ÖSTERREICHISCHES INSTITUT
FÜR WIRTSCHAFTSFORSCHUNG

WORKING PAPERS

Job Creation and the Intra-distribution Dynamics of the Firm Size Distribution

Peter Huber, Harald Oberhofer, Michael Pfaffermayr

395/2011

Job Creation and the Intra-distribution Dynamics of the Firm Size Distribution

Peter Huber, Harald Oberhofer, Michael Pfaffermayr

WIFO Working Papers, No. 395
May 2011

E-mail addresses: Peter.Huber@wifo.ac.at, harald.oberhofer@sbg.ac.at. Michael.Pfaffermayr@wifo.ac.at

2011/132/W/0

Medieninhaber (Verleger), Hersteller: Österreichisches Institut für Wirtschaftsforschung • 1030 Wien, Arsenal, Objekt 20 • Tel. (43 1) 798 26 01-0 • Fax (43 1) 798 93 86 • http://www.wifo.ac.at/ • Verlags- und Herstellungsort: Wien

Job Creation and the Intra-distribution Dynamics of the Firm Size Distribution

Peter Huber*, Harald Oberhofer**, Michael Pfaffermayr** *

Abstract

Based on a structural model for initial firm size, survival and firm growth we estimate firm-specific transition probabilities between size classes of the firm size distribution. This allows an assessment of the impact of different (counterfactual) economic policy measures on intra-distribution dynamics of the firm size distribution. We find that policies increasing the life span of firms reduce the exit hazard of young firms, but also reduce the probability to be a Gazelle. An increase in the industry-wide entry rate increases the exit hazards of incumbent firms and has no strong impact on the likelihood of firms to become Gazelles. Increasing market growth, by contrast, decreases the exit hazards for incumbent firms and slightly increases the likelihood of firms to be Gazelles. Finally, an increase in the birth size of firms increases the probability of young firms to be Gazelles with strongest effects for the smallest firms.

Keywords: Firm growth; survival; entry size; Gazelles; economic policy; sample selection.

JEL: C24; D22; L11; L25; L26; M13.

*Austrian Institute of Economic Research, Arsenal, Objekt 20, A-1030 Vienna, Austria. Email: huber@wifo.ac.at.

**Department of Economics and Social Sciences and Salzburg Centre of European Union Studies (SCEUS), University of Salzburg, Kapitelgasse 5-7, 5010 Salzburg, Austria, The Austrian Center for Labor Economics and the Analysis of the Welfare State. E-mail address: harald.oberhofer@sbg.ac.at.

***Department of Economics, University of Innsbruck, Universitaetsstr. 15, A-6020 Innsbruck, Austria, Austrian Institute of Economic Research and CESifo, E-mail: Michael.Pfaffermayr@uibk.ac.at.

1 Introduction

Since the seminal work of Birch (1979) policy makers have been concerned with the question whether small or large firms are the more important contributors to (net) job creation. Evidently, the implementation of specific public policy measures, such as the regulations for the provision of venture capital, depends on the answer to this question. Political support for entrepreneurship and small firms will *inter alia* be justified if they are important net contributors to job generation. In consequence, policy debates frequently focus on the role of (relatively) small fast-growing firms (often referred to as *Gazelles*[1]).

Empirically, the (relative) impact of small firms on (net) job creation is still ambiguous. Davis *et al.* (1996), for example, find that small firms constitute the vast majority of businesses, but they are only of limited importance with regard to overall employment. Contrary, a number of empirical contributions provide evidence that jobs are mainly created by small firms (see, e.g., Broersma and Gautier 1997, Davidsson *et al.* 1998 and Picot and Dupuy 1998). Likewise, Haltiwanger *et al.* (2010) stress the key role played by (small and large) young firms. Small firms, however, also differ from large ones in a number of other ways. For instance, in comparison to large and old firms small businesses and new entrants are more likely to experience job losses (see, e.g., Bartelsman *et al.* 2005, Voulgaris *et al.* 2005, and Neumark *et al.* 2011). This suggests a considerable volatility in the number of employees in small firms usually referred to as *churning*. Moreover, the empirical literature on firm survival demonstrates that small firms face a substantially increased exit hazard leading to additional job losses (see, e.g., Hart and Oulton 1996, Audretsch *et al.* 2000, Fotopoulos and Louri 2000 and Yasuda 2005).

Altogether, these empirical findings imply that economic policy might influence the overall level of job creation via a relatively complicated relationship. To give one example, public provision of financial resources (e.g., in terms of venture capital) might, ceteris paribus, allow start-up firms to ini-

[1]According to OECD (2009), Gazelles are firms which are younger than 5 years, initially employed ten or more employees and experienced average annualized growth rates of (at least) 20 percent a year during at least three consecutive years.

tially produce at a larger scale. An increase in the average start-up firm size will raise the job creation rate of new firms. Moreover, initially larger firms are less likely to exit the market and, consequently, are less likely to destroy jobs. On the contrary, the (initially) large firms exhibit lower growth rates in comparison to small businesses so that their post-start-up job creation rates may be smaller.

In order to more fully understand the relative importance of small versus large and young versus old firms with regard to (net) job creation, this paper looks at the population of manufacturing firms operating in 1999 in Austria and traces its development until 2004. We specify an econometric model which simultaneously examines initial firm size in 1999, firm survival and (average) firm growth. In particular, we generalize the Heckman (1976, 1979) sample selection model by specifying a structural form model that includes initial firm size, survival and actual firm size in a three equation system. Using a comprehensive sample of Austrian manufacturing firms from administrative data, we are able to identify the structural parameters of interest. This allows us to estimate firm-specific transition probabilities (e.g., the probability to be a Gazelle) and, therefore, to explore the intra-distribution dynamics of the firm size distribution conditional on a set of explanatory variables. Additionally, it is possible to estimate the (overall) employment effects of different (counterfactual) economic policy measures. In particular, we investigate the impact of small business and entrepreneurship policy (i.e., increasing the life span of firms, which is equivalent to increasing firm age, or the firm's size at foundation), competition policy (i.e., increasing market entry) and growth oriented policies (i.e., increasing market growth rates) on a firm's mobility in the firm size distribution. Moreover, we calculate the overall employment effects of these different (counterfactual) policy measures and investigate whether small or large and young or old firms are more sensitive to these changes.

In line with previous empirical studies, with regard to firm survival our findings indicate that initially larger firms are more likely to survive, while in industries with a larger minimum efficient scale (MES) and more market entries especially new firms are more likely to exit. In addition, in industries with higher market growth rates firms are more likely to survive. The firm growth equation reveals that smaller and younger firms tend to grow more rapidly, while this effect vanishes for the largest and oldest firms. Finally, higher market growth rates positively affect a firm's individual growth performance.

Our counterfactual economic policy analysis suggests that increasing the life span of firms reduces the exit hazard of young and old firms, only slightly increases intra-distribution dynamics and reduces the probability to be a Gazelle. In a similar vein, an increase in the entry rate of new firms primarily increases the exit hazards for incumbent firms, reduces intra-distribution dynamics and has virtually no impact on the likelihood of firms to be Gazelles. Increasing market growth, by contrast, decreases the exit hazards for incumbent firms, increases intra-distribution dynamics and has a small positive impact on the likelihood of firms to become Gazelles. Finally an increase in the birth size of firms slightly decreases exit hazards for all firms with effects, however, strongest for the smallest-oldest firms and increases the probability of becoming a Gazelle. Moreover, an increase in birth size marginally decreases downsizing tendencies in the largest firms.

The paper is organized as follows. In the next section, we briefly survey the related literature on firm growth, firm survival and fast-growing firms. Section 3 lays out an econometric model, which simultaneously explains a firm's entry size, firm survival and firm growth. In Section 4 we describe our data and discuss estimation results. Section 5 offers a counterfactual analysis for different public policy instruments, while Section 6 investigates the robustness of our baseline results. Finally, Section 7 provides concluding remarks.

2 A Brief Review of the Related Literature

Since the seminal work of Gibrat (1931) a large literature has developed on the relationship between the firm size distribution and firm growth (see Coad 2009 for a recent survey). One strand of this literature has focused on the question, whether firm growth is random so that firm size follows a random walk and thus obeys *Gibrat's law of proportionate growth*. Empirically, in comparison to large and old firms, small and young firms tend to exhibit higher growth rates, while Gibrat's law accurately describes the growth performance of large and old firms (see, e.g., Hart 2000). This empirical 'stylized fact' supports the view that small and young firms are important contributors to (net) job creation, while in the group of large and old firms the number of employees is relatively persistent.

Another, more recent, strand of the literature has firstly described the evolution of the shape of the firm size distribution over time in terms of an adjustment process (see for example Cabral and Mata 2003) and, secondly examines the cross-sectional distribution of firm growth rates (see, e.g., Botazzi and Secchi 2006, 2009). With regard to this latter literature an additional focus has been put on different types of firms. Thereby, the role of high-growth firms (i.e., Gazelles) for (net) job creation has attracted special attention. Empirically, Gazelles are found to contribute significantly to overall job generation. Moreover, Gazelles tend to be small and young firms which exist in all types of industries (see, e.g., Henrekson and Johansson 2010 for a survey on the job creation of Gazelles). Additionally, Haltiwanger *et al.* 2010 demonstrate that young firms, irrespective of whether they are small or large, are most likely to be Gazelles.

