denotes the time until a firm dies,
- $[t, t+dt]$ is a time interval,
- dt is the width of the interval

The numerator is thus in fact the probability that a firm will be closed in the interval $[t, t+dt]$, given that it has not closed before that time. Dividing it with the denominator gives us the closure rate per time unit, and taking the limit results in a measurement of instantaneous closure (Rodríguez, 2007).

The diagram shows how this rate actually increases initially after the firms' inception, indicating a rather "risky" time period of shortly after a firm has been established. Thereafter, the rate gradually declines, showing how firms are more likely to survive the longer they manage to avoid closure. Towards the end of the time period, the rate has significantly dropped, indicating a small share of firms closing by this stage, i.e. about 12 years after being established.

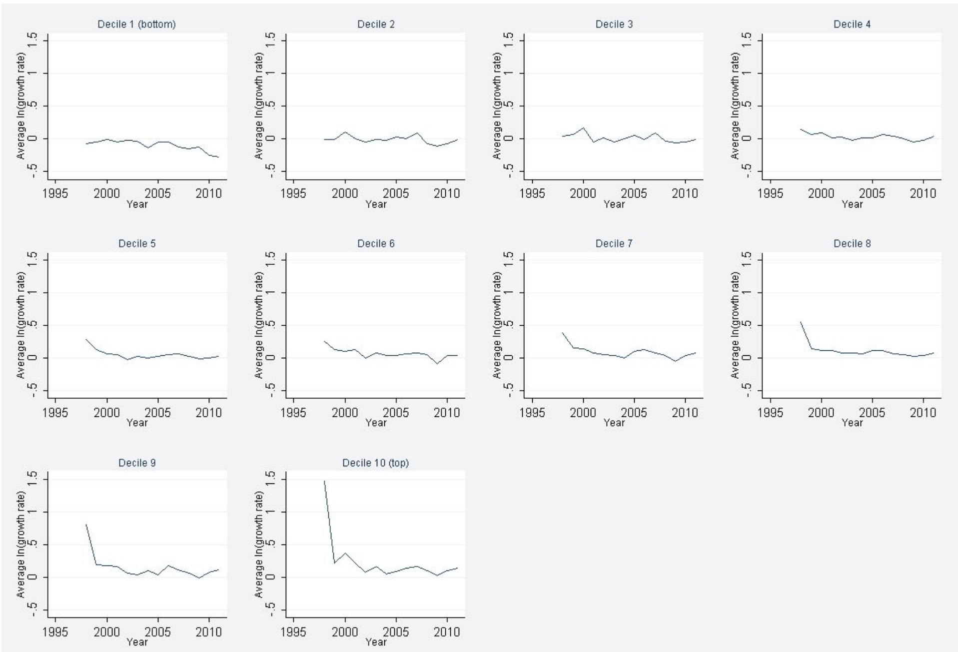
Figure 6 compares the average growth rates by industry over time. While most industries do not display much volatility, in particular construction, education and hotel/hospitality services, others tend to fluctuate significantly over time. Examples of the latter pattern include mining, utilities and consulting services.

Figure 6 Comparison of Average Growth Rates by Industry and Year



Looking at the firms that survive the entire analyzed time period, i.e. until 2011, Figure 7 compares the growth patterns of the ten cumulative growth deciles in the dataset. The top decile is thus constituted by the firms in the data that have grown the most over the period 1997 to 2011, while the bottom decile comprises the firms that have grown the least. A pattern that emerges is that the firms that have achieved the highest cumulative growth rates, i.e. increased their turnover the most in the 14 years following their establishment, have grown rather rapidly in the first years of their existence. The top three deciles, and particularly the top decile, displayed comparatively high growth rates in 1997 through 1999, before seeing their growth rates rapidly diminishing by 2000 and thereafter remaining at a lower, stable rate (albeit somewhat higher than the firms in the lower deciles).

Figure 7 **Survivors: Comparison of Average Growth Rates by Cumulative Growth Decile and Year**



Moving onto the transition probabilities between deciles for surviving firms in the data set, we see a large degree of apparent randomness in how the firms move between growth deciles over time. Table 6 shows the combined transition probabilities for all the years in the data (in %) that a firm in a given decile at time $t-1$ will wind up in another given decile at time t, where the unit of time once again is years.

Table 6 **Survivors: Decile Transition Probabilities Across Years**

Turnover growth decile at time t_{-1}	Turnover growth decile at time t top: 1	2	3	4	5	6	7	8	9	bottom: 10
top: 1	11.72	7.21	5.84	4.97	4.76	4.99	5.19	6.22	8.44	24.98
2	9.74	11.27	9.68	8.31	6.81	7.30	8.01	9.73	11.94	13.77
3	7.79	10.20	10.97	11.31	9.45	9.46	11.17	10.67	11.38	8.65
4	6.27	8.78	11.47	13.06	14.06	12.95	11.09	10.08	8.53	6.50
5	5.16	8.34	10.51	13.39	14.73	14.41	12.42	10.21	7.83	6.08
6	5.84	8.15	11.16	12.36	13.14	14.83	12.29	10.62	9.36	6.17
7	6.21	9.24	11.19	11.92	12.20	12.43	13.09	11.85	9.67	6.72
8	7.44	10.94	11.10	10.39	10.89	10.55	11.17	12.22	11.20	7.84
9	11.78	13.32	10.34	8.27	8.23	7.81	9.76	11.04	12.56	8.94
bottom: 10	28.06	12.56	7.74	6.04	5.72	5.26	5.81	7.37	9.08	10.36
Total	100	100	100	100	100	100	100	100	100	100

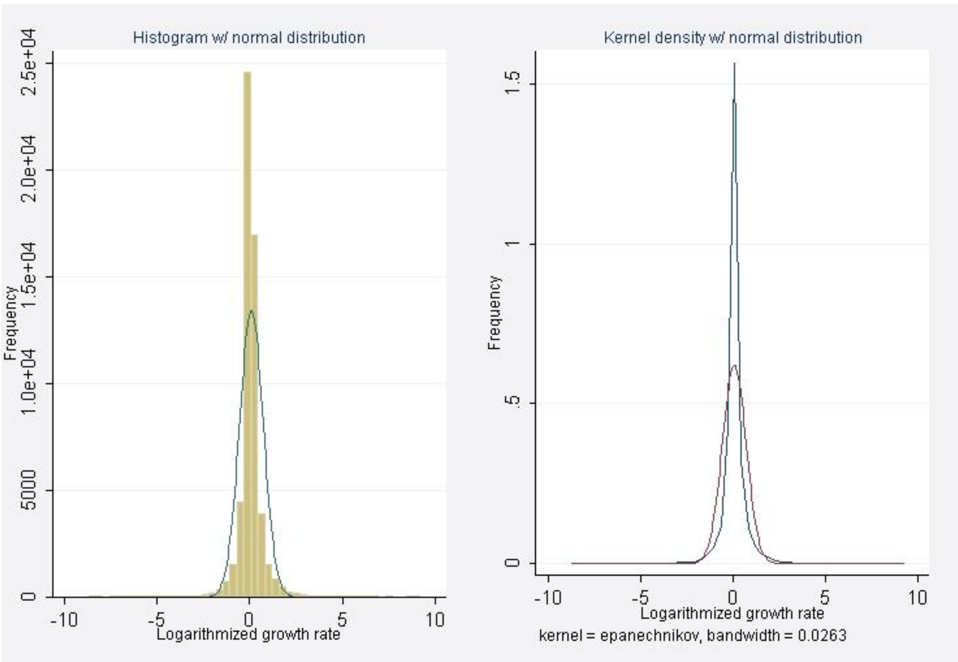
Transition probabilities given in percent

The transition probabilities between individual years can be found in Appendix C. The overall pattern is a, at least at first sight, a rather stochastic one. Generally, high-performing firms in high deciles are more likely to find themselves in a low decile the next year. For instance, a firm in the 1st (i.e. top) decile is more likely (about 25% likelihood) to wind up in the 10th (i.e. bottom) decile, than to remain a top performer (roughly 12%) in the following year. This finding in very much in line with that of Daunfeldt and Halvarsson (2012), where sustained high growth is found to be very unlikely. The pattern is reversed for low-performing firms, that tend to belong to the top performers (about 28%) in a year following poor performance in terms of growth, rather than continue to exhibit low growth rates (roughly 10%). Firms in the middle section, i.e. around deciles 4 through 6, on the other hand tend to remain in the same vicinity over time, with the highest transition probabilities found around the same or close-by deciles in consquent periods.

Analyzing transitions between individual years does not dramatically change the patterns outlined above. In general, sustained high or low performance among the surviving firms is rare, and the transition probabilities show that the likelihood of remaining a top (or bottom)-performer is quite low, particularly over time. Rather, high growth in a given year is most likely to be followed by low growth in the following year, and vice versa.

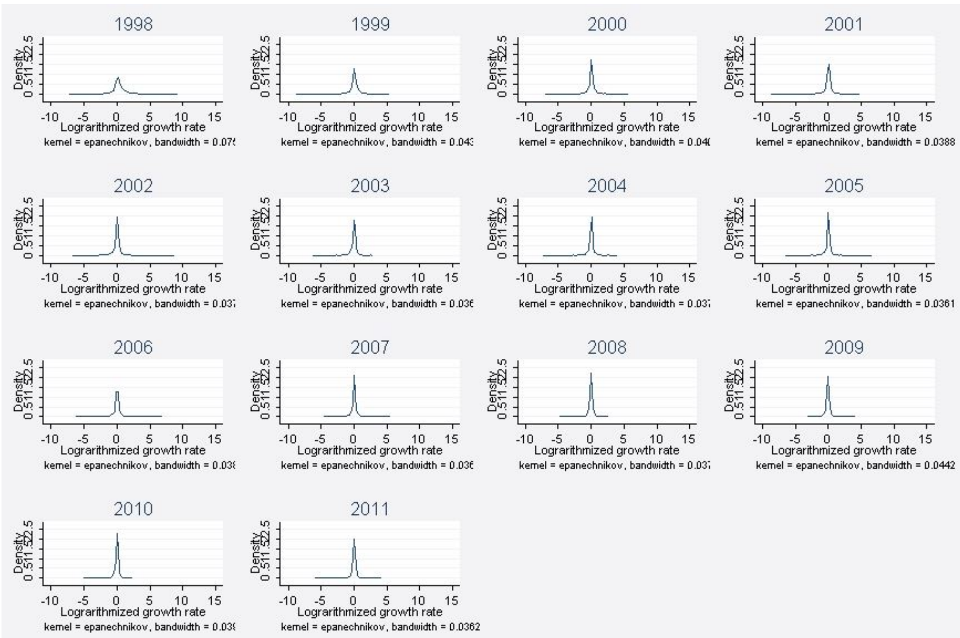
Turning to the actual growth rate distributions, the overall histogram and kernel density are given in Figure 8, while Figure 9 shows the distributions for each year separately.

Figure 8 **Growth Histogram and Kernel Distribution**



The overall distributions are overlaid with Gaussian distributions with the same means and standard errors for reference.[16] At first glance, the empirical distribution seems to be more "peaked" and have fatter tails than the Gaussian, i.e. there are more high- and low-performing firms than would be expected if firm growth was normally distributed. The shape is very much reminiscent of the "tent-shaped" distribution previously identified by Stanley et al. (1996) and Bottazzi and Secchi (2003b), among others. Specifically, this peaked characteristic seems to become more explicit over time, with the first few years not looking quite as skewed as the ones from 2002 and onwards.

