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## Working Paper Job creation and the intra-distribution dynamics of the firm size distribution

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PETER HUBER, HARALD OBERHOFER AND MICHAEL PFAFFERMAYR

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# WORKING PAPERS IN ECONOMICS AND FINANCE

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

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

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#### Abstract

Based on a three equations 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 to analyze counterfactual scenarios that assess the impact of changes in exogenous variables on the intra-distribution dynamics of the firm size distribution. We find that a counterfactual decrease in average firm age increases the exit hazard of young firms, and at the same time reduces the probability to observe high growth firms. An increase in the industry-wide entry rate and an increase in market growth, by contrast, havw virtually no impact on the intra-distribution dynamics of the firm size distribution. Finally, a larger birth size increases the probability for the youngest and smallest firms to be fast growing ones.

**Keywords:** Firm growth; survival; entry size; high growth firms; counterfactual scenario analysis; sample selection.

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

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#### 1 Introduction

The issue of which types of firms contribute most to job creation remains highly controversial in the economic literature and in policy debates. A large share of researchers provides evidence for the importance of small firms for (net) job creation and this seems to motivate political support for entrepreneurship and small, high-growth firms that are most likely to be upwardly mobile in the firm size distribution.<sup>1</sup>

However, the economic literature has also documented that the size of firms influences (net) job creation via various channels. Typically, small firms are more likely to exit the market reducing their constribution to (net) job creation. However, conditional on survival, small firms exhibit larger job creation rates, as is also documented by the literature on *Gibrat's* law of proportionate growth.<sup>2</sup> In a similar vein, firm age has also been identified to crucially affect (net) job creation. Thereby, young firms are less likely to survive but, again conditional on survival, are responsible for the overwhelming fraction of all newly created jobs. Altogether, these stylized facts imply that economic policy might influence the overall level of job creation via a relatively complicated relationship. To give only one example, public provision of financial resources (e.g., in terms of venture capital) might, ceteris paribus, allow start-up firms to initially produce at a larger scale and raise the job creation rate of these new firms. Moreover, initially larger firms are less likely to exit the market and, consequently, are less likely to destroy jobs. By contrast, these initially larger firms exhibit lower growth rates in comparison to small businesses so that their post-start-up job creation rates may be smaller. Generalizing this example, previous literature established systematic relationships between (i) (initial) firm size and survival, (ii) (initial) firm size and firm growth and (iii) survival and firm growth. Interestingly,

<sup>&</sup>lt;sup>1</sup>The literature typically refers to the latter as *Gazelles*. Accordingly, the OECD (2009) defines Gazelles as 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. Henrekson and Johansson (2010) show that these high growth firms exist across all different industries.

<sup>&</sup>lt;sup>2</sup>Although firm growth and job creation are discussed within two mainly unconnected strands of the literature, in this paper we argue that firm growth captures one important aspect of job creation, once the former is measured in terms of employment.

however, to our knowledge there is no paper that incorporates these different determinants of job creation in a single framework, which allows to disentangle direct and indirect effects of policy on the mobility within the firm size distribution and to examine its overall employment effects.

This paper aims to fill this gap by proposing an econometric approach which, for example, allows to identify the consequences of counterfactual policy scenarios for the occurrence of high growth firms. In addition, this approach allows to examine the impact of specific types of firms (such as high growth firms) on the (net) job creation at an aggregated level. To this end – building on the literature of firm growth and job creation – we generalize Heckman's (1976, 1979) sample selection model to obtain a three equations system that includes initial firm size, firm survival and final firm size. The parameters of interest are estimated for the population of Austrian manufacturing firms that operated in 1999 are observed until 2004. With these parameters at hand, we are able to estimate firm-specific transition probabilities (e.g., the probability to be a high growth firm) and to explore the intra-distribution dynamics of the firm size distribution conditional on a set of explanatory variables. Additionally, this model allows to assess the impact of counterfactual (policy) scenarios on the intra-distribution dynamics and on overall employment. We are thus able to assess the impact of changes in policy variables on the frequency of high growth firms. In particular, we investigate the impact of a decrease in (average) firm age, e.g., the share of young firms,  $vis-\dot{a}-vis$  a counterfactual situation of a larger firm size in the year of foundation. We also examine the hypothetical intra-distribution dynamics and job effects of an increase in market entry and market growth rates.