On the other hand, market exit of firms is a very common phenomenon (see, e.g., Geroski 1995 and Knaup 2005). As already mentioned, small and young firms are much more likely to be forced out of the market. Over time therefore non-random exit of firms generates (highly) selected samples of surviving firms. Focusing exclusively on surviving firms is likely to bias any empirical results (see, e.g., Evans 1987a,b, Hall 1987, Dunne and Hughes 1994 and Pfaffermayr 2007). However, with regard to the relative importance of small firms for (net) job creation, the empirical evidence suggests that only a small fraction of small and young firms grows very rapidly (i.e., becomes Gazelles), while the overwhelming majority struggles for survival. From a job generating point of view, one might therefore argue that economic policy should support (already existing) small and young firms in order to increase their survival probability because, in case of survival, they are more likely to be Gazelles later on.

Alternatively, economic policy might aim at directly supporting new entrants with more financial resources so that they are able to start their business at a larger scale. This is usually accompanied with higher labor demand and, therefore, positively contributes to net job creation. Additionally, initially larger firms persistently face lower exit probabilities (see, e.g., Geroski *et al.* 2010). Yet, in line with the discussion above, initially larger firms are less likely to be Gazelles. Consequently, economic policy which intends to increase the average start-up firm size may initially increase (net) job creation rates, while reducing post-start-up job generation later on.

Finally, the macroeconomic environment and the competitive environment have been identified as crucial determinants of firm survival. In particular, unfavorable macroeconomic conditions (e.g., recessions) increase a firm's exit hazard (see, e.g., Geroski *et al.* 2010). However, the impact of macroeconomic conditions on already established firms is less pronounced for two reasons. Firstly, during recession entry rates are lower and, therefore, the competitive pressure of new entrants on already existing firms is reduced (Caballero and Hammour 1994). Secondly, already established firms are less likely to be financially constrained (Cabral and Mata 2003) allowing them to survive more easily during recession periods. Overall, this reasoning suggests that especially new entrants and small firms are more likely to suffer existentially from economic downturns. With reference to

the competitive environment, economic literature and organizational ecology has demonstrated that within highly competitive industries market exit is more likely. Put differently, high market entry rates render survival more difficult and, ceteris paribus, increase the exit hazard (see, e.g., Mata and Portugal 1994, Geroski *et al.* 2010).

To sum up, previous literature already established systematic relationships between (i) (initial) firm size and survival, (ii) (initial) firm size and firm growth and (iii) survival and firm growth. However, to our knowledge there is no paper which incorporates these different determinants of job creation in a unique framework, which allows to disentangle direct and indirect effects of policy on the intra-distribution dynamics of the firm size distribution and to examine overall employment effects of different policy measures. Finally, this approach allows to identify the role of policy for the occurrence of Gazelles.

3 The specification of initial firm size, survival and firm growth equations

Following the discussion from above, the firm growth literature offers several explanations why Gibrat's law might not hold and a process of partial adjustment better describes the growth process of young firms. Among the most influential explanations are Penrose effects (Penrose 1959), organizational capabilities (Slater 1980), learning theories (Jovanovic 1982), financial constraints (Fazzari *et al.* 1988) and adjustment cost theories (Hamermesh and Pfann 1996). Empirically, they commonly suggest to model actual firm size as a function of initial firm size, where the point estimate of initial size is expected to be smaller than one (i.e., smaller firms grow more rapidly).

Additionally, concentrating on surviving firms only leads to a sample selection bias since the exiting firms may systematically differ in their observed and unobserved characteristics from their surviving counterparts (see, e.g., Evans 1987a,b, Hall 1987, Dunne and Hughes 1994 and Pfaffermayr, 2007). Therefore, we specify a Heckman sample selection model for the population of firms at time 1 and follow its evolution up to time period T. For this, we establish a structural form three equation system with an equation for the log size of the surviving firms at time T (y_{iT}) and one for the firm size (y_{i1}) in the initial period which, typically, is not the firm size in the year of founding of firm i. The third equation explains the probability that a firm survives up to period T modeled by the latent variable d_i^*. This motivates the following generalized Heckman-sample selection firm growth model.

$$\begin{aligned}
y_{iT}^* &= \lambda_i y_{i1} + \mathbf{x}_{iT}'\beta_T + u_i && (1)\\
y_{i1} &= \mathbf{x}_{i1}'\beta_1 + v_i && (2)\\
d_i^* &= \mathbf{x}_{id}'\beta_d + w_i && (3)\\
d_i &= 1 \quad \text{if } d_i^* > 0 &&\\
y_{iT} &= y_{iT}^* \quad \text{if } d_i = 1 &&\\
y_{iT} &= \text{unobserved if } d_i = 0. &&
\end{aligned}$$

The star for y_{iT}^* and d_i^* indicates that these are latent variables, while y_{iT}, y_{i1} and d_i (without a star) refer to observed values. The dummy d_i takes the value 1 if $d_i^* > 0$ and the firm survives and 0 otherwise. $\mathbf{x}_{iT}, \mathbf{x}_{i1}$ and $\mathbf{x}_{id}$ comprise the set of exogenous explanatory variables in each respective equation while β_T, β_1 and β_d denote the corresponding vectors of parameters to be estimated.

The specification of the equation explaining final firm size (y_{iT}^*) follows the literature (see Hart 2000 and Coad 2009, for recent surveys), and contains the (logs of) initial firm size, firm age, age squared and an interaction effect between age and initial firms size as well as (European-wide) 3-digit specific industry value added to factor costs growth rates. Moreover, following Peneder (2003) we classify the observed 3-digit industries with regard to their factor and skill intensity and additionally control for those differences. Formally, we specify the persistence parameter as $\lambda_i = \lambda_0 + \lambda_1 \ln Age_i$, where Age_i denotes the age of the firm, in order to account for potentially higher persistence of firm size in older firms (Huber and Pfaffermayr 2010). In line with Jovanovic (1982) we assume that, over time, young firms learn their productivity and the successful ones expand their firm size. By contrast, older established firms already know their productivity and, therefore, exhibit a different growth pattern characterized by high persistence which may be well described by Gibrat's law. Additionally, following the recent literature we assume that a firm's growth performance is affected by sector-specific business cycle fluctuations (see, e.g., Oberhofer 2010) and control for 3-digit industry-specific average growth rates during the observed time period. In order to control for additional unobserved industry-specific firm growth determinants we additionally include a set of 2-digit industry fixed effects.

The survival equation contains firm size in the founding year, firm age, age squared, an interaction term of founding year firm size with firm age and the industry minimum efficient scale (MES) which is interacted with firm age to capture a potentially decreasing impact of MES on the survival probability of older firms. In addition the survival equation contains two industry-specific variables which are measured on the 3-digit industry level: market growth rates and industry-wide entry rates. Given our set of exogenous variables and following the related literature on firm survival we expect that initially small and young firms are more likely to exit the market. Moreover, in more prosperous industries firms should find it easier to survive while high entry rates should decline the survival probability of incumbent firms. Finally, we additionally control for differences in factor and skill intensities and include a set of 2-digit industry effects.

Finally, with regard to the initial firm size, we consider the population of firms in 1999, excluding new entrants. This allows us to specify the initial firm size in period 1 as a function of the firm size in the founding year, firm age, age squared and an interaction term of founding year firm size with firm age. Smiliar to the above argument, the latter accounts for a potentially diminishing impact of birth size over time. Moreover, our initial firm size equation contains within-industry MES which is again interacted with a firm's age as well as an interaction effect of market growth in the period 1988 to 1998 with firm age. Lastly, we again control for 2-digit industry-specifc effects and differences with regard to factor and skill intensities across industries.