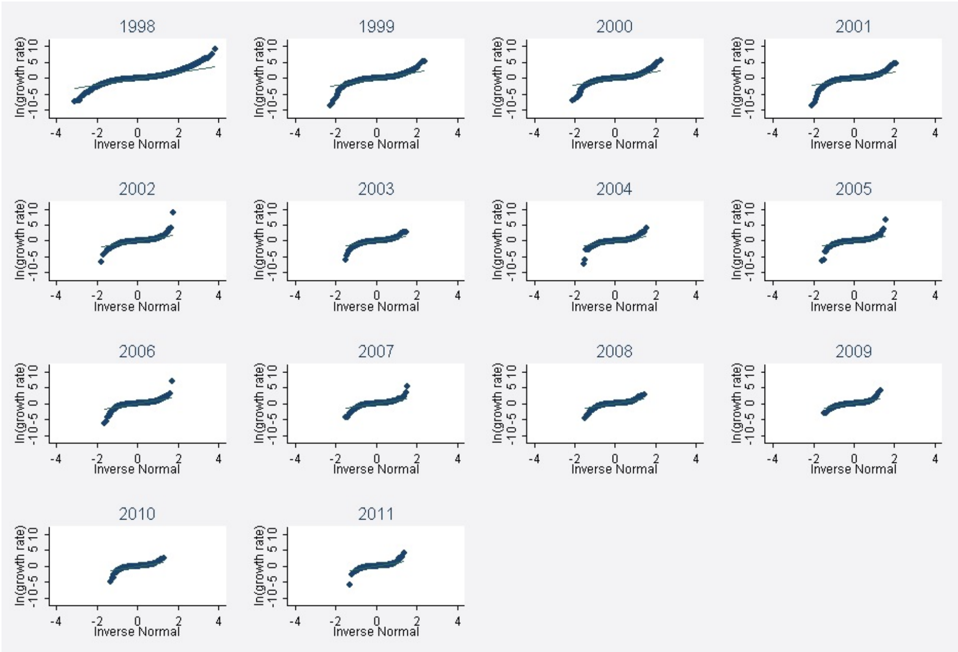
Figure 9 **Comparison of Growth Distributions by Year**



Looking at the normal quantile plots in Figure 10 further indicates that the growth rates are not normally distributed. Normal quantile plots (also referred to as normal Q-Q plots) graph the data quantile points against those of a Gaussian distribution, with the latter forming a straight line. Empirical points deviating from this line consequently also indicates that the data is most likely not normally distributed. In particular, we can see that the tails (i.e. the left- and right-most points in the graphs) are fatter than what would be the case with normally distributed data.

[16] The diagram on the left shows a histogram of the frequency distribution of the growth rates, while the diagram on the right illustrates the kernel density estimate, i.e. the sum of Epanechikov kernels (see Epanechnikov, 1969) for the frequencies of observations. Both were included in order for the reader to be able to compare the discrete (histogram) and continuous (kernel density) visualizations of the growth rate distributions (see Scott, 1979).

Figure 10 **Normal Quantile Plots of Growth Rates by Year**



In addition to this graphic analysis, Jarque-Bera (also known as Skewness-Kurtosis, or "SK") and Shapiro-Wilk tests for normality were conducted for all years in the dataset. The zero hypothesis of a normal distribution of the growth rates was rejected at all conventional significance levels for the entire period jointly, as well as for each separate year. These findings mirror those of Reichstein and Jensen (2003), who also soundly reject normality for their data. The output from the tests can be found in Appendix D.

As previous literature has suggested that firm growth tends to follow a Laplace distribution (e.g. Coad, 2009), Figure 11 provides a visual illustration of how well the empirical observations fit with a stylized Laplace distribution. Taking the simple goodness-of-fit measure of the R^2 from regressing the Laplace function on the empirical distribution given in Table 7 (yielding close to 90%), along with the graphic overlay, we can see a rather close fit between the two distributions. It should be pointed out that these two measures do not constitute conventional "tests" of the nature of the distribution. Nonetheless, they serve as indications that the notion that growth rates may follow a Laplace distribution is a feasible one. Judging from Figure 11, the tails actually appear to be even fatter than those of the Laplace, with an even more pronounced peak at the center of the distribution. This lends tentative support to the findings by Fu et al. (2005), who also propose that growth rates may follow an even more skewed distribution than the Laplace.

Figure 11 **Comparison of Growth Distribution with Laplace Distribution**

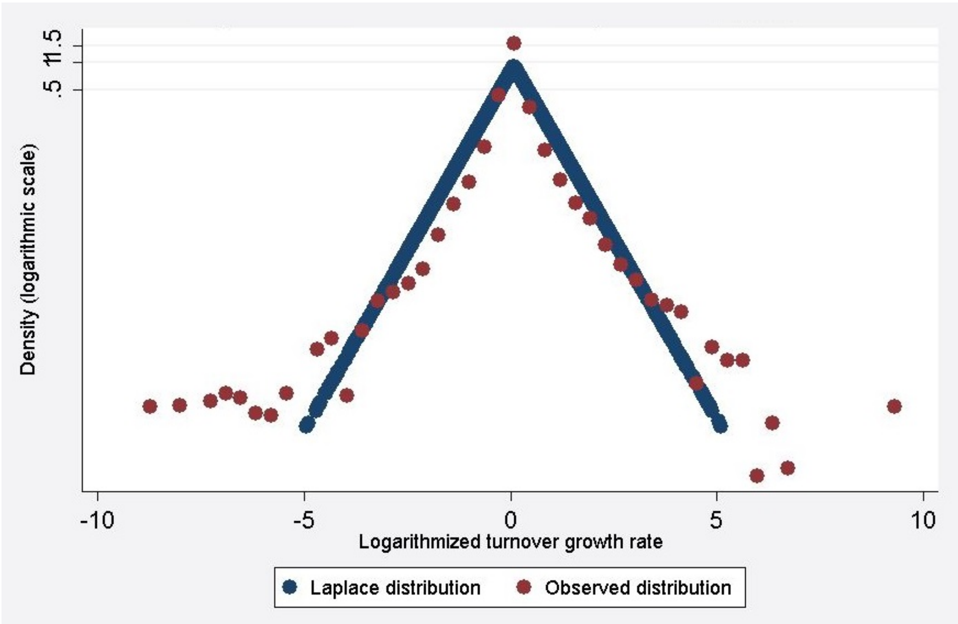


Table 7 **Goodness of Fit of the Laplace Distribution**

	(1)
	ln_growth
laplace	-1.0110***
	(-16.93)
_cons	-1.436316***
	(-5.08)
R^2	0.8748
adj. R^2	0.8718

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

4.2 Inferential Analysis

Generating the Balanced Dataset

As described in the Method section, the firms that were closed at some point during the examined time frame were divided into four groups in order to simulate and impute their growth rates in the dataset. The reason is to avoid, or at least alleviate, the bias from solely analyzing the surviving firms. The firms that closed within the first two years, i.e. 1997 and 1998, were excluded however, as they did not exhibit sufficient growth potential to warrant their inclusion in the analysis.

Table 8 summarizes the simulation set, which comprises 9 153 firms. Most of the firms had closed by 2002, after which a more gradual decline leads up to no firms remaining after 2010.

Table 8 **Count and Survival Among Simulation Firms**

Year	Established	Closed	Remaining
1997	9 153	0	9 153
1998		0	9 153
1999		2 741	6 412
2000		1 729	4 683
2001		1 156	3 527
2002		782	2 745
2003		660	2 085
2004		468	1 617
2005		375	1 242
2006		314	928
2007		270	658
2008		261	397
2009		197	200
2010		200	0

Breaking down the set into the four distinct groups, Table 9 shows how most firms belong to the tertiary sector and closed early, while there were quite few firms in the primary or secondary sector that survived past 2004.

Table 9 **Number of Firms in Each Simulation Group (N.B. Measured at the Beginning of Each Year)**

Year	Simulation Group 1	Simulation Group 2	Simulation Group 3	Simulation Group 4	Total
1997	1 471	347	6 065	1 270	9 153
1998	1 487	345	6 049	1 272	9 153
1999	1 484	344	6 052	1 273	9 153
2000	944	343	3 851	1 274	6 412
2001	621	346	2 445	1 271	4 683
2002	387	352	1 523	1 265	3 527
2003	226	356	902	1 261	2 745
2004	99	350	369	1 267	2 085
2005	0	350	0	1 267	1 617
2006	0	287	0	955	1 242
2007	0	215	0	713	928
2008	0	151	0	507	658
2009	0	99	0	298	397
2010	0	47	0	153	200

Group 1: Firms that closed early (before 2005) belonging to primary/secondary sectors
Group 2: Firms that closed late (after 2004) belonging to primary/secondary sectors
Group 3: Firms that closed early (before 2005) belonging to tertiary sector
Group 4: Firms that closed late (after 2004) belonging to tertiary sector

We thus use the limited regression model to attain the coefficients for the simulation runs for the different groups (the output from the Hausman and Wooldridge tests is available in Appendix E). Data is randomly selected from these runs for the respective simulation groups, which consequently gives us a balanced panel with imputed growth rates for the firms that did not survive the entire period.

Regression Output from the Imputed Panel

Moving onto the results from the regression analysis for the balanced panel, the attained coefficients are shown in Table 10. The Hausman test concluded that a fixed effects model was preferable over a random effects one, and results from the Wooldridge test did not indicate the presence of serial correlation (the output from these tests can be found in Appendix F). Thus, a fixed effects panel regression with robust standard errors was used to attain the fixed effects in the panel. The coefficients are found in the table under Regression (1) but should be interpreted conservatively, as the purpose of the first stage estimation is not to evaluate the causal links, but rather to isolate the fixed effects. For reasons mentioned in the Method section, they identify the “average” effects on the "average" firm, which is not part of the scope of this thesis. Rather, we are examining the high-performing firms in the data, which is why the next stage of the analysis is to regress the independent variables on a new growth variable that has had these fixed effects subtracted using a quantile regression.

The output from this second step-regression is found under Regression (2), which is the 0.9 quantile regression, meaning that it evaluates the effect of the coefficients on the top decile of firms in terms of growth. The standard errors in this set-up are also robust. Lastly, as a comparison, a quantile regression identical to the aforementioned one is performed for the bottom decile of firms, i.e. the ones with the slowest growth rates, with corresponding coefficients listed under Regression (3).

Table 10 **Regression Output for Imputed Panel**

	(1)	(2)	(3)
	ln_growth	ln_growth	ln_growth
employees	-0.0004	-0.0014***	-0.0004*
	(-0.44)	(-6.54)	(-2.23)
offices	-0.0048	0.0355***	-0.0048
	(-0.48)	(4.29)	(-0.71)
netinvestment	0.000002	-4.60e-08	0.000002***
	(1.71)	(-0.35)	(16.17)
partconcern	0.0162	-0.349***	0.240***
	(1.17)	(-19.29)	(14.40)
publicprog	0.0019	-0.149	0.245**
	(0.02)	(-0.71)	(3.24)
_cons	0.251	1.168***	-0.967***
	(1.40)	(129.18)	(-120.41)
N	160 194	160 194	160 194
R^2	0.000568	0.000520	0.000142

Regression (1): Imputed Panel - FE Panel Regression
Regression (2): Imputed Panel - FE-Adjusted 0.9 Quantile Regression
Regression (3): Imputed Panel - FE-Adjusted 0.1 Quantile Regression

t Statistics in Parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

None of the coefficients for the overall panel regression are significant, and all of the R^2-values are remarkably low, particularly in the case of Regression (3). Looking closer at the coefficients for the top decile of performers, we see that estimates for the number of employees and belonging to a concern are negative and highly significant, while the number of offices, i.e. geographic expansion, is positive, with high significance. Net investment and being part of a public program, however, appear to have no discernible effect on growth in this setup.

Since the dependent variable, i.e. turnover growth, is logarithmized, the interpretation of the coefficients in Regression (2) are as follows: all else equal, an additional employee appears to decrease growth by 0.14% (an economically negligible result), while being part of a concern causes an almost 35% decrease. Having an additional office, on the other hand, seemingly causes growth to increase by roughly 3.6%.