Our analysis suggests that a decrease in (average) firm age increases the exit hazards for both small and large young firms and reduces the frequency of small and young high growth firms. These negative effects on job creation are, however, offset by the the positive impact on the group of medium sized firms. An increase in the entry rate and enhanced market growth rates both exert virtually no impact on the intra-distribution dynamics of the firm size distribution and thus are not able to increase the share of fast growing firms. Finally, a counterfactual increase in a firm's birth size positively affects the smallest and youngest firms. Accordingly, these firms are more likely to become high growth firms. From a job creation point of view, our estimation results reveal that policies which aim at reducing average firm age might be most successful in creating additional jobs in the overall economy.

The remainder of the paper is organized as follows. In the next section, we briefly survey the related literature on job creation, firm survival and fast-growing firms to motivate our empirical approach. Section 3 lays out the econometric model, which simultaneously explains a firm's entry size, survival and growth, describes our data and discusses the estimation results. Section 4 offers the counterfactual scenario analysis. Finally, in Section 5 we provide concluding remarks.

#### 2 A Brief Review of the Related Literature

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. A number of other 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). Haltiwanger *et al.* (2012) 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). 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).

Since the seminal work of Gibrat (1931), the analysis of the relationship between firm size and firm growth has developed as a second and related strand of the literature (see, Coad 2009 for a recent survey). In particular, this literature has focused on the question whether firm growth is random (i.e., firm size follows a random walk) and thus obeys *Gibrat's law of proportionate growth*. Empirically, however, 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 '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.

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, while the overwhelming majority struggles for survival.

In a similar vein, the macroeconomic conditions 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), while the impact of the macroeconomic environment on already established firms seems to be less pronounced. This is 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, the economic literature and organizational ecology have demonstrated that 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). For these reasons, the impact of the surrounding macroeconomic conditions and market entry on overall

(net) job creation is ambiguous.

Alternatively, economic policy might therefore aim at directly supporting new entrants with additional financial resources so that they are able to start their business at a larger scale. This is usually accompanied by 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 high growth firms. 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. To sum up, the previous literature documents substantial trade-offs for economic policy aiming at increasing the overall number of jobs in an economy.

# 3 Modeling the Intra-distribution Dynamics of Firm Size

### 3.1 An Econometric Model of Firm Growth and Survival

The discussion above indicates that economic policy examines both direct and indirect effects on the overall level of (net) job creation. A careful treatment of these interactions requires an explicit econometric modeling at the firm level in system of equations that augments the typical Gibrat's law regression framework.<sup>3</sup> In addition, modeling initial firm size in a separate equation permits the calculation of the full transition matrix upon which the analysis of the (counterfactual) intra-distribution dynamics of the firm size distribution can be based.

Econometrically, we specify a three equations Heckman-type model with an equation for the log size of a surviving firm i at time  $T(y_{iT})$  and one for

<sup>&</sup>lt;sup>3</sup>For example, it allows to analyze the impact of changes in a firm's birth size on both its survival probability and its (estimated) size at the beginning of the time frame under investigation. The latter is commonly used to explain subsequent firm growth (see the growth equations used to test Gibrat's law).

its size in the initial period  $(y_{i1})$ , which typically is not the firm's birth size. The third equation accounts for sample selection due to exit and explains the probability that a firm's survival up to period T modeled by the latent variable  $d_i^*$ . Formally, the system of equations reads as

$$y_{iT}^* = \lambda_i y_{i1} + \mathbf{x}_{iT}' \beta_T + u_i \tag{1}$$

$$y_{i1} = \mathbf{x}'_{i1}\beta_1 + v_i \tag{2}$$

$$d_i^* = \mathbf{x}_{id}^{\prime} \beta_d + w_i \tag{3}$$

$$d_i = 1 \quad \text{if } d_i^* > 0$$
  

$$y_{iT} = y_{iT}^* \quad \text{if } d_i = 1$$
  

$$y_{iT} = \text{unobserved if } d_i = 0,$$

where  $\mathbf{x}_{i1}$  includes a firm's birth size  $y_{i0}$ . The stars for  $y_{iT}^*$  and  $d_i^*$  indicate 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  $\beta_T, \beta_1$  and  $\beta_d$  denote the corresponding vectors of parameters to be estimated.<sup>4</sup>

Based on the assumption that for each firm i the error term follows a trivariate normal distribution, this system of equations can be estimated using standard maximum likelihood methods.<sup>5</sup>

Moreover, this approach enables us to calculate transition probabilities by integrating the trivariate normal for each firm i and, thus, allows to estimate overall job creation rates for different types of firms. <sup>6</sup> For this we use the

<sup>6</sup>The technical details on the calculation of the transition probabilities and on the job

 $<sup>^4{\</sup>rm The}$  empirical specification for our application of this model is discussed in Section 3.2.