Econometrically, for each firm i the error term is assumed to follow a trivariate normal distribution which for the structural model is given by

$$\begin{bmatrix} u_i \\ v_i \\ w_i \end{bmatrix} \sim iid\ N\left(\mathbf{0}, \begin{bmatrix} \sigma_u^2 & 0 & \rho_{uw}\sigma_u \\ 0 & \sigma_v^2 & \rho_{vw}\sigma_v \\ \rho_{uw}\sigma_u & \rho_{vw}\sigma_v & 1 \end{bmatrix}\right). \tag{4}$$

where ρ_{uw} and ρ_{vw} are correlations obeying the condition $\rho_{uw}^2 + \rho_{vw}^2 < 1$. This assumption guarantees a positive variance of d_i^*. Therefore, the log likelihood of the trivariate system under sample selection can be based on the conditional distributions of $d_i^*|y_{iT}^*, y_{i1}$ and $d_i^*|, y_{i1}$, which are given by (see Greene, 2003, p. 76 and Appendix 1 for details):

$$\begin{aligned} d_i^*|y_{iT}^*, y_{i1} &\sim N(\mathbf{x}_{id}'\beta_d + \tfrac{\rho_{uw}}{\sigma_u}(u_i + \lambda v_i) + \tfrac{\rho_{vw}}{\sigma_v}v_i, 1 - \rho_{uw}^2 - \rho_{vw}^2). \\ d_i^*|y_{i1} &\sim N(\mathbf{x}_{id}'\beta_d + \tfrac{\rho_{vw}}{\sigma_v}v_i, 1 - \rho_{vw}^2). \end{aligned} \tag{5}$$

With this result at hand, the log likelihood can be written as

$$
\begin{aligned}
\ln L \;=\; & \sum_{\{d_i=0\}} \left(\ln \Phi \left(- \frac{\mathbf{x}'_{id}\beta_d + \frac{\rho_{vw}}{\sigma_v} v_i}{\sqrt{1-\rho^2_{vw}}} \right) + \sum_{\{d_i=1\}} \ln f(y_{i1}) \right) \qquad (6) \\
& + \sum_{\{d_i=1\}} \left(\ln \Phi \left(\frac{\mathbf{x}'_{id}\beta_d + \frac{\rho_{uw}}{\sigma_u}(u_i+\lambda v_i) + \frac{\rho_{vw}}{\sigma_v} v_i}{\sqrt{1-\rho^2_{uw}-\rho^2_{vw}}} \right) + \ln f(y^*_{iT}; y_{i1}) \right)
\end{aligned}
$$

with

$$
\begin{aligned}
\ln f(y^*_{iT}, y_{i1}) &= -\tfrac{1}{2}\ln(2\pi^2) - \ln(\sigma_u\sigma_v) - \tfrac{1}{2}\left(\frac{y_{iT}-\lambda y_{i1} - \mathbf{x}'_{iT}\beta_T}{\sigma_u}\right)^2 - \tfrac{1}{2}\left(\frac{y_{i1}-\mathbf{x}'_{i1}\beta_1}{\sigma_v}\right)^2 \\
\ln f(y^*_{i1}) &= -\tfrac{1}{2}\ln(2\pi) - \ln(\sigma_v) - \tfrac{1}{2}\left(\frac{y_{i1}-\mathbf{x}'_{i1}\beta_1}{\sigma_v}\right)^2 .
\end{aligned}
$$

In order to analyze the intra-distribution dynamics of different public policy measures, we estimate the probability that a firm changes its position in the firm size distribution (e.g., to be a Gazelle). For this we split the initial and final firm size distributions into its quartiles and allocate the firms to four groups, respectively. For period T, the quartiles (groups) of the firm size distribution are defined by the bounds $y_{T,k}$, with $k = 1, \ldots, 4$ and $y_{1,l}$ with $l = 1, \ldots, 4$ for the initial period.[2] In the final period there is an additional group which includes all exiting firms. Overall, this gives a 4 by 5 matrix of transition probabilities that can be derived from the estimated parameters of the system specified above. In particular, we estimate firm specific probabilities

$$
\begin{aligned}
\widehat{q}_{i,k,l} &= P(\widehat{y}_{iT} + u_i \le y_{T,k},\ \widehat{y}_{i1} + v_i \le y_{1,l},\ w_i \le \widehat{d}^*_i) \qquad (7) \\
&= \Phi\left(y_{T,k} - \widehat{y}_{iT}, y_{1,l} - \widehat{y}_{i1}, \widehat{d}^*_i; \widehat{\Sigma}\right),\ k, l = 1, .., 4 \\
\widehat{q}_{i,l,e} &= P(\widehat{y}_{i1} + v_i \le y_{1,l},\ w_i \le -\widehat{d}^*_i) \\
&= \Phi\left(\frac{y_{1,l} - \widehat{y}_{i1}}{\widehat{\sigma}_v}, -\widehat{d}^*_i; \widehat{\rho}_{vw}\right),\ l = 1, .., 4,
\end{aligned}
$$

where a 'hat' over a variable indicates an estimate and $\widehat{\Sigma}_i$ denotes the estimated variance covariance of the system's disturbances. We concentrate on firms in the first and fourth quartile of the 1999 size distribution ($l = 1, 4$) and, in the sequel, we refer to them as initially small and initially large firms,

[2] By definition the bounds for $k = l = 4$ are ∞.

respectively. From the estimated $\widehat{q}_{i,k,l}$ and $\widehat{q}_{i,l,e}$, the transition probabilities are estimated recursively as

$$\begin{aligned}
\widehat{p}_{i,1e} &= \widehat{q}_{i,1,e} \\
\widehat{p}_{i,le} &= \widehat{q}_{i,l,e} - \widehat{q}_{i,l-1,e}, \quad l = 2,3,4 \\
\widehat{p}_{i,e} &= \sum_{l=1}^{4} \widehat{p}_{i,l,e} \\
\widehat{p}_{i,1,1} &= \widehat{q}_{i,1,1} \\
\widehat{p}_{i,1,k} &= \widehat{q}_{i,1,k} - \widehat{q}_{i,1,k-1}, \\
\widehat{p}_{i,k,1} &= \widehat{q}_{i,k,1} - \widehat{q}_{i,k-1,1}, \\
\widehat{p}_{i,k,l} &= \widehat{q}_{i,k,l} - \widehat{q}_{i,k-1,l} - \widehat{q}_{i,k,l-1} + \widehat{q}_{i,k-1,l-1}, \quad k,l = 2,3,4.
\end{aligned}$$

Note, $\sum_{k=1}^{4}\sum_{l=1}^{4}\widehat{p}_{i,k,l} + \sum_{l=1}^{4}\widehat{p}_{i,l,e} = 1$. The estimation of the transition probabilities requires the integration of the trivariate normal distribution for each firm in the sample. For this we use the Geweke-Hajivassiliou-Keane (GHK) simulator (see Greene, 2003, pp. 931-933, and Train, 2003 for a detailed description). To avoid an excessive computational burden, we make the simplifying assumption that $\lambda_i = \lambda_0 + \lambda_1 \overline{\ln Age}_k$, where $\overline{\ln Age}_k$ is the mean of $\ln Age_i$ within each of the quartiles. Therefore, we treat the variance covariance matrix of the disturbances of the reduced form of the system (derived in the Appendix) as constant across firms within each quartile.

To obtain a prediction of the job creation rates both in the baseline and in the counterfactual, we calculate the predictions of the unconditional expectation, transform them to levels and aggregate them. In particular, at known parameters it follows (Cameron and Trivedi, 2005) that

$$\begin{aligned}
\mu_{iT} &= E\left[y_{iT}\right] = E_{d_i^*}\left[E\left[y_{iT}|\mathbf{x}_{iT}, d_i^*\right]\right] \\
&= \Phi(\mathbf{x}_{id}'\beta_d)(\lambda_i y_{i1} + \mathbf{x}_{iT}'\beta_T) + \rho_{uw}\sigma_u\phi(\mathbf{x}_{id}'\beta_d) \\
\mu_{i1} &= \mathbf{x}_{i1}'\beta_1.
\end{aligned}$$

4 Data and estimation results

We use data from the Austrian Social Security Database (ASSD) which is a widely used administrative data set in empirical research (see, e.g., Card *et al.* 2007, Huber and Pfaffermayr 2010, Del Bono *et al.* 2011).[3] Thereby, we utilize data from Austrian manufacturing industries between 1972 and 2005 and, following European Union's definition of small and medium sized entreprises (SMEs), we focus on all business units with less than 250 employees in 1999.[4] Moreover, since information on firm age is only available for firms founded after 1972 we exclude 8,292 firms already existing in 1972 in order to avoid a censoring bias.[5]

Empirically, we take explicit account of OECD's (2009) definition of Gazelles by focusing on firm growth during a five year time period. In particular, we define $T = 2004$ and include all firms existing in 1999 in our analysis so that the availability of firm specific information prior to the year 1999 allows to model a firm's initial size in 1999. In consequence, we have to exclude new entrants after 1999 from our analysis. After this restriction the data covers 17,239 business units providing information on size (employment), age, region and industry. Out of these 12,036 firms (or, equivalently, 70% of all already existing firms) survived the 5-year time period under consideration.

Among the explanatory variables used in our three equation model described above market growth is calculated as the average annual value added at factor costs growth rate in a European Union 3-digit NACE industry in the time period 1999 to 2004.[6] Entry rates are defined as the share of firms

[3]The ASSD contains a daily calendar of the starting date of an individual's employment relationship at a particular business unit and the corresponding end date (if employment spells are terminated before the end of 2005). From these data we constructed the measure of firm size as the number of employees of each business unit on June 7th in each year using a head count of employment (see, Fink *et al.* 2010 for a comprehensive description).

[4]We exclude 151 large firms with more than 250 employees in the initial year because our results indicate that the growth performance of these outliers is hard to predict. However, Section 6 offers a robustness analysis where we report the results obtained from the full sample including these largest firms.

[5]In our robustness analysis, in Section 6, we also provide results where these firms are included. Thereby, we slightly modify our estimation strategy to take account for the above mentioned censoring problem.