For the lowest decile, all estimates except the one for number of offices are significant. Although the coefficients for employees (negative) and net investment (positive) are significant, they are so small that they can be omitted from further analysis (0.04% and less than 0.01%, respectively). For these firms, however, being part of a concern (24.0%) or a public growth program (24.5%) seems to have a large positive effect on growth rates.

Robustness Checks

Moving onto the robustness checks, we again see very low R^2-levels for all the regressions. Evidently, including the simulations did not change the explanatory power of the model noticeably.

In Regression (4), the results from running a fixed effects robust panel regression for only the top growth decile in the panel are shown. The variable for participation in a public program is omitted, as there are no such participants in this subset of firms. Among the remaining variables, however, only geographic expansion is significant, but with a large positive effect on firm growth (nearly 47%); noticeably higher than the one attained in the 0.9 quantile regression.

The final robustness check reruns Regressions (1) through (3) only for the surviving firms in the dataset, thereby disregarding the simulations made for the purpose of imputation. The panel regression, i.e. Regression (5), has two negative significant coefficients, namely those for geographic expansion and for belonging to a concern (at about 7.2% and 7.6 %, respectively). As these estimates designate the effect on growth for the average firm, however, we will not go into these further. Instead, we turn to Regression (6), that gives us the coefficients for the top decile of firms. Here, all estimates except the one for participation in a public program are significant, but at roughly 0.1% and less than 0.01%, the negative coefficients for the number of employees, along with that for net investments can be excluded from further inquiry. However, the results indicate that incremental geographic expansion or belonging to a concern will decrease a high-performing firm's growth by around 11.8% and 7.0%, respectively. Lastly, as a comparison, we turn to the output from Regression (7), that analogously to Regression (3) estimates the independent variables' effects on the bottom decile of firms. The pattern is quite similar to that of the top decile, whereby all coefficients are significant with the exception of participation in a public growth program. The number of employees has a somewhat negative and significant, yet economically negligible effect on growth (0.1%), and net investment is also significant (positive), but too small to take into consideration (less than 0,01%). Just as in the previous regression, this leaves the estimations for geographic expansion and belonging to a concern, which are both negative. Expansion in terms of an additional office appears to decrease growth by around 13.2%, while belonging to a concern is associated with a growth decrease of around 8.3%.

Table 11 **Regression Output from Robustness Checks**

	(4)	(5)	(6)	(7)
	ln_growth	ln_growth	ln_growth	ln_growth
employees	-0.0003	-0.0011	-0.0012**	-0.0011**
	(-0.06)	(-1.07)	(-3.12)	(3.13)
offices	0.4670*	-0.0720**	-0.1180***	-0.1320**
	(2.32)	(-2.59)	(-7.38)	(-2.76)
netinvestment	0.00001	0.0000008	0.0000005*	0.000001***
	(0.86)	(1.39)	(2.01)	(6.51)
partconcern	-0.0587	-0.0759**	-0.0697***	-0.0825***
	(-1.10)	(-2.59)	(-4.42)	(-5.93)
publicprog	(omitted)	0.1510	-0.0272	0.1270
	(.)	(0.89)	(-0.22)	(1.16)
_cons	-0.3450	0.2520***	-0.6430***	-0.2400***
	(-0.89)	(3.72)	(36.38)	(-4.99)
N	16 183	22 899	22 899	22 899
R^2	0.002040	0.00540	0.00406	0.00383

Regression (4): Imputed Panel - Robustness Check 1
Top Cumulative Growth Decile: FE Panel Regression
Regression (5): Survivors - Robustness Check 2: FE Panel Regression
Regression (6): Survivors - Robustness Check 2a: FE-Adjusted 0.9 Quantile Regression
Regression (7): Survivors - Robustness Check 2b: FE-Adjusted 0.1 Quantile Regression

t Statistics in Parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Although several statistically significant estimates for the effect of the number of employees are attained, they are too small to warrant further analysis. Likewise, even though the effect from net investments is repeatedly positive and significant, it is much too small to indicate any substantial influence on the growth rates.

Participation in a public program is not associated with significant affects except in the case of the bottom decile of the firms, which however is merely included as a comparison case. Geographic expansion, on the other hand, is repeatedly negative and significant among the surviving firms, but strongly positive among the top cumulative decile in the panel regression setup, i.e. the first robustness check. It is also significant, but more modest in its magnitude, for the top decile of firms in the regression with simulated data. Thus, the evidence appears to be quite inconclusive regarding geographic expansion and its effect on growth for young firms.

Finally, belonging to a concern tends to decrease growth rates in all robustness checks with the surviving firms, and even more so for the top decile of the imputed, balanced panel. It is only significantly positive for the least-performing firms of the imputed dataset. This implies that the most robust result among the regression estimates is that there is a slightly negative effect of concern affiliation on growth rates, ranging from roughly 7.0% to about 34.9%.

In conclusion, the attained coefficients are not decisive and give a quite scattered picture, indicating that the estimates are quite sensitive to the choice of regression model. The particularly low R^2-values indicate that the vast majority of firm growth dynamics nevertheless is obscured from view in this setup. This result also proves robust with respect to the exclusion of the imputed data. Even though a few statistically significant, albeit inconclusive, links were found with respect to firm growth, they represent a very small fraction of the variation in the dependent variable. Thereby, the observed growth rates appear to be largely random, or at least driven by unobserved factors.

5 Conclusion

Going back to the purpose of this thesis, we will restate the first of the research questions, which was motivated by the apparent need for additional insights into firm growth patterns, due to the inconclusive findings in previous studies.

1. *How can the observed growth patterns be characterized?*

To answer this question, we summarize the findings pertaining to the observed growth patterns in the descriptive section of the analysis. Overall, approximately 10% of the limited firms established in 1997 survive until 2011. A marked decline in turnover and growth is seen in the time periods following two major macroeconomic shocks that affected Sweden during the analyzed time frame, namely the bursting of the dot-com bubble around the year 2000 and the global financial crisis that started between the years 2007 and 2008. Firm mortality goes up immediately after the first year of the companies' existence, only to rapidly fall until the end of the period. The highest rate of mortality is seen in the years following shortly after a firms' inception.

Even though there were outliers present throughout the analyzed time frame, the range of observed growth rates tended to decrease as time progressed. Average growth rates fell quite rapidly for the firms in the dataset, although not as quickly compared with the subset of firms surviving the entire period. Seen across industries, average growth rates were generally rather stable over time. However, a few industries exhibited rather volatile and seemingly erratic growth, such as mining and utilities. The growth rates diverged quite quickly after the first year, resulting in a skewed distribution. Having divided the cohort into deciles of cumulative growth, there was also a quite clear tendency for the top deciles to grow rapidly in the first few years, whereafter growth stabilized on a lower level. Lower deciles, on the other hand, did not experience as speedy early growth, but instead continuously remained at a steady, low growth level. Furthermore, high growth in one year was oftentimes followed by slow growth in a consequent year, and vice versa, whereas moderate growth rates tended to be sustained.

Looking at the distribution of the empirical growth rates, previous studies' contention that it follows a skewed, rather than a Gaussian distribution, found support in the results presented here. The hypothesis of normality was conclusively rejected in favor of a skewed distribution with fat tails, which became even more pronounced over time. The Laplace distribution constituted an attractive alternative, although the skewness appeared to be even more extreme than would be expected from such a distribution. This finding is in line with the results presented by Fu et al. (2005), and the results indicate that the Pareto, Linnik or perhaps, more generally, the Subbotin family of distributions constitute a more accurate fit for firm growth rates.

We now move on to the second research question:

2. *Can we identify factors that have a significant causal effect on the growth rates, and if so, which are they?*

We find the answer in the inferential part of the analysis. Even though a few significant causal links between the independent variables and the growth rates were found, most were inconclusive when compared to the coefficients of the robustness checks. The only economically and statistically significant variable was belonging to a concern, that continuously decreased growth rates for the high-growing firms, although the weak overall explanatory power of the regressions does not motivate further analysis of this link.

Consistently low R^2-values were seen in the results, and the robustness checks did not call this finding into question. Considering this ascertainment along with a lack of evidence for serial correlation, we find that even though certain tentative patterns were identified, they nonetheless account for such a small share of the variation that randomness is still appears to be the main driver of growth.

6 Discussion and Suggestions for Further Research

Judging from the growth distribution itself, the results attained in this study indicated that the growth rates may follow an even more skewed distribution than that of the Laplace, rather than what has previously been assumed in research. This implies that additional studies along the lines of Halvarsson (2013) that take more fat-tailed models like the Pareto or Linnik distributions into consideration appear to be warranted in order to accurately model firm growth.

Analysis of the growth patterns also indicated that the firms which achieved the highest growth rates experienced the bulk of this growth in the years immediately following their inception, whereas firms with more modest growth simply remained at a continuously low level. At the same time, hazard rates appear to be highest in the same time frame, namely shortly after the establishment of the firms. Relating this insight to “stages of growth” models in future research could provide insights into the importance of tackling early stage obstacles that entrepreneurs are faced with, such as obtaining customers and broadening their sales base in order to survive - both from a managerial and policy perspective (e.g. Churchill & Lewis, 1983; Greiner, 1983).

Another result was that participation in a public growth program was positive and significant in the case of the bottom decile in the imputed dataset, even though the effect became insignificant when disregarding the simulations. The notion that slow-growing firms, rather than fast-growing ones, stand to benefit the most from public subsidies or support isn’t one that, at least to the author’s knowledge, has been covered extensively by academic studies. Even though the low explanatory power of the model employed precludes any far-reaching conclusions, further support for this finding would carry significance for where public resources should be channeled most effectively. As most government programs aim to support high-growth firms and the top performers, it’s vital to establish if these are indeed the firms, and in extension the drivers of growth and employment, that benefit the most from the programs. If these companies fare as well without these resources, these programs may perhaps generate more of the aforementioned benefits by being investing in other companies than the conventionally chosen HGFs and Gazelles.

An additional matter that warrants further analysis is that of other firm-specific resources that were not included in this study. These include human capital and innovative capabilities among others, yet can be hard to define and measure (Denrell, Arvidsson, & Zander, 2004). A framework that enables meaningful quantification and tracking of these variables over time is needed if one is to include these other potential determinants of growth. Gaining explanatory power has proven difficult in the field of growth studies, and improving (or finding new) empirical methods to uncover previously obscured determinant factors may lead to new fundamental insights in the future. One specific suggestion for such research are other modes of growth than a purely organic one that was the object of study here. They are also likely to play a role in driving employment and economic growth, but were beyond the scope of this study. For example, growth through mergers, acquisitions and spin-offs is a field of study worthy of further investigation.

Geography is also an important factor to take into consideration when building on the findings presented here. The fact that this study has followed Swedish firms implies that the results should be applied with caution in other countries or regions. The vast majority of firm-level growth studies have been conducted in industrialized or developed countries that have at least moderately developed legal institutions with property rights enforcement, along with a relatively high level of technological development.[17] For countries that are not at the technological frontier, firm incentives and dynamics may be quite different, and consequently give rise to differing growth distributions. In fact, this is what Hölzl (2008) finds when studying high-growth firms across 16 countries; namely that firms in economies closer to the technological frontier tend to be more innovative due to less frequent business opportunities. This increases the importance of innovation as a means to achieve rapid growth. What this means for growth rate distributions and R&D's determinance of firm growth is another opportunity for further academic study and analysis.

The inclusion of simulated data contributed to the analysis insofar that its low explanatory power was robust to alternate regression models and comparison with non-simulated data. Even though congruent causal links were not identified, the finding that randomness is the main determinant of the firms' growth rates can be considered a robust one, at least for the object of study. The evidence provided here makes it appear unlikely that the inclusion of additional variables would greatly increase the explanatory power of the model. Combining the simulation framework with quantile regression approach is quite novel, and has not been encountered in previous literature by the author. Using this work as a methodological proof of concept, further studies may be able to contrast these findings with other data and alternate models in the future.