<sup>&</sup>lt;sup>5</sup>For technical details concerning the estimation procedure see Appendix A. Note, the law of large numbers implies that log firm size converges in distribution to a log normal (see, e.g., Sutton 1997 as well as Coad and Hölzl 2012). Thus, the yearly shocks reflected by the disturbances of the firm growth equation need not be normal. Form this point of view, the normality assumption should be interpreted as an approximation. More importantly, it allows to model sample selection and to derive transition probabilities by integrating the resulting trivariate normal. Since the transition probabilities are derived from the joint distribution of initial and final firm size, the absence of the equation for initial firm size would render such an approach impossible.

Geweke-Hajivassiliou-Keane (GHK) simulator (see Train 2003, for a detailed description). In order to do so, we have to 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, the GHK simulator treats 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.

#### **3.2** Data and Empirical Specification

For our empirical analysis, 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.* 2012).<sup>7</sup> The dataset captures the universe of firms in the Austrian manufacturing industries between 1972 and 2004. 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.<sup>8</sup> Empirically, we take explicit account of the OECD's (2009) definition of high growth firms by focusing on firm growth during a five year time period. 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. Hence, we have to exclude post 1999 entrants from our analysis. After this restriction the data covers 17,390 firms providing information on size (employment), age, region and industry. Out of these 12,167 firms (or, approximately 70%) survived the 5-year time period under consideration.

Among the explanatory variables used in our specification of the three

creation rates are reported in Appendix B.

<sup>&</sup>lt;sup>7</sup>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 2004). 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).

 $<sup>^{8}</sup>$ In the working paper version of this paper we provide a robustness analysis where we additionally incorporate these firms. There, we slightly modify our estimation strategy to take account of the above mentioned censoring problem. This in turn, unfortunately, renders a direct comparison of the results impossible. For further details see Huber *et al.* (2011).

equation model described above, firm size at times T, 1 and 0 are measured in terms of employment. Thereby, birth size refers to the number of employees when a firm enters the ASSD for the first time.<sup>9</sup> Firm age is calculated using a firm's year of incorporation relative to the year 2004. Market growth is based on the average EU-wide average annual value added at factor costs growth rate in a 3-digit NACE industry during the time period 1999 to 2004.<sup>10</sup> Entry rates are defined as the share of firms entering a 3-digit industry during the considered time period. Following, e.g., Scherer and Ross (1990) and Pfaffermayr (2007) the third quartile in the log firm size distribution within each 3-digit industry serves as a proxy for minimum efficient scale (MES).<sup>11</sup>

The specification of equation (1) 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 firm size as well as (European-wide) 3-digit industry specific growth rates of value added to factor costs. Moreover, following Peneder (2003) we classify the observed 3-digit industries with regard to their factor and skill intensity and additionally control for these 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 (see, e.g., Huber and Pfaffermayr 2010 and Oberhofer and Pfaffermayr 2012).<sup>12</sup> Additionally, following the recent

<sup>&</sup>lt;sup>9</sup>New firms are identified by their first appearance in the records. However, in establishing that database the Austrian Institute of Economic Research ran a series of checks and data cleaning procedures to make sure that only new firms are identified as entrants (see Schöberl 2004).

<sup>&</sup>lt;sup>10</sup>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 exportdependence of Austrian manufacturing firms an EU-wide measure better reflects the market growth opportunities for the respective firms.

<sup>&</sup>lt;sup>11</sup>Since the ASSD only contains employee characteristics any output or profit measures are missing in the data at hand and, thus, we are not able to calculate alternative measures for MES.

<sup>&</sup>lt;sup>12</sup>Thus, this equation nests both Gibrat's law (which is equivalent to testing whether  $\lambda = 1$ ) as well as some of the most influential explanations for deviations from this law, such as 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). 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 described well

literature we assume that a firm's growth performance is affected by sectorspecific business cycle fluctuations (see, e.g., Oberhofer 2012) 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.