[6]This indicator is based on Europe-wide industry data obtained from Eurostat and collected by the Austrian Institute of Economic Research (WIFO). Given the high export-dependence of Austrian manufacturing firms an EU-wide measure better reflects the mar-

Table 1: Descriptive Statistics for SMEs

Variable	Obs.	Mean	Std. dev.	Min	Max
Final firm size (04)	12,036	10.35	27.10	1	869
Survival	17,239	0.70	0.46	0	1
Initial firm size (99)	17,239	11.57	24.01	1	249
Birth size	17,239	8.30	25.31	1.5	1,488
Firm age	17,239	15.45	7.98	5	31
Mes	17,239	12.88	14.68	2	395
Market growth (88-98)	17,239	0.04	0.02	-0.05	0.09
Market growth (99-04)	17,239	0.01	0.02	-0.07	0.07
Entry rate	17,239	0.16	0.06	0.03	0.83

Notes: Source: Austrian Social Security Database (ASSD).

entering a 3-digit industry during the considered time period. The third quartile in the log firm size distribution within each 3-digit industry serves as a measure of minimum efficient scale (MES). To control for remaining unobserved heterogeneity across industries we also include a set of 3-digit (in the initial firm size equation) or 2-digit (in the other two equations) industry dummies. Additionally, the survival and firm growth equations contain further dummy variables which capture differences in factor and skill intensities across industries, respectively (see, Peneder 2003, for details).

Table 1 reports descriptive statistics for our sample. Comparing final firm size in 2004 with initial firm size in 1999 the considerable downsizing of Austrian manufacturing in the time period analyzed becomes evident. The average number of employees per business unit decreased from 11.57 in 1999 to only 10.35 in 2004 although we restrict our sample to firms which are SMEs in 1999. With regard to firm age, we define 2004 as our reference year and, therefore, minimum (maximum) firm age is 5 (31) years for all firms which started their business in 1999 (1973). In 2004 the average firm in our sample is approximately 15.5 years old. Focusing on industry-specific information, the average MES is approximately 13 employees, while industry-specific market growth rates are, on average, 4% during the time period 1988 to 1998 and only 1% from 1999 to 2004. Finally, market entry rates are 16% on average ranging from a minimum of 3% (in the manufacture of knitted and crocheted fabrics industry, code 176) to a maximum of 83% in (manufacture

ket growth opportunities for the respective firms.

of industrial process control equipment, code 333).

Table 2 presents our baseline estimation results. The estimated parameters are well in line with the literature. We reject Gibrat's law for small and young firms implying that they grow more rapidly on average than old and large firms. The impact of initial firm size, however, increases with firm age although the estimated λ_i significantly differs from one for the overwhelming majority of firms. In accordance with much of the literature Gibrat's law therefore seems to accurately describe the growth process of large and old firms, only. The firm growth equation also indicates that firm age exhibits a non-linear impact on the firm size in 2004. Young firms tend to increase employment more rapidly with the decrease reducing with age.[7] Firms also tend to be positively affected by market conditions: An increase in the 3-digit industry-specific growth rates, on average, leads to higher firm growth rates. Finally, 3-digit market entry rates do not directly influence variations in firm size in 2004.

With regard to firm survival, the estimation results are again in line with previous findings. Larger and older firms are more likely to survive, as demonstrated by the significantly positive interaction effect of birth size with firm age. In addition, the overall effect of birth size is positive and increasing with firm age although the main effect of this variable turns out to be insignificant and our results also suggest that older firms are less likely to exit the market. The former empirical finding is known as *liability of smallness* (see, e.g., Freeman *et al.* 1983) while the latter is often referred to as *liability of newness* (see, e.g., Stinchcombe 1965). Both of these results have especially been put forward by population ecology. However, for very old firms the exit hazard increases again as indicated by the negative parameter estimate associated with age-squared. Additionally, in industries with a larger MES, firms are more likely to exit the market. This effect, however, diminishes with firm age. This is well in line with the neo-classical theory of the firm which argues that, in case of the existence of scale economies, firms which fail to reach the MES quickly will not be able to successfully compete in their markets. Furthermore, a firm's market exit probability is also systematically

[7]Note that for the relevant age distribution in our sample (5 to 31) years the impact of age on firm growth is negative throughout.

Table 2: Estimation results for SMEs

Variable	Firm Size (1999) (1)	Survival (2)	Firm Size (2004) (3)
Birth Size	1.293***	−0.024	-
	(0.028)	(0.052)	-
Initial Firm Size (99)	-	-	0.512***
	-	-	(0.026)
Age	1.909***	0.458**	−1.175***
	(0.109)	(0.192)	(0.108)
Age^2	−0.347***	−0.113***	0.155***
	(0.019)	(0.036)	(0.022)
Birth Size*Age	−0.202***	0.045**	-
	(0.010)	(0.019)	-
Initial Firm Size (99)*Age	-	-	0.141***
		-	(0.010)
Mes	-	−0.184**	-
	-	(0.075)	-
Mes*Age	0.137***	0.057**	-
	(0.017)	(0.028)	-
Market Growth (88-98) *Age	3.214***	-	-
	(0.636)	-	-
Market Growth (99-04)	-	2.520***	1.041**
	-	(0.817)	(0.490)
Entry Rate	-	−0.672**	0.166
	-	(0.285)	(0.168)
Industry Effects[a]	361.52***	51.94***	129.12***
Factor Intensity	-	4.82	8.59
Skill Intensity	-	2.55	11.49***
Observations	17,239	17,239	12,036

Notes: Parameter estimates are reported. Standard errors in parenthesis. [a]The initial size equation comprises 3-digit industry effects, while we control for 2-digit industry effects in the survial and firm growth equations, respectively. *, ** and *** denote significance at 10%, 5% and 1% levels, respectively.

affected by the market and competitive environment. In more prosperous industries a firm's average survival probability is higher while more market entry increases a firm's exit hazard.

Finally, with regard to the initial firm size equation, unsurprisingly, firms with a larger birth size are also larger in 1999. This effect, however, is decreasing with firm age, implying that the impact of birth size disappears over time. In addition, older firms are larger on average and the market growth rate in the period from 1988 to 1998 positively influences the firm size in 1999. Finally, older firms in industries with a larger MES, on average, exhibit a larger initial firm size.

5 Policy Experiments, Gazelles and Job Creation

The results obtained from our three equation structural system allow a straightforward analysis of the counterfactual impact of economic policy changes on exit hazards, intra distribution dynamics as well as the probability to be a Gazelle. Moreover, this approach also permits an examination of the respective impacts of economic policies on overall job creation and allows to investigate counterfactual outcomes for different types of firms. While in principle this can be done for arbitrary groupings of firms, we are interested in the role of economic policy for small versus large and young versus old firms.

In particular, we analyze four different policy changes. Firstly, we increase each firm's age by one standard deviation to simulate an increase in the life span of firms, which is an objective of many small business and entrepreneurship policies. Secondly, we increase market entry rates by one standard deviation. This could be the result of competition policies aiming to facilitate market entry. Thirdly, we increase market growth by one standard deviation. This could result from fiscal and monetary policies aimed at market stabilization as well as sectoral growth policies. Finally, we increase a firm's birth size by one employee as this could be the result of policies providing additional finance to young firms. This last experiment also allows to analyze a potential trade-off between initial firm size and firm growth. As discussed in the introduction, firms with a larger birth size increase the start-up job creation rate while they might exhibit lower post-start-up growth rates. Consequently, the post-start-up job creation rates for firms with a larger birth size are expected to be lower.

Table 3 presents the main results of our counterfactual analysis. The upper part of Table 3 reports the baseline transition probabilities obtained from our three equation system. Here, we only report the full matrices of transition probabilities for the groups of smallest and largest firms in 1999 and separately display the respective probabilities for the four quartiles of the firm age distribution. To give an example, the exit hazard for the initially smallest and youngest firms (reported in the left hand side panel of the table) is approximately 37.8%, while the smallest but oldest firms only exit the market with a 36.9% probability. Contrary to this, the largest but youngest firms (in the right hand side panel) exhibit an exit probability of approximately 32.3% while for the largest and oldest firms the respective value is given by 22.9%.