Lastly, and perhaps most importantly, the concept of "randomness" has been pervasive throughout this study. Attempting to identify and disentangle factors that have a significant effect on firm performance has been the object of numerous studies in the fields of economics, finance and management alike. This study is not the only one that has not been able to reject the hypothesis of randomness in this regard. For example, previous results have proposed that CEOs are to a large extent rewarded for luck, rather than performance (Bertrand & Mullainathan, 2001). Similarly, high-performing firms may oftentimes be successful not because of their capabilities, but rather because of luck or, if they engage in practices that have a wide range of divergent and risky outcomes, even because of sheer incompetence (Denrell, 2005; Denrell & Liu, 2012). Researchers have

[17] One example of a study of high-growth firms in developing countries is that of Goedhuys and Sleuwaegen (2009), which follows manufacturing companies in a number of Sub-Saharan African countries and makes use of quantile regression techniques.

attributed randomness, or near randomness, with explaining outcomes in both careers (March & March, 1977), as well as "expert" forecasts of interest rates and inflation (Denrell, 2013). In fact, Denrell, Fang, and Liu (2013) go as far as proposing that "random variation should be considered as one of the most important explanatory mechanisms in management" and that stochastic variation can provide a parsimonious model for organizational phenomena. This reasoning is reminiscent of that of Levy (1994), among others, who have introduced chaos theory in the field of management to analyze firms as belonging to complex and highly unpredictable dynamic systems.

Considering the human tendency to fall for cognitive biases, e.g. by focusing solely on surviving and high-performing firms, this complexity is important to keep in mind when faced with uncertainty (Tversky & Kahneman, 1974). Taleb (2007) suggests that rather than actively searching for "Black Swans", it is more worthwhile to adapt to uncertainty. Applying his reasoning to firm growth, adopting optimal settings for coping with poor firm performance while being able to gain from beneficial, high-growth outliers is preferable over attempting to predict these occurrences. As Denrell et al. (2013) point out, this reasoning constitutes a new potential paradigm for strategy and management science:

> *"How can managers manage in a world governed largely by chance? Finance accepted the idea that returns are unpredictable a long time ago and has nevertheless developed a normative framework centered on minimizing variability. Can strategy do something similar?"*

References

Amaral, L. A. N., Buldyrev, S. V., Havlin, S., Leschhorn, H., Maass, P., Salinger, M. A., ... Stanley, M. H. R. (1997). Scaling Behavior in Economics: I. Empirical Results for Company Growth. *Journal de Physique I*, *7*(4), 621-633.

Amaral, L. A. N., Buldyrev, S. V., Havlin, S., Maass, P., Salinger, M. A., Stanley, H. E., & Stanley, M. H. R. (1997). Scaling Behavior in Economics: The Problem of Quantifying Company Growth. *Physica A: Statistical Mechanics and its Applications*, *244*(1), 1-24.

Andersson, J., & Arvidson, G. (2004). *Företagens och Arbetsställenas Dynamik (FAD).* Data Description Published by SCB.

Arellano, M., & Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Review of Economic Studies*, *58*(2), 277-97.

Ashton, T. S. (1926). The Growth of Textile Businesses in the Oldham District, 1884-1924. *Journal of the Royal Statistical Society*, *89*(3), 567-583.

Audretsch, D. B., Klomp, L., & Thurik, A. R. (2002). *Gibrat's Law: Are the Services Different?* (Research Paper No. ERS-2002-04-STR). Erasmus Research Institute of Management (ERIM).

Audretsch, D. B., & Mahmood, T. (1994). Firm Selection and Industry Evolution: The Post-entry Performance of New Firms. *Journal of Evolutionary Economics*, *4*(3), 243-260.

Barnes, M. L., & Hughes, A. W. (2002). *A Quantile Regression Analysis of the Cross Section of Stock Market Returns* (Working Papers No. 02-2). Federal Reserve Bank of Boston.

Bernard, A. B., Massari, R., Reyes, J.-D., & Taglioni, D. (2013). *Exporter Dynamics, Firm Size and Growth, and Partial Year Effects* (Policy Research Working Paper Series No. 6711). The World Bank.

Bertrand, M., & Mullainathan, S. (2001). Are CEOs Rewarded for Luck? The Ones Without Principals Are. *The Quarterly Journal of Economics*, *116*(3), 901-932.

Birch, D. L. (1979). *The Job Generation Process.* M.I.T. Program on Neighborhood and Regional Change.

Bolagsverket. (2013). *Statistik om Företag och Föreningar.* Retrieved from `http://www.bolagsverket.se/om/oss/etjanster/statistik/statistik-1.3538`

Bottazzi, G., Cefis, E., & Dosi, G. (2002). Corporate Growth and Industrial Structures: Some Evidence from the Italian Manufacturing Industry. *Industrial and Corporate Change*, *11*(4), 705-723.

Bottazzi, G., Cefis, E., Dosi, G., & Secchi, A. (2003). *Invariances and Diversities in the Evolution of Manufacturing Industries* (Working Papers No. 03-17). Utrecht School of Economics.

Bottazzi, G., Coad, A., Jacoby, N., & Secchi, A. (2011). Corporate Growth and Industrial Dynamics: Evidence from French Manufacturing. *Applied Economics*, *43*(1), 103-116.

Bottazzi, G., Pirino, D., & Tamagni, F. (2013). *Zipf Law and the Firm Size Distribution: A Critical Discussion of Popular Estimators* (LEM Papers Series No. 2013/17). Laboratory of Economics and Management (LEM), Sant'Anna School of Advanced Studies, Pisa, Italy.

Bottazzi, G., & Secchi, A. (2003a). Common Properties and Sectoral Specificities in the Dynamics of U.S. Manufacturing Companies. *Review of Industrial Organization*, *23*(3), 217-232.

Bottazzi, G., & Secchi, A. (2003b). Why are Distributions of Firm Growth Rates Tent-Shaped? *Economics Letters*, *80*(3), 415-420.

Bottazzi, G., & Secchi, A. (2005). *Explaining the Distribution of Firms Growth Rates* (LEM Papers Series No. 2005/16). Laboratory of Economics and Management (LEM), Sant'Anna School of Advanced Studies, Pisa, Italy.

Buldyrev, S. V., Amaral, L. A. N., Havlin, S., Leschhorn, H., Maass, P., Salinger, M. A., ... Stanley, M. H. R. (1997). Scaling Behavior in Economics: II. Modeling of Company Growth. *Journal de Physique I*, *7*(4), 635-650.

Cabral, L. M. B. (1995). Sunk Costs, Firm Size and Firm Growth. *Journal of Industrial Economics*, *43*(2), 161-172.

Cabral, L. M. B., & Mata, J. (2001). *On the Evolution of the Firm Size Distribution: Facts and Theory* (CEPR Discussion Papers No. 3045). C.E.P.R.

Canay, I. A. (2011). A Simple Approach to Quantile Regression for Panel Data. *Econometrics Journal*, *14*(3), 368-386.

Capasso, M., Cefis, E., & Frenken, K. (2009). *Do Some Firms Persistently Outperform?* (Working Papers No. 09-28). Utrecht School of Economics.

Carpenter, J. N., & Lynch, A. W. (1999). Survivorship Bias and Attrition Effects in Measures of Performance Persistence. *Journal of Financial Economics*, *54*(3), 337-374.

Churchill, N. C., & Lewis, V. L. (1983). The Five Stages of Small Business Growth. *Harvard Business Review*, *61*(3), 30-50.

Coad, A. (2007a). A Closer Look at Serial Growth Rate Correlation. *Review of Industrial Organization*, *31*(1), 69-82.

Coad, A. (2007b). *Firm Growth: A Survey* (Documents de travail du Centre d'Economie de la Sorbonne). Université Panthéon-Sorbonne (Paris 1), Centre d'Economie de la Sorbonne.

Coad, A. (2009). *The Growth of Firms: A Survey of Theories and Empirical Evidence.* Edward Elgar Publishing.

Coad, A., & Hölzl, W. (2008). *On the Autocorrelation of Growth Rates: Evidence for Micro, Small and Large Firms from the Austrian Service Industries, 1975-2004* (WIFO Working Papers No. 332). WIFO - Austrian Institute of Economic Research.

Coad, A., & Hölzl, W. (2010). *Firm Growth: Empirical Analysis* (WIFO Working Papers No. 361). WIFO.

Colombelli, A., Haned, N., & Le Bas, C. (2011). *On Firm Growth and Innovation - Some New Empirical Perspectives Using French CIS (1992-2004)* (ICER Working

Papers No. 07-2011). ICER - International Centre for Economic Research.
Cox, D. R., & Oakes, D. (1984). *Analysis of Survival Data.* Taylor & Francis.
Daunfeldt, S.-O., & Elert, N. (2013). When is Gibrat's Law a Law? *Small Business Economics*, *41*(1), 133-147.
Daunfeldt, S.-O., & Halvarsson, D. (2012). *Are High-Growth Firms One-Hit Wonders? Evidence from Sweden* (HUI Working Papers No. 73). HUI Research.
Davidsson, P., & Wiklund, J. (2013). *New Perspectives on Firm Growth.* Edward Elgar Publishing.
Davila, A., Foster, G., & Gupta, M. (2003). Venture Capital Financing and the Growth of Startup Firms. *Journal of Business Venturing*, *18*(6), 689-708.
De Clercq, D., Meuleman, M., & Wright, M. (2012). A Cross-Country Investigation of Micro-Angel Investment Activity: The Roles of New Business Opportunities and Institutions. *International Business Review*, *21*(2), 117-129.
de Meza, D., & Webb, D. (1999). Wealth, Enterprise and Credit Policy. *Economic Journal*, *109*(455), 153-163.
Denrell, J. (2003). Vicarious Learning, Undersampling of Failure, and the Myths of Management. *Organization Science*, *14*(3), 227-243.
Denrell, J. (2004). Random Walks and Sustained Competitive Advantage. *Management Science*, *50*(7), 922-934.
Denrell, J. (2005). Should We Be Impressed With High Performance? *Journal of Management Inquiry*, *14*(3), 292-298.
Denrell, J. (2013). "Experts" Who Beat the Odds are Probably Just Lucky. *Harvard Business Review*, *91*(4).
Denrell, J., Arvidsson, N., & Zander, U. (2004). Managing Knowledge in the Dark: An Empirical Study of the Reliability of Capability Evaluations. *Management Science*, *50*(11), 1491-1503.
Denrell, J., Fang, C., & Liu, C. (2013). *The Random School of Thought in Management.* (Mimeo)
Denrell, J., & Liu, C. (2012). Top Performers are not the Most Impressive When Extreme Performance Indicates Unreliability. *Proceedings of the National Academy of Sciences*, *109*(24), 9331-9336.
Drukker, D. M. (2003). Testing for Serial Correlation in Linear Panel-Data Models. *Stata Journal*, *3*(2), 168-177.
Dunne, P., & Hughes, A. (1994). Age, Size, Growth and Survival: UK Companies in the 1980s. *Journal of Industrial Economics*, *42*(2), 115-140.
Epanechnikov, V. A. (1969). Non-Parametric Estimation of a Multivariate Probability Density. *Theory of Probability and Its Applications*, *14*(1), 153–158.
Erlingsson, E. J., Alfarano, S., Raberto, M., & Stefánsson, H. (2012). *On the Distributional Properties of Size, Profit and Growth of Icelandic Firms* (Working Papers No. 2012/01). Economics Department, Universitat Jaume I, Castellón (Spain).
Fier, A., Aschhoff, B., & Löhlein, H. (2007). *Detecting Behavioural Additionality: An Empirical Study on the Impact of Public R&D Funding on Firms' Cooperative Behaviour in Germany* (ZEW Discussion Papers No. 06-037). ZEW - Zentrum für