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

The survival equation (3) is included to account for sample selection arising from the fact that exiting firms 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). In particular, the equation contains a firm's birth size, firm age, age squared, an interaction term of birth 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, industrywide entry rates as well as differences in factor and skill intensities as defined above and 2-digit industry fixed effects.<sup>13</sup>

Table 1 reports descriptive statistics for our sample. A comparison of final firm size in 2004 with initial firm size in 1999 indicates that the average number of employees per business unit slightly increased from 16.37 in 1999

by Gibrat's law.

<sup>&</sup>lt;sup>13</sup>Given our set of exogenous variables and following the literature on firm survival discussed above, 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 decrease the survival probability of incumbent firms.

Variable	Obs.	Mean	Std. dev.	Min	Max
Final firm size $(04)$	12,167	20.28	94.60	1	6,448
Survival	$17,\!390$	0.70	0.46	0	1
Initial firm size $(99)$	$17,\!390$	16.37	86.16	1	$7,\!836$
Birth size	17,390	11.23	71.72	1.5	$6,\!324.5$
Firm age	$17,\!390$	15.47	7.98	5	31
Mes	17,390	13.10	15.65	2	395
Market growth (88-98)	17,390	0.04	0.02	-0.05	0.09
Market growth (99-04)	17,390	0.01	0.02	-0.07	0.07
Entry rate	$17,\!390$	0.16	0.06	0.03	0.83

Table 1: Descriptive Statistics for the Full Sample

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

to 20.28 in 2004. However, when excluding exiting firms the average number of employees remained relatively stable over this time period.<sup>14</sup> 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 age in our sample is approximately 15.5 years. Focusing on industry-specific information, the average MES is approximately 13.1 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. Market entry rates are 16% on average and range from a minimum of 3% (in the knitted and crocheted fabrics industry, code 176) to a maximum of 83% in (manufacture of industrial process control equipment, code 333).

Table 2 additionally reports the distribution of firms by year of incorporation and across 2-digit industries. From the beginning of the nineties on, we observe a slight increase of market entries with an absolute maximum of 1,346 new firms in 1998. Focusing on the distribution of firms across industries, approximately 45% of all firms operate either in the manufacturing of food products, metal products or furniture. By contrast, the share of firms in pulp and paper production, office machinery and computers and in other transport equipment production is below 1 percent of the full sample, respectively.

<sup>&</sup>lt;sup>14</sup>The corresponding figures are available from the authors upon request.

	Га	DIE Z: DIS	tribution of Firms by Birth Year and Across Industries		
Birth year	Freq.	Percent	NACE Rev 1.1 2-digit Industry	Freq.	Percent
1973	639	3.67	Manufacture of food products and beverages	2,442	14.04
1974	509	2.93	Manufacture of textiles	506	2.91
1975	352	2.02	Manufacture of wearing apparel; dressing and dyeing of fur	576	3.31
1976	434	2.50	Manufacture of leather and leather products	192	1.1
1977	394	2.27	Manufacture of wood and wood products	1,505	8.65
1978	394	2.27	Manufacture of pulp, paper and paper products	148	0.85
1979	407	2.34	Publishing, printing and reproduction of recorded media	1,392	8.00
1980	467	2.69	Manufacture of chemicals and chemical products	543	3.12
1981	440	2.53	Manufacture of rubber and plastic products	518	2.98
1982	469	2.70	Manufacture of other non-metallic mineral products	823	4.73
1983	437	2.51	Manufacture of basic metals	190	1.09
1984	472	2.71	Manufacture of fabricated metal products	2,644	15.20
1985	522	3.00	Manufacture of machinery and equipment n.e.c.	1,372	7.89
1986	507	2.92	Manufacture of office machinery and computers	73	0.42
1987	597	3.43	Manufacture of electrical machinery and apparatus n.e.c.	316	1.82
1988	614	3.53	Manufacture of radio, television, communication equipment	209	1.20
1989	763	4.39	Manufacture of medical, precision, optical instruments	1,130	6.50
1990	744	4.28	Manufacture of motor vehicles, trailers and semi-trailers	221	1.27
1991	679	3.90	Manufacture of other transport equipment	41	0.24
1992	712	4.09	Manufacture of furniture; manufacturing n.e.c.	2,549	14.66
1993	732	4.21			
1994	788	4.53			
1995	854	4.91			
1996	888	5.11			
1997	1,006	5.78			
1998	1,346	7.74			
1999	1,224	7.04			
Total	17, 390	100		17,390	100