Overall, the upper part of Table 3 shows that firms are most likely stay in their size class from 1999 to 2004. In fact, the staying probabilities range from 51.2% to 59.4% and increase for both firm groups. Interestingly, market exit constitutes the second most likely event for both the smallest and largest firms. Older firms face lower exit probabilities and firms which are initially larger face a lower exit hazard in comparison to the group of the smallest firms. With regard to the occurrence of Gazelles the probability for the smallest firms to transit to the third or fourth quartile (i.e., 3/4) is 3.1%, on average. However, young-small firms exhibit a significantly higher probability (of 4.6%) to be a Gazelle, and this effect is monotonically decreasing with firm age. By contrast, the downsizing probability for the initially largest firms (i.e., the probability to transit from the 4th to the 2nd/1st quartile) is 7.8% and tends to increase with firm age. Older large firms are, therefore, more likely to dramatically downsize their employment, which, in turn, leads to a significant amount of job destruction. For this reason, the last three columns in Table 3 present the estimated (net) job creation (in absolute terms) from 1999 to 2004 in the initially small firms, the initially large firms and the

Table 3: Transition Probabilities: Baseline Predictions and Counterfactual Changes for SMEs

	Initially Small Firms (1st qrt, in 1999)				Mobility	Initially Large Firms (4th qrt, in 1999)				Small Firms	Large Firms	Overall
Age group	Exit	1	2	3/4	Index[a]	Exit	4	3	2/1	Δ Jobs	Δ Jobs	Δ Jobs
Baseline probabilities												
1	0.378	0.512	0.064	0.046		0.323	0.532	0.095	0.050	-92	-2,413	-2,770
2	0.357	0.552	0.055	0.035		0.277	0.538	0.115	0.071	-1,200	-10,161	-14,000
3	0.356	0.591	0.035	0.018		0.243	0.544	0.127	0.087	-1,057	-16,267	-24,230
4	0.369	0.594	0.025	0.011		0.229	0.576	0.117	0.078	-722	-10,010	-16,406
Total	0.362	0.558	0.049	0.031	0.510	0.248	0.553	0.120	0.079	-3,070	-38,851	-57,406
Counterfactual changes in Transition Probabilities										Counterfactual Changes in Δ Jobs		
Experiment 1: age+1 Std. dev.												
1	-0.038	0.061	-0.010	-0.014		-0.086	0.087	-0.004	0.004	-1,049	-186	-1,857
2	-0.014	0.033	-0.009	-0.010		-0.042	0.046	-0.005	0.001	-1,993	954	-2,958
3	0.009	0.000	-0.005	-0.004		-0.009	0.013	-0.002	-0.002	-227	3,892	3,014
4	0.016	-0.011	-0.003	-0.002		0.002	-0.003	0.002	-0.001	28	2,881	3,305
Total	-0.010	0.026	-0.008	-0.008	0.512	-0.015	0.017	-0.001	-0.001	-3,241	7,540	1,504
Experiment 2: Entry rate+1 Std. dev.												
1	0.014	-0.010	-0.002	-0.002		0.014	-0.011	-0.002	-0.001	-15	-19	-44
2	0.013	-0.011	-0.001	-0.001		0.013	-0.010	-0.002	-0.002	-37	-60	-143
3	0.013	-0.011	-0.001	-0.001		0.013	-0.009	-0.002	-0.002	-13	-72	-160
4	0.013	-0.012	-0.001	0.000		0.012	-0.009	-0.002	-0.002	-8	-47	-113
Total	0.013	-0.011	-0.001	-0.001	0.500	0.013	-0.009	-0.002	-0.002	-73	-198	-459
Experiment 3: Market Growth +1 Std. dev.												
1	-0.015	0.004	0.005	0.006		-0.016	0.020	-0.002	-0.002	55	86	181
2	-0.015	0.005	0.005	0.005		-0.015	0.019	-0.002	-0.003	152	365	726
3	-0.014	0.008	0.004	0.003		-0.014	0.019	-0.002	-0.003	56	644	1,075
4	-0.014	0.010	0.003	0.002		-0.013	0.018	-0.002	-0.003	31	564	885
Total	-0.015	0.006	0.004	0.004	0.517	-0.014	0.019	-0.002	-0.003	295	1,659	2,867
Experiment 4: Birth Size + 1 Employee												
1	-0.002	-0.039	0.019	0.022		0.000	0.006	-0.004	-0.003	-198	-78	-371
2	-0.003	-0.031	0.017	0.017		-0.001	0.010	-0.005	-0.005	-911	-436	-2,203
3	-0.008	-0.014	0.012	0.009		-0.002	0.014	-0.006	-0.006	-502	-766	-3,238
4	-0.014	-0.002	0.010	0.006		-0.002	0.011	-0.004	-0.004	-230	-360	-1,790
Total	-0.005	-0.025	0.015	0.015	0.514	-0.002	0.012	-0.005	-0.005	-1,841	-1,639	-7,602

Notes: [a]The Prais mobility index is given by: $M = \left(4 * P_{\text{survival}} - \sum_{k=1}^{4} P_{k|k}\right)/3$, where $P_{k|k}$ is the probability of staying in the size class (k) (see, e.g., Biewen 2005).

overall job creation across all firms. Unsurprisingly, we estimate an overall loss of 57,406 jobs in Austrian manufacturing SMEs during our observation period with approximately 42% (i.e. 24,230) of the overall job loss due to downsizing in the third quartile of the age distribution. By contrast, the overall employment loss in the youngest age cohort only amounts to 2,770 jobs. Moreover, approximately two-third of all lost jobs (i.e. 38,851) can be traced back to downsizing in the initially largest firms.

The lower four parts of Table 3 report the changes in the transition probabilities due to the above described counterfactual changes in firm age, entry rate, market growth and birth size. Additionally, for all four age cohorts we calculate the changes in job creation rates based on the respective policy changes. To start with, we discuss the Prais mobility index which is an overall measure of the intra-distribution dynamics in the firm size distribution from 1999 to 2004. The Prais index is defined for values between 0 and $\frac{4}{3}$, where higher values are associated with more mobility. Evidently, our counterfactual policies do not significantly change the overall level of intra-distribution dynamics of the firm size distribution. In fact, the Prais mobility index for the baseline estimation is given by 0.510, while an increase in the market growth rate or an increase in the firms' birth size increases the mobility index only marginally to 0.517 and 0.514, respectively, and an increase in the industry-wide entry rate by one standard deviation reduces the index value to 0.500.

With regard to the transition probabilities for the group of the (initially) smallest and largest firms more substantial results can be obtained. Focusing on experiment 1, an increase in each firm's age by one standard deviation (which corresponds to approximately 8 years) reduces the exit hazard for the youngest firms, irrespective whether they are small or large in 1999. Interestingly, in comparison to our baseline scenario an increase in firm age slightly increases the exit probability for the oldest firms. This result accords with the hypotheses put forward in population ecology approaches to business exit, which claim that, due to 'structural inertia', an increase in firm age for already old and established firms increases their likelihood of market exit (see, e.g., Hannan and Freeman 1977). The probability to be a Gazelle by contrast decreases in this policy experiment as indictated by lower transition probabilities from the first to the third or fourth firm size quartiles. Finally, with reference to job creation, an increase in firm age by one standard deviation increases the overall level of employment by 1,504 jobs. Thus, instead of declining by 57,406 employees, in this counterfactual situation the overall employment loss would have been only 55,902. This lower job loss is due to slower downsizing in older and initially larger firms since in comparison to the baseline scenario younger and initially small firms lose even more jobs. In particular, all firms within the 4th quartile of the firm age (size) distribution would employ 3,305 (7,540) more employees if these firms were approximately 8 years older.

In experiments 2 and 3 we increase the entry rate and the market growth rate by one standard deviation, respectively. In the former case this corresponds to an increase in market entry by approximately 6%-points while market growth is increased by 2%-points. Evidently, an increase in competition has only a minor impact on the transition probabilities and, therefore, only slightly changes the overall employment level. More precisely, the increase in market entry increases the exit probability for small and large firms by approximately 1.3%-points. By contrast, the staying probabilities decrease by a similar magnitude, while downsizing probabilities are slightly lower for initially large firms. Overall, the number of jobs slightly decreases in comparison to the baseline scenario.

In comparison to more competition (or increased market entry), an increase in the market growth rate exhibits opposite effects on the estimated transition probabilities. In particular, higher market growth rates decrease the exit hazard for all firms by approximately 1.5%-points, increase the staying probabilities throughout and also slightly increase the likelihood of small firms to be Gazelles. The downsizing probabilities for initially large firms slightly decrease, as well. These changes in transition probabilities are found for all age cohorts. Consequently, in comparison to the baseline situation a counterfactual increase in market growth rates, increases the number of jobs throughout with the largest number of additional jobs in the third quartile of the firm age distribution. Overall, this experiment reduces the job losses in Austrian manufacturing firms by 2,867 employees, with the majority of 'additional' jobs generated in the initially large firms.

Finally, experiment 4 incorporates a counterfactual increase in the birth size of firms. According to our results larger start-up firms face a decreased exit hazard, where this effect is especially pronounced for the initially smallest (and oldest) firms. A larger birth size also increases the probability for small firms to be a Gazelle - in particular when small firms are young - and marginally decreases downsizing tendencies in the initially largest firms. However, from the firm growth equation in Table 2 it is evident that initially larger firms exhibit lower firm growth rates throughout. Consequently, an increase in the birth size of firms decreases post-start up job creation rates in the respective firms. For this reason, experiment 4 leads to even more job losses than in the baseline situation. However, given that the increase in birth size adds 18,380 additional jobs in 1999, the initial job creation effect outweighs the additional job destruction of 7,602 jobs between 1999 and 2004. Interestingly, however, the additional job destruction from 1999 to 2004 tends to be equally distributed across initially small and initially large firms.