Europäische Wirtschaftsforschung.
Fornahl, D., & Otto, A. (2008). Between Snails and Gazelles? Analysing the Effects of Regional Specialisation on Firm Growth: A Quantile Regression Approach. In *Paper presented at the 25th celebration conference 2008.* DRUID.
Forsgren, M. (2013). *Theories of the Multinational Firm: A Multidimensional Creature in the Global Economy.* Edward Elgar Publishing.
Fu, D., Pammolli, F., Buldyrev, S. V., Riccaboni, M., Matia, K., Yamasaki, K., & Stanley, H. E. (2005). *The Growth of Business Firms: Theoretical Framework and Empirical Evidence* (MPRA Paper No. 15905). University Library of Munich, Germany.
Garnsey, E., Stam, E., & Heffernan, P. (2006). New Firm Growth: Exploring Processes and Paths. *Industry and Innovation*, *13*(1), 1-20.
Geroski, P. A. (1999). *The Growth of Firms in Theory and in Practice* (CEPR Discussion Papers No. 2092). C.E.P.R.
Geroski, P. A., & Gugler, K. P. (2001). *Corporate Growth Convergence in Europe* (CEPR Discussion Papers No. 2838). CEPR.
Gibrat, R. (1931). *Les Inégalités Économiques: Applications: Aux Inégalités des Richesses, à la Concentration des Entreprises, aux Populations des Villes, aux Statistiques des Familles, etc., d'une Loi Nouvelle, la Loi de l'Effect Proportionnel.* Recueil Sirey.
Gladwell, M. (2008). *Outliers: The Story of Success.* Little, Brown.
Goedhuys, M., & Sleuwaegen, L. (2009). *High-Growth Entrepreneurial Firms in Africa: A Quantile Regression Approach* (Working Paper Series No. 2009/11). World Institute for Development Economic Research (UNU-WIDER).
González-Val, R., & Sanso-Navarro, M. (2008). *Gibrat's Law for Countries* (MPRA Paper No. 9733). University Library of Munich, Germany.
Greiner, L. E. (1972). Evolution and Revolution as Organizations Grow. *Harvard Business Review*, *50*(4), 37-46.
Greiner, L. E. (1983). Evolution and Revolution as Organizations Grow. *Harvard Business Review*, *50*(4), 37-46.
Halvarsson, D. (2013). *On the Estimation of Skewed Geometric Stable Distributions* (Ratio Working Papers No. 216). The Ratio Institute.
Hao, L., & Naiman, D. Q. (2007). *Quantile Regression* (No. 149). SAGE Publications.
Harhoff, D., Stahl, K., & Woywode, M. (1998). Legal Form, Growth and Exit of West German Firms - Empirical Results for Manufacturing, Construction, Trade and Service Industries. *Journal of Industrial Economics*, *46*(4), 453-488.
Henderson, A. D., Raynor, M. E., & Ahmed, M. (2012). How Long Must a Firm be Great to Rule out Chance? Benchmarking Sustained Superior Performance Without Being Fooled by Randomness. *Strategic Management Journal*, *33*(4), 387–406.
Henrekson, M., & Johansson, D. (2008a). *Competencies and Institutions Fostering High-growth Firms* (Working Paper Series No. 757). Research Institute of Industrial Economics.

Henrekson, M., & Johansson, D. (2008b). *Gazelles as Job Creators – A Survey and Interpretation of the Evidence* (Working Paper Series No. 733). Research Institute of Industrial Economics.

Heshmati, A. (2001). On the Growth of Micro and Small Firms: Evidence from Sweden. *Small Business Economics*, *17*(3), 213-228.

Hölzl, W. (2008). *Is the R&D Behaviour of Fast Growing SMEs Different? Evidence from CIS III Data for 16 Countries* (WIFO Working Papers No. 327). WIFO.

Hölzl, W., & Friesenbichler, K. S. (2006). Gazelles. *Innovation Watch, Europe Innova, Scoping Paper*, *31*.

Hyytinen, A., & Toivanen, O. (2005). Do Financial Constraints Hold Back Innovation and Growth?: Evidence on the Role of Public Policy. *Research Policy*, *34*(9), 1385-1403.

Juglar, C. (1862). *Des Crises Commerciales et de Leur Retour Périodique en France, en Angleterre, et aux États-Unis*. Guillaumin.

Kantarelis, D. (2007). *Theories of the Firm*. Inderscience Enterprises.

Kitchin, J. (1993). Cycles and Trends in Economic Factors. *Review of Economics and Statistics*, *5*(1), 10-16.

Koch, A., Späth, J., & Strotmann, H. (1998). Small Business Growth Through Geographic Expansion: A Comparative Case Study. *Journal of Business Venturing*, *13*(6), 467-492.

Koch, A., Späth, J., & Strotmann, H. (2013). Survivorship Bias and Attrition Effects in Measures of Performance Persistence. *Small Business Economics*, *41*(3), 733-755.

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

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

Kogut, B., & Zander, U. (1993). Knowledge of the Firm and the Evolutionary Theory of the Multinational Corporation. *Journal of International Business Studies*, *24*(4), 625-645.

Lerner, J. (1999). The Government as Venture Capitalist: The Long-Run Impact of the SBIR Program. *The Journal of Business*, *72*(3), 285-318.

Lerner, J. (2002). When Bureaucrats Meet Entrepreneurs: The Design of Effective "Public Venture Capital" Programmes. *Economic Journal*, *112*(477), F73-F84.

Levy, D. (1994). Chaos Theory and Strategy: Theory, Application, and Managerial Implications. *Strategic Management Journal*, *15*, 167-178.

Lévy, M., Lévy, H., & Solomon, S. (1994). A Microscopic Model of the Stock Market: Cycles, Booms and Crashes. *Economics Letters*, *45*(1), 103-111.

Lotti, F., & Santarelli, E. (2001). *Industry Dynamics and the Distiribution of Firm Sizes: A Non-Parametric Apporoach* (Working Papers No. 406). Dipartimento Scienze Economiche, Universita' di Bologna.

Lotti, F., Santarelli, E., & Vivarelli, M. (2007). *Defending Gibrat's Law as a Long-Run Regularity* (IZA Discussion Papers). Institute for the Study of Labor (IZA).

Lu, X., & White, H. (2014). Robustness checks and robustness tests in applied economics. *Journal of Econometrics*, *178, Part 1*(0), 194 - 206.

Machado, J. A. F., Parente, P. M. D. C., & Santos Silva, J. M. C. (2011). *QREG2: Stata Module to Perform Quantile Regression with Robust and Clustered Standard Errors.* Statistical Software Components, Boston College Department of Economics. Retrieved from `http://ideas.repec.org/c/boc/bocode/s457369.html`

Maican, F. G. (2012). *From Boom to Bust and Back Again: A Dynamic Analysis of IT Services* (Working Papers in Economics No. 543). University of Gothenburg, Department of Economics.

Maksimovic, V., & Phillips, G. (2008). The Industry Life Cycle, Acquisitions and Investment: Does Firm Organization Matter? *Journal of Finance*, *63*(2), 673-708.

Mandelbrot, B. B. (1963). The Variation of Certain Speculative Prices. *The Journal of Business*, *36*(4), 394-419.

Mandelbrot, B. B. (1965). Forecasts of Future Prices, Unbiased Markets, and "Martingale" Models. *The Journal of Business*, *39*(1), 242-255.

Mantegna, R. N., & Stanley, H. E. (2000). *Introduction to Econophysics: Correlations and Complexity in Finance.* Cambridge University Press.

March, J. C., & March, J. G. (1977). Almost Random Careers: The Wisconsin School Superintendency, 1940-1972. *Administrative Science Quarterly*, *22*(3), 377-409.

Marsili, O. (2001). *The Anatomy and Evolution of Industries: Technological Change and Industrial Dynamics.* Edward Elgar Publishing.

Minniti, M., Zacharakis, A., Spinelli, S., Rice, M., & Habbershon, T. (2006). *Entrepreneurship: The Engine of Growth.* Greenwood Publishing Group.

Nelson, R. R., & Winter, S. G. (1982). *An Evolutionary Theory of Economic Change.* Belknap Press of Harvard University Press.

Niefert, M. (2005). *Patenting Behaviour and Employment Growth in German Start-up Firms: A Panel Data Analysis* (ZEW Discussion Papers No. 05-03). ZEW - Zentrum für Europäische Wirtschaftsforschung / Center for European Economic Research.

Pedersen, M. E. H. (2013). *Monte Carlo Simulation in Financial Valuation* (Hvass Laboratories Report No. HL-1302). Hvass Laboratories.

Penrose, E. T. (1995). *The Theory of the Growth of the Firm.* Oxford University Press.

Powell, D. (2010). *Unconditional Quantile Regression for Panel Data with Exogenous or Endogenous Regressors* (Working Papers No. 710-1). RAND Corporation Publications Department.

Reichstein, T., & Dahl, M. (2004). Are Firm Growth Rates Random? Analysing Patterns and Dependencies. *International Review of Applied Economics*, *18*(2), 225-246.

Reichstein, T., Dahl, M., Ebersberger, B., & Jensen, M. (2010). The Devil Dwells in the Tails. *Journal of Evolutionary Economics*, *20*(2), 219-231.

Reichstein, T., & Jensen, M. B. (2003). *Analyzing the Distributions of the Stochastic Firm Growth Approach* (DRUID Working Papers No. 03-12). DRUID.

Reichstein, T., & Jensen, M. B. (2005). Firm Size and Firm Growth Rate Distributions - The Case of Denmark. *Industrial and Corporate Change*, *14*(6), 1145-1166.

Rodríguez, G. (2007). *Lecture Notes on Generalized Linear Models.* Princeton University. Retrieved from http://data.princeton.edu/wws509/notes/

Rosser, B. (2008). Econophysics and Economic Complexity. *Advances in Complex Systems (ACS)*, *11*(5), 745-760.

Rossi-Hansberg, E., & Wright, M. L. J. (2006). *Establishment Size Dynamics in the Aggregate Economy* (Staff Report No. 382). Federal Reserve Bank of Minneapolis.

Rudolph, P., & Jostarndt, P. (2007). *Financial Distress, Corporate Restructuring and Firm Survival: An Empirical Analysis of German Panel Data.* Deutscher Universitäts-Verlag.

Samuelson, P. A. (2007). Money, Distribution and Economic Policy: Alternatives to Orthodox Macroeconomics. In (chap. Long-Run Risk Tolerance when Equity Returns are Mean Regressing: Pseudo-Paradoxes and Vindication of Business-Man's Risk). Edward Elgar Publishing.

SCB. (2013). *Statistics Sweden - About Us.* Retrieved from http://www.scb.se/aboutscb

Scott, D. (1979). On Optimal and Data-Based Histograms. *Biometrika*, *66*(3), 605–610.

Sexton, D. L., & Kasarda, J. D. (1992). *The State of the Art of Entrepreneurship.* PWS-Kent.

Shane, S. (2009). Why Encouraging More People to Become Entrepreneurs is Bad Public Policy. *Small Business Economics*, *33*(2), 141-149.

Shechter, S. M., Schaefer, A. J., Braithwaite, R. S., & Roberts, M. S. (2006). Increasing the Efficiency of Monte Carlo Cohort Simulations with Variance Reduction Techniques. *Medical Decision Making*, *26*(5), 550-553.

Skatteverket. (2013). *SKV 260B - E-Filing Income Statements – A Technical Description - Income Year 2013.* Retrieved from https://www.skatteverket.se/download/18.8dcbbe4142d38302d755a4/1387385701228/SKV+260B_english_+2014.pdf (Edition 3, Version 1.0)

Stanley, M. H. R., Amaral, L. A. N., Buldyrev, S. V., Havlin, S., Leschhorn, H., Maass, P., ... Stanley, H. E. (1996). Scaling Behaviour in the Growth of Companies. *Nature*, *379*(6568), 804-806.

Starbuck, W. H. (1971). *Organizational Growth and Development.* Rand McNally.

Sutton, J. (1997). Gibrat's Legacy. *Journal of Economic Literature*, *35*(1), 40-59.

Taleb, N. N. (2007). *The Black Swan: The Impact of the Highly Improbable.* Random House Publishing Group.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic Capabilities and Strategic Management". *Strategic Management Journal*, *18*(7), 509-533.

Tillväxtanalys. (2012). *Knowledge for Growth.* Retrieved from http://www.tillvaxtanalys.se/download/18.69e9bee013b03a9470a120/1352983174386/Knowledge_for_growth_2012.pdf

Tversky, A., & Kahneman, D. (1974). Judgment under Uncertainty: Heuristics and Biases. *Science*, *185*(4157), 1124-1131.

Vinnova. (2011). *Vinnova - Sweden's Innovation Agency.* Retrieved from http://www.tillvaxtanalys.se/download/18.69e9bee013b03a9470a120/1352983174386/Knowledge_for_growth_2012.pdf (Vinnova Information Vi2011:06)

White, H. (2001). *Asymptotic Theory for Econometricians.* Academic Press.

Wilkinson, J. T., Spong, K., & Christensson, J. (2010). Financial Stability Reports: How Useful During a Financial Crisis? *Economic Review - Federal Reserve Bank of Kansas City.*

Wooldridge, J. M. (2002). *Econometric Analysis of Cross Section and Panel Data.* MIT Press.

Wooldridge, J. M. (2009). *Introductory Econometrics: A Modern Approach.* South Western, Cengage Learning.

Appendices

A Further Description of the Dataset

The following tables show a breakdown of the firms in the dataset by industry, including attrition by year.

Table 12 **Breakdown by Industry, Part 1**

Year	**Agriculture, forestry, fishing**	**Mining, gas extraction**	**Manufacturing (food, beverages, tobacco)**	**Manufacturing (textiles, clothing, leather)**	**Manufacturing (wood, pulp and paper)**
Established 1997	461	45	138	57	196
1997	12	2	6	3	4
1998	167	18	75	26	78
1999	65	7	20	7	25
2000	34	3	16	8	20
2001	38	3	9	2	9
2002	18	4	6	0	9
2003	19	2	2	1	10
2004	16	0	4	1	6
2005	4	0	1	0	2
2006	13	1	1	2	2
2007	4	2	0	1	4
2008	8	1	0	0	3
2009	2	0	2	2	1
2010	4	0	0	1	2
2011	3	0	1	0	1

Table 13 **Breakdown by Industry, Part 2**

Year	**Manufacturing (for graphic and recording media)**	**Manufacturing (mineral, chemical and plastic goods)**	**Manufacturing (steel and metal goods, electronics, vehicles and furniture)**	**Utilities (electricity, gas, heating, cooling)**
Established 1997	361	129	804	121
1997	7	3	22	4
1998	157	46	295	52
1999	58	22	110	14
2000	38	11	79	11
2001	17	11	52	5
2002	15	10	42	4
2003	5	5	37	4
2004	9	1	22	3
2005	9	0	15	2
2006	4	3	11	1
2007	10	5	13	1
2008	3	2	12	0
2009	3	2	16	1
2010	1	4	11	1
2011	3	1	5	1

Table 14 **Breakdown by Industry, Part 3**

Year	Construction	Motor vehicle repairs	Logistics, transport, storage and postal services	Hotel, restaurant and hospitality
Established 1997	1 541	4 929	1 216	1 809
1997	44	131	30	46
1998	608	1 940	504	1 094
1999	218	676	166	301
2000	109	474	118	130
2001	91	307	72	72
2002	55	201	59	39
2003	41	169	42	30
2004	37	116	23	22
2005	32	108	17	12
2006	30	83	22	13
2007	25	72	11	9
2008	22	65	17	7
2009	23	49	12	3
2010	23	44	15	6
2011	7	22	8	5

Table 15 **Breakdown by Industry, Part 4**

Year	**Information, IT and communication services**	**Real estate, financial and insurance services**	**Consulting (legal, business, science and technology)**	**Facility management, rental, leasing, travel**
Established 1997	895	792	76	4 213
1997	14	15	0	124
1998	328	325	30	1 575
1999	138	111	13	609
2000	98	49	10	388
2001	65	49	5	262
2002	45	35	5	191
2003	37	34	5	165
2004	29	24	1	116
2005	18	19	1	103
2006	15	21	0	76
2007	15	21	6	51
2008	19	16	54	12
2009	5	7	49	7
2010	14	12	42	6
2011	11	5	31	4

Table 16 **Breakdown by Industry, Part 5**

Year	**Education, healthcare, social services**	**Cultural, leisure, religious and other services**	**Total**
Established 1997	618	831	19 232
1997	20	22	509
1998	257	355	7 930
1999	70	111	2 741
2000	67	66	1 729
2001	35	52	1 156
2002	17	27	782
2003	20	32	660
2004	12	26	468
2005	16	16	375
2006	5	11	314
2007	13	7	270
2008	12	8	261
2009	8	5	197
2010	8	6	200
2011	9	6	123

B Industry Categorization

In the initial dataset, the industry variable was coded according to the Swedish Standard Industrial Classification System ("SNI") employed by Statistics Sweden (SCB). The coding was at a five digit level, and was consequently aggregated to a two level coding in order to allow for meaningful analysis. Thereafter, the codes were grouped further into coherent industries closely following the most aggregated (single letter) division used by SCB, which resulted in the 19 industries presented in the previous section.

However, SNI coding changed in 2002, resulting in a need to recode companies from before the change to the present 2007 SNI categorization standard. This was done by comparing coding tables provided by SCB describing both the 2002 and 2007 SNI systems. The wide majority of cases were straightforward insofar that the nomenclature was identical and only called for a simple recoding. A few instances were ambiguous with respect to specific disaggregated categorization, but allocation was unproblematic on an aggregated level.

For the sake of completeness and transparency, however, the allocation procedure is presented here (albeit in Swedish). The left hand side of the table shows the respective outdated coding from 2002, while the right hand side shows how the respective codes were recoded, and under which main disaggregated industry category they were filed.

SNI 2002	**SNI 2007**
C Utvinning av mineral	
10 Kol- och torvutvinning	05 Kolutvinning
11 Utvinning av råpetroleum och	06 Utvinning av råpetroleum
naturgas samt service i anslutning härtill	09 Service till utvinning
12 Utvinning av uran- och toriummalm	07 Utvinning av metallmalmer
13 Utvinning av metallmalmer	07 Utvinning av metallmalmer
14 Annan mineralutvinning	08 Annan utvinning av mineral

SNI 2002	SNI 2007
D Tillverkning	
15 Livsmedels- och dryckesvaruframställning	10 Livsmedelsframställning
16 Tobaksvarutillverkning	12 Tobaksvarutillverkning
17 Textilvarutillverkning	13 Textilvarutillverkning
18 Tillverkning av kläder; pälsberedning	14 Tillverkning av kläder
19 Garvning och annan läderberedning; tillverkning av reseffekter, handväskor, skodon o.d.	15 Tillverkning av läder, läder- och skinnvaror m.m
20 Tillverkning av trä och varor av trä, kork och rotting o.d. utom möbler	16 Tillverkning av trä och varor av trä, kork, rotting o.d. utom möbler
21 Massa-, pappers- och pappersvarutillverkning	17 Pappers- och pappersvarutillverkning
22 Förlagsverksamhet; grafisk produktion och reproduktion av inspelningar	18 Grafisk produktion och reproduktion av inspelningar
23 Tillverkning av stenkolsprodukter, raffinerade petroleumprodukter och kärnbränsle	19 Tillverkning av stenkolsprodukter och raffinerade petroleumprodukter
24 Tillverkning av kemikalier och kemiska produkter	20 Tillverkning av kemikalier och kemiska produkter
25 Tillverkning av gummi- och plastvaror	22 Tillverkning av gummi- och plastvaror
26 Tillverkning av icke-metalliska mineraliska produkter	23 Tillverkning av andra icke-metalliska mineraliska produkter
27 Stål- och metallframställning	24 Stål- och metallframställning
28 Tillverkning av metallvaror utom maskiner och apparater	25 Tillverkning av metallvaror utom maskiner och apparater
29 Tillverkning av maskiner som ej ingår i annan underavdelning	28 Tillverkning av övriga maskiner
30 Tillverkning av kontorsmaskiner och datorer	26 Tillverkning av datorer, elektronikvaror och optik
31 Tillverkning av andra elektriska maskiner och artiklar	26 Tillverkning av datorer, elektronikvaror och optik
32 Tillverkning av teleprodukter	26 Tillverkning av datorer, elektronikvaror och optik
33 Tillverkning av precisionsinstrument, medicinska och optiska instrument samt ur	26 Tillverkning av datorer, elektronikvaror och optik
34 Tillverkning av motorfordon, släpfordon och påhängsvagnar	29 Tillverkning av motorfordon, släpfordon och påhängsvagnar
36 Tillverkning av möbler; annan tillverkning	32 Annan tillverkning
37 Återvinning	38 Avfallshantering; återvinning

SNI 2002	SNI 2007
E El-, gas-, värme- och vattenförsörjning	
40 El-, gas-, ång- och hetvattenförsörjning	35 Försörjning av el, gas, värme och kyla
41 Vattenförsörjning	36 Vattenförsörjning
F Byggverksamhet	
45 Byggverksamhet	41 Byggande av hus
G Partihandel och detaljhandel; reparation av motorfordon, hushållsartiklar och personliga artiklar	
50 Handel med och service av motorfordon; detaljhandel med drivmedel	47 Detaljhandel utom med motorfordon och motorcyklar
51 Parti- och agenturhandel utom med motorfordon	47 Detaljhandel utom med motorfordon och motorcyklar
52 Detaljhandel utom med motorfordon; reparation av hushållsartiklar och personliga artiklar	47 Detaljhandel utom med motorfordon och motorcyklar
H Hotell- och restaurangverksamhet	
55 Hotell- och restaurangverksamhet	55 Hotell- och logiverksamhet 56 Restaurang-, catering och barverksamhet
I Transport, magasinering och kommunikation	
60 Landtransport; transport i rörsystem	49 Landtransport; transport i rörsystem
61 Sjötransport	50 Sjötransport
62 Lufttransport	51 Lufttransport
63 Stödtjänster till transport; resebyråverksamhet	52 Magasinering och stödtjänster till transport
64 Post- och telekommunikationer	53 Post- och kurirverksamhet
J Finansiell verksamhet	
65 Finansförmedling utom försäkring och pensionsfondsverksamhet	64 Finansiella tjänster utom försäkring och pensionsfondsverksamhet
67 Stödtjänster till finansiell verksamhet	66 Stödtjänster till finansiella tjänster och försäkring

SNI 2002	SNI 2007
K Fastighets- och uthyrningsverksamhet, företagstjänster	
70 Fastighetsverksamhet	68 Fastighetsverksamhet
71 Uthyrning av fordon och maskiner utan bemanning samt av hushållsartiklar och varor för personligt bruk	77 Uthyrning och leasing
72 Databehandlingsverksamhet m.m.	63 Informationstjänster
73 Forskning och utveckling	72 Vetenskaplig forskning och utveckling
74 Andra företagstjänster	82 Kontorstjänster och andra företagstjänster
M Utbildning	
80 Utbildning	85 Utbildning
N Hälso- och sjukvård, sociala tjänster; veterinärverksamhet	
85 Hälso- och sjukvård, sociala tjänster; veterinärverksamhet	86 Hälso- och sjukvård 88 Öppna sociala insatser 75 Veterinärverksamhet
O Andra samhälleliga och personliga tjänster	
90 Avloppsrening, avfallshantering, renhållning o.d.	37 Avloppsrening 38 Avfallshantering; återvinning 39 Sanering, efterbehandling av jord och vatten samt annan verksamhet för föroreningsbekämpning
91 Intressebevakning; religiös verksamhet	94 Intressebevakning; religiös verksamhet
92 Rekreations-, kultur- och sportverksamhet	90 Konstnärlig och kulturell verksamhet samt underhållningsverksamhet 93 Sport-, fritids- och nöjesverksamhet
93 Annan serviceverksamhet	96 Andra konsumenttjänster

C Decile Transition Probabilities by Year

Tables 17 through 29 illustrate the transition probabilities for the firms by year with respect to growth deciles. The values denote the probabilities (in %), that a firm in a given decile at time *t-1* will find itself in the different deciles in time *t*.