6 Robustness Analysis: Incorporating Large and Age-Censored Firms

In the analysis above we imposed two potentially important restrictions with regard to the included firms: Firstly, we only focused on SMEs and, therefore, miss 151 firms with 250 or more employees in 1999. Secondly, due to censoring of the firm age information we excluded approximately 8,300 very old firms. Evidently, both these restrictions directly influence the observed firms size distribution, and could, therefore, affect our results. For this reason, we also investigate the reliability of the estimates discussed above when dropping these restrictions.

With regard to the first data restriction we simply re-estimate our model including all firms by including the 151 firms with 250 or more employees in our sample. The inclusion of these large firms reduces the predictive power of our econometric model, somewhat. However, Table 4 clearly points to the robustness of our original results with regard to the inclusion of large

Table 4: Transition Probabilities: Baseline Predictions and Counterfactual Changes for Firms of all Sizes

	Initially Small Firms (1st qrt, in 1999)				Mobility	Initially Large Firms (4th qrt, in 1999)				Small Firms	Large Firms	Overall
Age group	Exit	1	2	3/4	Index[a]	Exit	4	3	2/1	Δ Jobs	Δ Jobs	Δ Jobs
Baseline probabilities												
1	0.381	0.510	0.065	0.043		0.328	0.535	0.095	0.042	-87	-2,821	-3,163
2	0.359	0.550	0.057	0.033		0.272	0.555	0.114	0.060	-1,151	-13,161	-16,978
3	0.358	0.588	0.037	0.017		0.231	0.568	0.126	0.074	-1,066	-24,681	-32,659
4	0.374	0.590	0.026	0.010		0.214	0.603	0.117	0.067	-737	-12,327	-18,779
Total	0.365	0.556	0.050	0.029	0.504	0.237	0.576	0.119	0.067	-3,040	-52,990	-71,579
Counterfactual changes in Transition Probabilities										Counterfactual Changes in Δ Jobs		
Experiment 1: age+1 Std. dev.												
1	-0.040	0.061	0.056	-0.013		-0.101	0.101	-0.004	0.004	-1,011	-335	-2,000
2	-0.014	0.032	-0.017	-0.009		-0.049	0.053	-0.005	0.001	-1,932	1,725	-2,249
3	0.011	-0.001	-0.027	-0.004		-0.012	0.015	-0.002	-0.001	-222	7,982	7,081
4	0.018	-0.012	-0.014	-0.002		0.000	-0.002	0.002	0.000	31	4,146	4,577
Total	-0.009	0.025	0.017	-0.008	0.508	-0.019	0.020	-0.001	0.000	-3,135	13,518	7,410
Experiment 2: Entry rate+1 Std. dev.												
1	0.014	-0.011	-0.002	-0.002		0.015	-0.013	-0.002	-0.001	-17	-29	-58
2	0.014	-0.011	-0.002	-0.001		0.014	-0.011	-0.002	-0.001	-44	-90	-193
3	0.014	-0.012	-0.001	-0.001		0.013	-0.010	-0.002	-0.001	-16	-91	-202
4	0.014	-0.012	-0.001	0.000		0.012	-0.009	-0.002	-0.001	-10	-57	-141
Total	0.014	-0.011	-0.002	-0.001	0.494	0.013	-0.010	-0.002	-0.001	-87	-266	-594
Experiment 3: Market Growth +1 Std. dev.												
1	-0.014	0.003	0.005	0.006		-0.014	0.019	-0.002	-0.002	53	102	196
2	-0.013	0.004	0.005	0.005		-0.013	0.018	-0.002	-0.003	149	464	833
3	-0.013	0.007	0.004	0.003		-0.012	0.017	-0.002	-0.003	57	949	1,390
4	-0.013	0.008	0.003	0.002		-0.011	0.017	-0.002	-0.003	31	744	1,071
Total	-0.013	0.005	0.004	0.004	0.510	-0.012	0.017	-0.002	-0.003	290	2,259	3,490
Experiment 4: Birth Size + 1 Employee												
1	-0.002	-0.039	0.019	0.021		0.000	0.006	-0.004	-0.002	-183	-77	-353
2	-0.003	-0.031	0.018	0.016		-0.001	0.010	-0.005	-0.004	-876	-434	-2,175
3	-0.010	-0.013	0.013	0.009		-0.002	0.014	-0.006	-0.006	-524	-805	-3,336
4	-0.017	0.000	0.011	0.006		-0.003	0.011	-0.005	-0.004	-251	-386	-1,896
Total	-0.006	-0.024	0.016	0.014	0.509	-0.002	0.012	-0.005	-0.005	-1,834	-1,702	-7,760

Notes: [a]The Prais mobility index is given by: $M = \left(4 * P_{\text{survival}} - \sum_{k=1}^{4} P_{k|k}\right)/3$, where $P_{k|k}$ is the probability of staying in the size class (k) (see, e.g., Biewen 2005).

firms. Qualitatively, these are hardly affected. Most importantly, our new baseline predictions suggest that the inclusion of the largest firms increases the number of lost jobs to 71,579. This comes as no surprise because obviously during the last years the (employment) downsizing tendencies have been most pronounced in large manufacturing firms, as demonstrated by the estimated loss of 52,990 jobs in the respective group of firms. Interestingly, taking the largest firms into account the impact of an increase in the life span of firms on the overall job creation is approximately quintupled. Contrary, the job generating consequences of the other policy measures is hardly affected. Finally, focusing on the impact of different economic policy measures on the probability to create Gazelles our baseline results are not affected by the inclusion of 151 large firms.

In order to properly deal with the second data restriction which is based on the censoring of firm age for firms older than 31 years we adapt our estimation framework. In particular, we replace our firm age information by four dummy variables which classify each firm in one of the four age cohorts (0-5, 5-10, 10-20, >20). This allows to include all age-censored firms as these are categorized into the oldest cohort. Disadvantageously, this approach renders a direct comparison of experiments 1 and 4 with the baseline results impossible. Given our model structure, the counterfactual changes in firm age are inherently incomparable between the basic model and the alternative dummy variable design. Since, for age-censored firms birth size is not available and since it is interacted with firm age in the initial firm size and the survival equations, respectively, the incomparability of the counterfactual outcomes carries over to the experiment 4.

Table 5 reports the transition probabilities and counterfactual policy changes for all firms (including age-censored firms and the largest firms) utilizing the alternative firm age dummy specification. Focusing on experiments 2 and 3 of Table 5 it becomes evident that our qualitative and quantitative baseline results are hardly affected by the inclusion of the firm age-censored firms and the re-formulation of the econometric model. Therefore, we can still conclude that an increase in market entry rates increases the exit hazard for all firms and marginally decreases the probability to observe Gazelles. On the contrary, higher market growth rates decrease market exits and slightly

Table 5: Transition Probabilities: Baseline Predictions and Counterfactual Changes for all Firms Including Age Dummies

	Initially Small Firms (1st qrt, in 1999)				Mobility	Initially Large Firms (4th qrt, in 1999)				Small Firms	Large Firms	Overall
Age group	Exit	1	2	3/4	Index[a]	Exit	4	3	2/1	Δ Jobs	Δ Jobs	Δ Jobs
Baseline probabilities												
1	0.290	0.446	0.136	0.128		0.550	0.258	0.128	0.064	1,308	-1,259	-52
2	0.415	0.532	0.040	0.013		0.239	0.632	0.100	0.029	-1,700	-9,709	-14,041
3	0.329	0.606	0.048	0.016		0.197	0.657	0.112	0.034	-1,355	-16,034	-22,170
4	0.359	0.590	0.040	0.012		0.194	0.652	0.117	0.038	-1,661	-50,510	-65,557
Total	0.362	0.553	0.056	0.029	0.471	0.204	0.646	0.114	0.036	-3,407	-77,512	-101,821
Counterfactual changes in Transition Probabilities											Counterfactual Changes in Δ Jobs	
Experiment 2: Entry rate+1 Std. dev.												
1	0.009	-0.005	-0.002	-0.002		0.012	-0.008	-0.003	-0.001	-16	-9	-34
2	0.010	-0.009	-0.001	0.000		0.010	-0.008	-0.001	0.000	-41	-47	-140
3	0.010	-0.008	-0.001	0.000		0.009	-0.007	-0.001	0.000	-21	-39	-124
4	0.010	-0.009	-0.001	0.000		0.008	-0.007	-0.001	-0.001	-22	-101	-273
Total	0.010	-0.008	-0.001	-0.001	0.465	0.009	-0.007	-0.001	0.000	-100	-196	-571
Experiment 3: Market Growth +1 Std. dev.												
1	-0.009	0.000	0.003	0.006		-0.012	0.011	0.001	-0.001	60	16	102
2	-0.010	0.006	0.002	0.001		-0.009	0.011	-0.001	-0.001	104	365	624
3	-0.009	0.005	0.003	0.001		-0.008	0.011	-0.002	-0.001	73	619	958
4	-0.009	0.006	0.002	0.001		-0.008	0.010	-0.001	-0.001	67	1,866	2,527
Total	-0.009	0.005	0.003	0.002	0.475	-0.008	0.011	-0.001	-0.001	304	2,866	4,211

Notes: [a]The Prais mobility index is given by: $M = \left(4 * P_{\text{survival}} - \sum_{k=1}^{4} P_{k|k}\right)/3$, where $P_{k|k}$ is the probability of staying in the size class (k) (see, e.g., Biewen 2005).

increase the small firms' Gazelle probabilities. Overall, the former policy would increase the lost jobs by 571, while increasing market growth rates by one standard deviation (counterfactually) provides 4,211 more jobs, with the overwhelming majority of 2,866 jobs created in the initially largest firms.