Table 17 **Decile Transition Probabilities 1998-1999**

Turnover growth decile in 1998	Turnover growth decile in 1999 top: 1	2	3	4	5	6	7	8	9	bottom: 10
top: 1	8.84	7.89	6.58	4.40	5.13	5.24	5.38	7.50	10.42	23.94
2	7.58	11.03	10.93	8.67	9.88	9.24	7.51	10.38	10.17	9.78
3	4.04	9.27	12.30	16.46	13.00	10.61	12.14	7.63	9.40	7.21
4	4.17	8.52	13.04	16.46	15.50	14.36	11.39	8.50	6.10	4.89
5	5.56	10.53	11.06	12.94	11.63	13.98	12.64	11.75	7.88	6.31
6	6.31	10.65	10.19	9.92	11.13	12.11	11.89	13.25	12.58	8.11
7	8.46	11.78	9.81	9.80	10.88	11.74	12.39	11.38	11.05	9.14
8	9.47	10.78	8.45	9.80	8.75	10.86	10.51	12.38	10.80	11.07
9	18.43	11.78	9.44	6.53	7.75	6.49	9.76	8.50	11.94	8.37
bottom: 10	27.15	7.77	8.20	5.03	6.38	5.37	6.38	8.75	9.66	11.20
Total	100	100	100	100	100	100	100	100	100	100

Transition probabilities given in percent

Table 18 **Decile Transition Probabilities 1999-2000**

Turnover growth decile in 1999	Turnover growth decile in 2000 top: 1	2	3	4	5	6	7	8	9	bottom: 10
top: 1	10.51	8.33	5.82	5.85	5.20	7.39	7.54	5.97	7.69	23.46
2	8.76	8.96	8.96	8.70	6.77	6.45	8.32	10.68	13.50	14.33
3	8.76	11.48	12.42	11.39	7.87	8.96	11.46	11.15	8.48	10.08
4	4.62	9.43	10.85	12.82	14.02	13.05	12.24	10.52	9.73	6.93
5	4.46	8.81	9.59	14.24	18.27	13.99	12.09	9.58	7.85	4.88
6	5.89	9.91	13.52	14.24	11.81	18.24	11.30	8.63	6.75	5.67
7	6.21	8.96	14.62	11.39	11.50	8.96	13.66	10.52	7.85	6.46
8	9.55	10.53	10.22	8.07	12.28	9.28	10.36	13.97	11.15	7.87
9	11.94	12.11	8.81	8.23	7.09	8.33	8.16	11.15	16.01	10.55
bottom: 10	29.30	11.48	5.19	5.06	5.20	5.35	4.87	7.85	10.99	9.76
Total	100	100	100	100	100	100	100	100	100	100

Transition probabilities given in percent

Table 19 **Decile Transition Probabilities 2000-2001**

Turnover growth decile in 2000	Turnover growth decile in 2001									
	top: 1	2	3	4	5	6	7	8	9	bottom: 10
top: 1	9.06	8.29	5.18	6.35	5.57	3.66	3.84	6.72	9.42	25.72
2	9.06	11.95	7.87	7.69	6.33	7.71	8.83	9.79	13.65	14.78
3	8.09	8.67	8.83	11.15	9.02	11.18	10.94	11.90	12.31	8.25
4	6.74	7.51	12.28	11.35	15.93	14.45	10.75	10.75	6.73	6.14
5	4.43	9.06	8.83	15.96	14.40	14.26	11.52	8.83	6.54	9.02
6	3.85	6.36	13.24	13.46	12.09	16.57	11.32	11.71	8.27	6.72
7	4.62	9.44	13.24	12.88	13.05	11.95	14.40	9.98	8.46	6.53
8	7.90	13.68	11.52	11.35	10.17	8.29	10.94	11.90	11.73	5.76
9	12.52	14.45	10.75	5.58	9.02	8.09	10.17	11.32	15.19	7.68
bottom: 10	33.72	10.60	8.25	4.23	4.41	3.85	7.29	7.10	7.69	9.40
Total	100	100	100	100	100	100	100	100	100	100

Transition probabilities given in percent

Table 20 **Decile Transition Probabilities 2001-2002**

Turnover growth decile in 2001	Turnover growth decile in 2002 top: 1	2	3	4	5	6	7	8	9	bottom: 10
top: 1	11.82	7.53	5.47	6.39	3.64	4.76	5.92	5.92	8.20	23.69
2	10.00	12.56	10.02	10.50	7.97	7.26	5.69	8.43	11.16	12.53
3	8.64	9.13	10.25	9.59	10.25	9.52	11.62	10.48	13.44	9.57
4	7.73	7.31	9.34	12.56	14.81	14.29	10.48	9.79	10.71	6.61
5	5.91	7.31	10.48	10.27	15.95	15.87	15.26	10.71	6.61	6.15
6	7.50	6.16	9.34	11.19	13.90	14.29	11.16	11.85	10.93	6.15
7	4.77	7.31	11.16	10.50	12.53	13.61	15.72	14.81	10.25	6.15
8	7.05	11.87	13.21	12.10	9.57	9.98	10.02	10.25	11.39	8.88
9	7.95	16.21	12.76	9.36	7.06	7.03	8.43	12.07	10.71	9.34
bottom: 10	28.64	14.61	7.97	7.53	4.33	3.40	5.69	5.69	6.61	10.93
Total	100	100	100	100	100	100	100	100	100	100

Transition probabilities given in percent

Table 21 **Decile Transition Probabilities 2002-2003**

Turnover growth decile in 2002	Turnover growth decile in 2003									
	top: 1	2	3	4	5	6	7	8	9	bottom: 10
top: 1	12.83	6.93	8.02	6.68	3.74	4.81	4.00	6.93	4.81	22.93
2	11.50	13.07	10.43	6.15	3.48	5.35	8.00	9.87	9.63	16.80
3	10.16	9.07	10.43	11.50	9.36	6.68	10.13	10.67	11.23	10.67
4	7.22	10.40	9.63	12.30	13.37	11.76	9.07	9.33	10.70	9.33
5	8.29	8.00	10.43	10.43	14.44	16.04	12.80	9.60	7.75	5.33
6	5.35	8.80	11.50	13.37	14.97	16.58	10.93	8.27	8.02	6.13
7	5.35	7.20	8.82	11.23	13.37	13.10	13.60	14.13	10.43	7.20
8	6.15	9.33	12.57	9.89	10.70	12.30	14.40	14.93	12.03	5.60
9	8.82	13.33	9.89	9.89	8.82	7.75	11.20	10.40	16.04	6.67
bottom: 10	24.33	13.87	8.29	8.56	7.75	5.61	5.87	5.87	9.36	9.33
Total	100	100	100	100	100	100	100	100	100	100

Transition probabilities given in percent

Table 22 **Decile Transition Probabilities 2003-2004**

Turnover growth decile in 2003	Turnover growth decile in 2004 top: 1	2	3	4	5	6	7	8	9	bottom: 10
top: 1	17.18	6.42	4.27	3.06	3.36	3.98	6.44	2.74	7.93	25.08
2	12.58	12.23	11.89	8.26	7.34	8.56	6.44	10.37	10.06	13.46
3	8.28	13.46	8.84	8.56	6.12	10.09	11.35	9.45	11.89	9.79
4	9.51	10.70	9.76	12.23	12.84	12.84	8.28	10.37	9.45	6.42
5	3.99	6.73	12.80	12.23	15.90	13.15	10.74	10.06	11.28	6.42
6	4.91	7.34	12.50	14.07	13.76	12.23	12.88	11.28	7.93	5.50
7	4.29	9.17	9.15	14.37	12.54	11.93	15.64	13.41	9.76	3.98
8	7.36	7.34	12.50	11.62	14.07	11.31	11.66	11.59	10.67	7.34
9	11.66	13.76	9.15	9.17	8.56	9.48	11.04	10.67	10.37	9.17
bottom: 10	20.25	12.84	9.15	6.42	5.50	6.42	5.52	10.06	10.67	12.84
Total	100	100	100	100	100	100	100	100	100	100

Transition probabilities given in percent

Table 23 **Decile Transition Probabilities 2004-2005**

Turnover growth decile in 2004	Turnover growth decile in 2005 top: 1	2	3	4	5	6	7	8	9	bottom: 10
top: 1	11.03	6.55	6.23	3.10	5.17	4.12	4.50	3.45	10.34	27.68
2	9.66	11.72	7.61	8.62	6.21	6.53	7.27	10.69	12.07	16.96
3	9.66	12.41	13.84	7.24	9.31	9.62	8.30	12.41	12.07	6.92
4	5.86	6.55	13.49	12.76	14.48	8.93	12.80	11.38	7.24	6.92
5	4.14	10.00	9.69	14.83	15.86	12.03	14.19	10.69	7.24	5.54
6	5.17	6.90	11.76	12.76	14.48	14.43	15.57	9.31	7.93	5.19
7	5.86	10.00	8.30	14.83	11.03	15.46	12.46	10.69	11.03	5.19
8	7.59	11.38	9.00	13.45	10.00	14.09	9.34	12.07	11.72	7.27
9	11.38	13.10	10.73	7.93	7.24	9.28	9.34	13.10	9.31	8.65
bottom: 10	29.66	11.38	9.34	4.48	6.21	5.50	6.23	6.21	11.03	9.69
Total	100	100	100	100	100	100	100	100	100	100

Transition probabilities given in percent

Table 24 **Decile Transition Probabilities 2005-2006**

Turnover growth decile in 2005	Turnover growth decile in 2006									
	top: 1	2	3	4	5	6	7	8	9	bottom: 10
top: 1	15.63	3.46	6.59	5.77	5.41	3.08	3.08	6.59	9.65	29.73
2	10.94	8.85	10.47	6.54	5.79	8.08	10.00	8.91	13.51	15.44
3	6.64	8.85	9.30	12.69	9.65	8.46	13.08	10.47	11.97	9.65
4	6.64	10.00	11.63	11.54	11.97	13.08	11.54	11.24	7.72	4.25
5	4.30	9.62	12.79	14.62	15.06	12.31	11.54	8.53	6.95	3.47
6	7.03	4.62	10.47	15.00	13.13	16.54	11.54	10.85	8.49	6.18
7	6.25	10.38	8.53	13.46	14.29	13.46	10.00	12.40	7.72	7.72
8	8.59	11.92	13.18	7.31	9.65	10.00	13.08	12.02	9.27	7.34
9	7.81	14.23	9.69	6.15	10.42	8.85	10.00	13.18	15.06	7.34
bottom: 10	26.17	18.08	7.36	6.92	4.63	6.15	6.15	5.81	9.65	8.88
Total	100	100	100	100	100	100	100	100	100	100

Transition probabilities given in percent

Table 25 **Decile Transition Probabilities 2006-2007**

Turnover growth decile in 2006	Turnover growth decile in 2007									
	top: 1	2	3	4	5	6	7	8	9	bottom: 10
top: 1	12.99	7.79	4.33	4.78	4.33	3.88	3.90	8.66	6.93	24.24
2	13.85	9.96	10.39	8.70	6.93	8.19	8.23	9.09	12.55	10.39
3	7.36	8.66	9.96	8.70	9.09	9.48	12.55	13.42	11.69	9.09
4	5.63	9.52	13.42	16.09	12.99	12.07	11.26	11.26	4.76	6.93
5	3.90	7.79	9.52	14.78	16.45	14.66	11.69	10.82	8.23	5.19
6	4.76	7.79	10.39	10.87	17.75	14.66	11.69	9.09	11.69	4.76
7	6.93	9.52	11.69	7.83	12.99	13.36	14.29	12.55	9.52	6.49
8	3.46	11.26	11.26	10.00	11.26	10.34	13.42	9.96	13.42	6.93
9	12.55	12.55	12.12	10.87	5.19	6.47	7.79	7.79	13.42	12.99
bottom: 10	28.57	15.15	6.93	7.39	3.03	6.90	5.19	7.36	7.79	12.99
Total	100	100	100	100	100	100	100	100	100	100

Transition probabilities given in percent

Table 26 **Decile Transition Probabilities 2007-2008**

Turnover growth decile in 2007	Turnover growth decile in 2008 top: 1	2	3	4	5	6	7	8	9	bottom: 10
top: 1	16.67	6.34	4.37	2.44	4.37	3.41	6.31	3.90	8.25	25.37
2	9.80	11.71	13.59	8.78	4.85	4.88	6.80	10.24	11.65	15.12
3	5.39	11.22	13.11	12.20	4.85	8.29	12.62	10.24	14.08	8.29
4	8.33	5.37	9.22	11.71	15.53	10.73	14.08	11.22	10.19	3.90
5	2.94	5.85	9.22	13.66	15.05	17.07	12.62	9.76	7.28	7.80
6	7.35	7.80	8.25	11.22	12.14	14.63	15.05	9.76	8.74	6.34
7	6.86	7.80	15.53	11.22	11.65	12.20	10.19	12.68	9.22	7.32
8	4.41	10.73	9.22	13.66	10.19	11.22	9.22	10.73	15.05	7.80
9	8.82	13.66	9.22	9.76	13.11	11.22	8.74	15.61	4.37	10.24
bottom: 10	29.41	19.51	8.25	5.37	8.25	6.34	4.37	5.85	11.17	7.80
Total	100	100	100	100	100	100	100	100	100	100

Transition probabilities given in percent

Table 27 **Decile Transition Probabilities 2008-2009**

Turnover growth decile in 2008	Turnover growth decile in 2009									
	top: 1	2	3	4	5	6	7	8	9	bottom: 10
top: 1	15.22	7.03	7.07	2.70	4.32	8.15	2.16	5.95	7.03	22.83
2	9.24	14.05	7.07	7.57	3.78	7.07	10.27	5.95	11.35	21.20
3	7.61	13.51	14.13	9.73	11.35	8.70	6.49	10.27	13.51	4.89
4	4.89	9.19	10.33	11.35	12.43	13.04	12.97	11.35	9.73	8.15
5	9.24	5.95	12.50	12.97	8.65	15.22	11.89	11.89	8.11	5.98
6	8.15	7.57	7.07	10.27	11.35	9.24	19.46	12.97	10.27	4.89
7	10.33	6.49	9.24	16.76	12.43	12.50	12.43	9.73	10.81	5.98
8	4.89	7.57	13.04	9.19	16.22	11.96	10.81	10.27	10.27	7.07
9	9.78	10.27	11.41	9.73	11.35	8.15	9.19	14.59	11.89	9.78
bottom: 10	20.65	18.38	8.15	9.73	8.11	5.98	4.32	7.03	7.03	9.24
Total	100	100	100	100	100	100	100	100	100	100

Transition probabilities given in percent

Table 28 **Decile Transition Probabilities 2009-2010**

Turnover growth decile in 2009	Turnover growth decile in 2010									
	top: 1	2	3	4	5	6	7	8	9	bottom: 10
top: 1	10.37	7.32	2.42	3.05	6.71	8.48	5.49	6.06	7.32	29.88
2	10.98	10.37	7.27	6.71	4.27	5.45	8.54	7.27	17.07	13.41
3	12.20	9.15	6.67	7.93	10.98	8.48	11.59	16.36	10.37	9.15
4	8.54	9.76	15.76	10.98	10.98	8.48	9.76	9.70	12.20	6.71
5	4.88	4.88	13.33	14.63	12.20	15.76	10.37	10.30	10.98	5.49
6	3.66	9.15	11.52	9.76	17.07	15.15	14.02	7.27	10.37	3.66
7	4.27	9.15	12.73	14.02	14.63	16.97	8.54	9.70	9.15	3.05
8	4.27	10.37	12.12	13.41	12.20	10.91	12.80	14.55	7.93	7.93
9	8.54	17.07	12.12	12.80	4.27	5.45	12.20	12.12	9.76	7.93
bottom: 10	32.32	12.80	6.06	6.71	6.71	4.85	6.71	6.67	4.88	12.80
Total	100	100	100	100	100	100	100	100	100	100

Transition probabilities given in percent

Table 29 **Decile Transition Probabilities 2010-2011**

Turnover growth decile in 2010	Turnover growth decile in 2011									
	top: 1	2	3	4	5	6	7	8	9	bottom: 10
top: 1	9.33	4.64	8.00	5.96	4.67	2.65	6.00	10.00	8.61	27.52
2	7.33	11.92	6.67	9.93	8.00	5.96	12.67	11.33	12.58	10.74
3	10.67	9.93	10.00	8.61	6.67	9.93	10.00	11.33	15.89	6.71
4	6.67	11.92	10.00	11.92	10.00	15.89	9.33	7.33	10.60	10.74
5	4.67	5.30	8.00	13.91	16.67	15.23	12.00	9.33	7.28	6.04
6	6.67	8.61	10.67	14.57	14.67	16.56	8.67	8.67	8.61	6.04
7	6.00	8.61	11.33	13.25	10.00	14.57	10.00	12.67	11.26	8.05
8	5.33	15.23	14.00	7.28	12.67	9.27	11.33	11.33	8.61	6.04
9	8.67	12.58	12.67	9.27	10.67	5.30	15.33	8.00	9.27	8.72
bottom: 10	34.67	11.26	8.67	5.30	6.00	4.64	4.67	10.00	7.28	9.40
Total	100	100	100	100	100	100	100	100	100	100

Transition probabilities given in percent

D Distribution Tests

Table 30 **Results from Jarque-Bera (Skewness/Kurtosis) Normality Tests**

Year	Observations	Pr(Skewness)	Pr(Kurtosis)
1997	-	-	-
1998	1.1e+04	0.0000	0.0000
1999	8.1e+03	0.0000	0.0000
2000	6.4e+03	0.0000	0.0000
2001	5.2e+03	0.0000	0.0000
2002	4.4e+03	0.0104	0.0000
2003	3.7e+03	0.0000	0.0000
2004	3.3e+03	0.0000	0.0000
2005	2.9e+03	0.0000	0.0000
2006	2.6e+03	0.0000	0.0000
2007	2.3e+03	0.0000	0.0000
2008	2.0e+03	0.0000	0.0000
2009	1.8e+03	0.0000	0.0000
2010	1.6e+03	0.0000	0.0000
2011	1.5e+03	0.0000	0.0000

Table 31 **Results from Shapiro-Wilk Normality Tests**

Year	Observations	W	V	z	Prob>z
1997	-	-	-	-	-
1998	10 740	0.87137	681.055	17.497	0.0000
1999	8 056	0.81196	776.039	17.708	0.0000
2000	6 351	0.77478	754.395	17.512	0.0000
2001	5 192	0.75073	698.449	17.203	0.0000
2002	4 387	0.75972	579.318	16.624	0.0000
2003	3 733	0.79427	429.158	15.758	0.0000
2004	3 270	0.75529	453.105	15.829	0.0000
2005	2 894	0.72671	453.178	15.764	0.0000
2006	2 583	0.70434	442.337	15.640	0.0000
2007	2 307	0.74334	346.569	14.953	0.0000
2008	2 049	0.76447	285.551	14.396	0.0000
2009	1 843	0.79975	220.411	13.684	0.0000
2010	1 638	0.77231	225.156	13.677	0.0000
2011	1 502	0.71532	260.135	13.995	0.0000

E Simulation Tests

Simulation 1

Table 32 **Hausman Test for Simulation 1**

Test: H0: difference in coefficients not systematic		
chi2(3)	=	8.25
Prob > chi2	=	0.0411

Table 33 **Wooldridge Test for Simulation 1**

H0: no first-order autocorrelation		
F (1, 606)	=	0.149
Prob > F	=	0.6994

Table 34 **Limited Panel Regression for Simulation 1**

	(1) ln_growth
employees	0.0420*
	(2.46)
offices	-0.4490
	(-1.71)
partconcern	-0.2501
	(-1.84)
_cons	0.4740
	(1.70)
N	3 756

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Simulation 2

Table 35 **Hausman Test for Simulation 2**

Test: H0: difference in coefficients not systematic		
chi2(3)	=	5.37
Prob > chi2	=	0.1464

Table 36 **Wooldridge Test for Simulation 2**

H0: no first-order autocorrelation		
F (1, 363)	=	4.846
Prob > F	=	0.0283

Table 37 **Limited Panel Regression for Simulation 2**

	(1)
	ln_growth
employees	0.0072*
	(2.06)
offices	-0.0330
	(-1.18)
partconcern	-0.0570
	(-2.15)
_cons	0.0615
	(2.44)
N	3 265

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Simulation 3

Table 38 **Hausman Test for Simulation 3**

Test: H0: difference in coefficients not systematic		
chi2(3)	=	21.79
Prob > chi2	=	0.0001

Table 39 **Wooldridge Test for Simulation 3**

H0: no first-order autocorrelation		
F (1, 2461)	=	2.803
Prob > F	=	0.0942

Table 40 **Limited Panel Regression for Simulation 3**

	(1)
	ln_growth
employees	0.0172*
	(2.12)
offices	-0.0537
	(-0.43)
partconcern	-0.2307
	(-3.86)
_cons	0.1746
	(1.45)
N	15 140

t statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Simulation 4

Table 41 **Hausman Test for Simulation 4**

Test: H0: difference in coefficients not systematic		
chi2(3)	=	21.74
Prob > chi2	=	0.0001

Table 42 **Wooldridge Test for Simulation 4**

H0: no first-order autocorrelation		
F (1, 606)	=	0.596
Prob > F	=	0.4403

Table 43 **Limited Panel Regression for Simulation 4**

	(1) ln_growth
employees	0.0135*
	(2.50)
offices	-0.0163
	(-2.50)
partconcern	-0.2008
	(-5.12)
_cons	0.0526
	(3.30)
N	11 404

t statistics in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

F Tests for Imputed Dataset Regressions

Table 44 **Hausman Test for Imputed Dataset Panel Regression**

Test: H0: difference in coefficients not systematic		
chi2(46)	=	102.42
Prob > chi2	=	0.0000

Table 45 **Wooldridge Test for Imputed Dataset Panel Regression**

H0: no first-order autocorrelation		
F (1, 606)	=	2.873
Prob > F	=	0.0901

Table 46 **Machado-Santos Silva heteroskedasticity test for 0.9 Quantile Regression**

H0: constant variance		
chi2 (2)	=	60.332
Prob > chi2	=	0.000

Variables: Fitted values of ln_growth_fecorrected and its squares

Table 47 **Machado-Santos Silva heteroskedasticity test for 0.1 Quantile Regression**

H0: constant variance		
chi2 (2)	=	104.019
Prob > chi2	=	0.000

Variables: Fitted values of ln_growth_fecorrected and its squares