7 Conclusions

This paper uses an econometric model which simultaneously examines initial firm size, firm survival and (average) firm growth to estimate firm-specific transition probabilities between size classes (such as the probability to be a Gazelle) and to explore the determinants of net job creation rates. This approach allows us to assess the impact of different (counterfactual) economic policy measures on intra-distribution dynamics of the firm size distribution. Investigating the impact of small business and entrepreneurship policy, competition policy and growth oriented policies we find that all of these policies have important structural implications. In particular, our results suggest that policies increasing the life span of firms reduce the exit hazard for young firms but slightly increase the exit hazard for older firms and, finally, reduce the small firms' probability to become a Gazelle. Similarly, an increase in the entry rate of new firms increases the exit hazards of incumbent firms and has virtually no impact on the likelihood of firms to be Gazelles. Increasing market growth, by contrast, decreases the exit hazards for incumbent firms and slightly increases the likelihood of firms to be Gazelles. Finally, a larger birth size of firms decreases exit rates for all firms with effects, however, strongest for the oldest firms. Moreover, an increase in the firms' birth size increases the chance to create Gazelles.

From a policy perspective our results therefore imply a number of interesting trade offs between important objectives of SME policy. For instance, policies that increase the founding size of firms introduce an inter-temporal trade-off where increased job creation today is likely to lower job growth later in the life of firms. Similarly, policies aiming at increasing entry rates are likely to also increase exit rates. Our method allows us to quantify these trade-offs as well as to distinguish the structural effects of different policies on firms of different size and age groups.

Finally, due to the lack of information of the potential costs of these policies, it is not possible to assess their efficiency. Nonetheless, our results provide evidence for the likely contribution of alternative policy measures to various objectives of SME policy. For instance, policies that are directed at increasing entry rates are unlikely to increase the share of Gazelles in an economy. By contrast, policies aiming at increasing the birth size of firms and (to a lesser degree) at enhancing market growth are likely to increase the share of Gazelles. Clearly, for policy makers focusing on net job creation it is important to understand these structural interactions when it comes to designing efficient SME policies.

Acknowledgements

We are grateful to the seminar participants at the University of Innsbruck and the participants of the workshop on high-growth firms, hosted by the Ratio institute in Stockholm in May 2011, for useful comments and valuable discussions. Financial support from the 'Oesterreichische Nationalbank' (OeNB, grant numbers 13370 and 12831) is gratefully acknowledged.

8 References

Amemiya, Takeshi (1974), Multivariate Regression and Simultaneous Equation Models when the Dependent Variables are Truncated Normal, Econometrica 42(6), pp. 999-1012.

Audretsch, David B., Patrick Houweling and A. Roy Thurik (2000), Firm Survival in the Netherlands, Review of Industrial Organization 16(1), pp. 1-11.

Bartelsman, Eric, Stefano Scarpetta and Fabiano Schivardeli (2005), Comparative Analysis of Firm Demographics and Survival: Evidence from Micro-Level Sources in OECD Countries, Industrial and Corporate Change 14(3), pp. 365-391.

Biewen, Martin (2005), The Covariance Structure of East and West German Incomes and its Implications for the Persistence of Poverty and Inequality, German Economic Review, 6(4), pp. 445-469.

Birch, David L. (1979), The Job Generation Process, MIT Program on Neighborhood and Regional Change.

Bottazzi, Giulio and Angelo Secchi (2003), Why Are Distributions of Firm Growth Rates Tent-Shaped?, Economics Letters 80(3), pp. 415-420.

Bottazzi, Giulio and Angelo Secchi (2006), Explaining the Distribution of Firm Growth Rates, RAND Journal of Economics 37(2), pp. 235-256.

Broersma, Lourens and Pieter Gautier (1997), Job Creation and Job Destruction by Small Firms: An Empirical Investigation for the Dutch Manufacturing Sector, Small Business Economics 9(3), pp. 211-224.

Caballero, Ricardo J. and Mohamad L. Hammour (1994), The Cleansing Effect of Recessions, American Economic Review 84(5), pp. 1350-1368.

Cabral, Luis M. B. and Jose Mata (2003), On the Evolution of the Firm Size Distribution: Facts and Theory, American Economic Review 93(4), pp. 1075-1090.

Cameron, A. Colin and Pravin K. Trivedi (2005), Microeconometrics: Methods and applications, Cambridge University Press.

Card, David, Raj Chetty and Andrea Weber (2007), Cash-on-Hand and Competing Models of Intertemporal Behavior: New Evidence from the Labor Market, Quarterly Journal of Economics 122(4), pp. 1511-1560.

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

Davidsson, Per, Leif Lindmark and Christer Olofsson (1998), The Extent of Overestimation of Small Firm Job Creation – An Empirical Examination of the Regression Bias, Small Business Economics 11(1) , pp. 87-100.

Davis, Steven J., John C. Haltiwanger and Scott Schuh (1996), Small Business and Job Creation: Dissecting the Myth and Reassessing the Facts, Small Business Economics 8(4), pp. 297-315.

Del Bono, Emilia, Andrea Weber and Rudolf Winter-Ebmer (2011), Clash of Career and Family: Fertility Decisions after Job Displacement, Journal of the European Economic Association, forthcoming.

Dunne, Paul and Alan Hughes (1994), Age, Size, Growth and Survival: UK Companies in the 1980s, Journal of Industrial Economics 42(2), pp. 115-140.

Evans David S. (1987a), The Relationship between Firm Growth, Size, and Age: Estimates for 100 Manufacturing Industries, Journal of Industrial Economics 35(4), pp. 567-581.

Evans David S. (1987b), Tests of Alternative Theories of Firm Growth, Journal of Political Economy 95(4), pp. 657-674.

Fazzari, Steven M., R. Glenn Hubbard and Bruce C. Petersen (1988), Financing Constraints and Corporate Investment, Brookings Papers on Economic Activity 1988(1), pp. 141-206.

Fink, Martina, Esther Kalkbrenner, Andrea Weber and Christine Zulehner (2010), Extracting Firm Information from Administrative Records: The ASSD Firm Panel, Working Paper 1004, NRN: The Austrian Center for Labor Economics and the Analysis of the Welfare State.

Fotopoulos, Georgios and Helen Louri (2000), Location and Survival of New Entry, Small Business Economics 14(4), pp. 311-321.

Freeman, John, Glenn R. Carroll and Michael T. Hannan (1983), The Liability of Newness: Age Dependence in Organizational Death Rates, American Sociological Review 48(5), pp. 692-710.

Geroski, Paul A. (1995), What do We Know about Entry?, International Journal of Industrial Organization 13(4), pp. 421-440.

Geroski, Paul A., José Mata and Pedro Portugal (2010), Founding Conditions and the Survival of New Firms, Strategic Management Journal 31(5), pp. 510-529.

Gibrat, Robert (1931), Les Inequalities Economiques, Sirey.

Greene, William H. (2003), Econometric Analysis, 5th edition, Pearson Prentice Hall.

Hall, Bronwyn. H. (1987), The Relationship between Firm Size and Firm Growth in the US Manufacturing Sector, Journal of Industrial Economics 35(4), pp. 583-606.

Haltiwanger, John C., Ron S. Jarmin and Javier Miranda (2010), Who Creates Jobs? Small vs. Large vs. Young, NBER Working Paper No. 16300, National Bureau of Economic Research.

Hamermesh, Daniel S. and Gerard A. Pfann (1996), Adjustment Costs in Factor Demand, Journal of Economic Literature 34(3), pp. 1264-1292.

Hannan, Michael T. and John Freeman (1977), The Population Ecology of Organizations, American Journal of Sociology 82(5), pp. 929-964

Hart, Peter E. (2000), Theories of Firms' Growth and the Generation of Jobs, Review of Industrial Organization 17(3), pp. 229-248.

Hart, Peter E. and Nicholas Oulton (1996), Growth and Size of Firms, Economic Journal, 106(438), pp. 1242-1252.

Heckman, James J. (1976), The Common Structure of Statistical Models of Truncation, Sample Selection and Limited Dependent Variables and a Simple Estimator for Such Models, Annals of Economic Social Measurement 5(4), pp. 475-492.

Heckman, James J. (1979), Sample Selection Bias as a Specification Error, Econometrica 47(1), pp. 153-161.

Henrekson, Magnus and Dan Johansson (2010), Gazelles as Job Creators: A Survey and Interpretation of the Evidence, Small Business Economics 35(2), pp. 227-244.

Huber, Peter and Michael Pfaffermayr (2010), Testing for Conditional Convergence in Variance and Skewness: The Firm Size Distribution Revisited, Oxford Bulletin of Economics and Statistics 72(5), pp. 648-668.

Jovanovic, Boyan (1982), Selection and The Evolution of Industry, Econometrica 50 (3), pp. 649-670.

Knaup, Amy E. (2005), Survival and Longevity in the Business Employment Dynamics Data, Monthly Labor Review, May, pp. 50-56.

Mata, José and Pedro Portugal (1994), Life Duration of New Firms, Journal of Industrial Economics 42(3), pp. 227-245.

Neumark, David, Brandon Wall and Junfu Zhang (2011), Do Small Businesses Create More Jobs? New Evidence for the United States from the National Establishment Time Series, Review of Economics and Statistics 93(1), pp. 16-29.

Oberhofer, Harald (2010), Firm Growth, European Industry Dynamics and Domestic Business Cycles, WIFO Working Papers 377, Austrian Institute of Economic Research.

OECD (2009), Measuring Entrepreneurship: A Collection of Indicators, OECD.

Peneder, Michael (2003), Industry Classifications: Aim, Scope and Techniques, Journal of Industry, Competition and Trade 3(1-2), pp. 109-129.

Penrose, Edith T. (1959), The Theory of the Growth of the Firm, Blackwell Publishing.

Pfaffermayr, Michael (2007), Firm Growth under Sample Selection: Conditional σ-Convergence in Firm Size?, Review of Industrial Organization 31(4), pp. 303-328.

Picot, Garnett and Richard Dupuy (1998), Job Creation by Company Size Class: The Magnitude, Concentration and Persistence of Job Gains and Losses in Canada, Small Business Economics 10(2), pp. 117-139.

Slater, Martin (1980), The Managerial Limitation to the Growth of Firms, Economic Journal 90(359), pp. 520-528.

Stinchcombe, Arthur L. (1965), Social Structure and Organizations, in March, James G. (ed.), Handbook of Organizations, Rand McNally, pp.142-193.

Tallis, G. M. (1961), The Moment Generating Function of the Truncated Multinormal Distribution, Journal of the Royal Statistical Society (Series B) 23(1), pp. 223-229.

Train, Kenneth E. (2003), Discrete Choice Methods with Simulation, Cambridge University Press.

Voulgaris, Fotini, Theodore Papadogonas and George Agiomirgianakis (2005), Job Creation and Job Destruction in Greek Manufacturing, Review of Development Economics 9(2), pp. 289-301.

Yasuda Takehiko (2005), Firm Growth, Size, Age and Behavior in Japanese Manufacturing, Small Business Economics 24(1), pp. 1-15.

Appendix 1

For the formal description of the estimated system of equations, we define the set of explanatory variables in each equation as $\mathbf{x}_{iT} = [\mathbf{x}_i, \mathbf{x}_{iTT}]$, $\mathbf{x}_{i1} = [\mathbf{x}_i, \mathbf{x}_{i11}]$ and $\mathbf{x}_{id} = [\mathbf{x}_i, \mathbf{x}_{iT1}, \mathbf{x}_{i11}, \mathbf{x}_{id}]$. Then the econometric model to be estimated is given by

$$
\begin{aligned}
y_{iT}^* &= \lambda y_{i1} + \mathbf{x}_i'\beta_T + \mathbf{x}_{iTT}'\beta_{TT} + u_i && (1)\\
y_{i1} &= \mathbf{x}_i'\beta_1 + \mathbf{x}_{i11}'\beta_{11} + v_i && (2)\\
d_i^* &= \mathbf{x}_i'\beta_d + \mathbf{x}_{iT1}'\beta_{dT} + \mathbf{x}_{i1}'\beta_{d1} + \mathbf{x}_{id}'\beta_{dd} + w_i, && (3)\\
d_i &= 1 \qquad if\ d_i^* > 0 \\
y_{iT} &= y_{iT}^* \qquad if\ d_i = 1.
\end{aligned}
$$

y_{i1} is always observed, while y_{iT} is only observed if firms survive and $d_i^* > 0$. Using this structural form representation we can write the system (1)-(3) in matrix form as

$$\mathbf{Y}\Gamma + \mathbf{RB} = \mathbf{q}$$

where

$$
\mathbf{Y} = \begin{bmatrix} y_{1T}^* & y_{11} & d_1^* \\ & \vdots & \\ y_{NT}^* & y_{N1} & d_N^* \end{bmatrix}, \ \mathbf{R} = -\begin{bmatrix} \mathbf{r}_1' \\ \vdots \\ \mathbf{r}_N' \end{bmatrix}, \ \mathbf{r}_i' = [\ \mathbf{x}_i' \quad \mathbf{x}_{iTT}' \quad \mathbf{x}_{i11}' \quad \mathbf{x}_{id}'\ ]
$$

$$
\mathbf{\Gamma} = \begin{bmatrix} 1 & 0 & 0 \\ -\lambda & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \mathbf{B} = \begin{bmatrix} \beta_T & \beta_1 & \beta_d \\ \beta_{TT} & \mathbf{0} & \beta_{dT} \\ \mathbf{0} & \beta_{11} & \beta_{d1} \\ \mathbf{0} & \mathbf{0} & \beta_{dd} \end{bmatrix}, \ \mathbf{q}_i' = \begin{bmatrix} u_i \\ v_i \\ w_i \end{bmatrix}.
$$

The reduced form of the system is given by

$$\mathbf{Y} = -\mathbf{RB\Gamma}^{-1} + \mathbf{q\Gamma}^{-1}$$

with

$$
\begin{aligned}
-\mathbf{B}\boldsymbol{\Gamma}^{-1} &= -\begin{bmatrix} \beta_T & \beta_1 & \beta_d \\ \beta_{TT} & \mathbf{0} & \beta_{dT} \\ \mathbf{0} & \beta_{11} & \beta_{d1} \\ \mathbf{0} & \mathbf{0} & \beta_{dd} \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ \lambda & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = -\begin{bmatrix} \beta_T + \beta_1\lambda & \beta_1 & \beta_d \\ \beta_{TT} & \mathbf{0} & \beta_{dT} \\ \beta_{11}\lambda & \beta_{11} & \beta_{d1} \\ \mathbf{0} & \mathbf{0} & \beta_{dd} \end{bmatrix} \\
\mathbf{q}\boldsymbol{\Gamma}^{-1} &= \begin{bmatrix} \mathbf{u} & \mathbf{v} & \mathbf{w} \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ \lambda & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} = \begin{bmatrix} \mathbf{u}+\lambda\mathbf{v} & \mathbf{v} & \mathbf{w} \end{bmatrix}
\end{aligned}
$$

Therefore, the joint distribution of the reduced form model is given by the following trivariate normal distribution:

$$
\begin{bmatrix} y_{iT}^* \\ y_{i1} \\ d_i^* \end{bmatrix} \sim N\left(\begin{bmatrix} \theta_{iT} \\ \theta_{i1} \\ \theta_{id} \end{bmatrix}, \begin{bmatrix} \lambda^2\sigma_v^2 + \sigma_u^2 & \lambda\sigma_v^2 & \rho_{uw}\sigma_u + \lambda\rho_{vw}\sigma_v \\ \lambda\sigma_v^2 & \sigma_v^2 & \rho_{vw}\sigma_v \\ \rho_{uw}\sigma_u + \lambda\rho_{vw}\sigma_v & \rho_{vw}\sigma_v & 1 \end{bmatrix} \right),
$$

where $\theta_{iT} = \mathbf{x}_i' (\beta_T + \beta_1\lambda) + \mathbf{x}_{iT}'\beta_{TT} + \mathbf{x}_{i1}'\beta_{11}\lambda$, $\theta_{i1} = \mathbf{x}_i'\beta_1 + \mathbf{x}_{i1}'\beta_{11}$ and $\theta_{id} = \mathbf{x}_i'\beta_d + \mathbf{x}_{iT}'\beta_{dT} + \mathbf{x}_{i1}'\beta_{d1} + \mathbf{x}_{id}'\beta_{dd}$. To derive the final form of the likelihood one needs the conditional distributions of $d_i = 1|y_{iT}^*, y_{i1}$ and $d_i^*|, y_{i1}$, which are given by (see Greene, 2003, p. 76) equations (5) and (6) in the text.

Furthermore, looking at the expectations of y_{iT} conditional on y_{i1} and on the survival of firm i illustrates the nature of the selection process formally. Using the results of Amemiya (1974, p. 1002) and Tallis (1961, p.225) the conditional exception of the final firms size conditional on survival can be written as

$$
E[y_{iT}\,|y_{i1}, d_i = 1] = (\mathbf{x}_i'\beta_1 + \mathbf{x}_{i11}'\beta_{11})\,\lambda + \mathbf{x}_i'\beta_T + \mathbf{x}_{iT1}'\beta_{T1} + \rho_{uv}\,(1 - \rho_{vw})\,\sigma_u\lambda_i(\theta_{id}),
$$