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

#### **3.3** Estimation Results

The estimated parameters of our baseline specification (shown in Table 3) 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 significantly increases with firm age with a parameter estimate of 0.128. However, the estimated  $\lambda_i$  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, while the growth process of old firms seems to follow a random walk. This can be inferred by the negative effect of age (-1.169) and the positive parameter estimate corresponding to its square (0.156). For the relevant age distribution in our sample (5 to 31) years the impact of age on firm growth is negative throughout. Firms also tend to be positively affected by market conditions: An increase in the 3-digit industry-specific growth rate, on average, leads to higher firm growth rates (parameter estimate: 1.125). Finally, 3-digit market entry rates do not directly influence variations in firm size in 2004 as indicated by the insignificant parameter estimate.

The estimation results, with regard to firm survival, 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 with a parameter estimate of 0.060. In addition, the overall effect of birth size is positive and increasing with firm age although the main effect of the former variable turns out to be insignificant. Our estimates also suggest that older firms are less likely to exit the market (see the significant parameter estimate of age amounting to 0.471). 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 organizational ecology. However, for very old firms the exit hazard increases again as indicated by the negative parameter estimate associated with age-squared

	Firm Size (1999)	Survival	Firm Size (2004)				
Variable	(1)	(2)	(3)				
Birth Size	1.275***	-0.050	_				
	(0.028)	(0.051)	-				
Initial Firm Size (99)	-	-	$0.555^{***}$				
	-	-	(0.025)				
Age	$1.868^{***}$	$0.471^{**}$	$-1.169^{***}$				
	(0.111)	(0.192)	(0.108)				
$Age^2$	$-0.355^{***}$	$-0.121^{***}$	$0.156^{***}$				
	(0.020)	(0.036)	(0.022)				
Birth Size*Age	$-0.183^{***}$	$0.060^{***}$	-				
	(0.010)	(0.018)	-				
Initial Firm Size $(99)^*$ Age	-	-	$0.128^{***}$				
		-	(0.009)				
Mes	-	$-0.204^{***}$	-				
	-	(0.076)	-				
Mes*Age	$0.160^{***}$	$0.064^{**}$	-				
	(0.017)	(0.028)	-				
Market Growth $(88-98)$ *Age	$3.460^{***}$	-	-				
	(0.647)	-	-				
Market Growth (99-04)	-	$2.284^{***}$	$1.125^{**}$				
	-	(0.811)	(0.483)				
Entry Rate	-	$-0.701^{**}$	0.147				
	-	(0.284)	(0.166)				
Industry $\text{Effects}^a$	$374.25^{***}$	55.91***	129.12***				
Factor Intensity	-	5.27	$9.67^{*}$				
Skill Intensity	-	3.46	$12.21^{***}$				
Observations	17,390	17,390	$12,\!167$				

Table 3: Estimation results for the full sample

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

(-0.121). The literature on firm survival refers to this latter result as *liabil-ity of adolescence* (see, e.g., Brüderl and Schüssler 1990). Additionally, in industries with a larger MES, firms are more likely to exit the market. This effect, however, diminishes with firm age. This finding 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 affected by market conditions and the competitive environment. In more prosperous industries a firm's exit hazard. The corresponding parameter estimates are 2.284 and -0.701, respectively.

Finally, with regard to the initial firm size equation, unsurprisingly, firms with a larger size at their year of incorporation (i.e., birth size) are also larger in 1999. This effect, however, is decreasing with firm age, implying that the impact of birth size vanishes 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.<sup>15</sup>

#### 4 A Counterfactual Scenario Analysis

The results obtained from our three equation system allow a counterfactual scenario analysis regarding the impact of changes in one of the exogeneous variables on exit hazards, intra distribution dynamics as well as on the probability to observe high growth firms. Moreover, this approach also permits an examination of the respective impacts on overall (net) job creation. While in principle this can be done for arbitrary groupings of firms, we are interested in the role of different scenarios for small versus large and young versus old firms. Moreover, this counterfactual scenario analysis allows to disentangle direct and indirect effects of variables targeted by economic policy on (net) job creation. Thereby, the former refers to the direct impact of policies on the number of employees while the latter is associated with changes

<sup>&</sup>lt;sup>15</sup>Note that in the initial firm size equation the main effects referring to market growth from 1988 to 1998 and to the MES are captured by the 3-digit industry fixed effects.

in survival probabilities and the changes in the firms' counterfactual growth performance.

In particular, we analyze four different counterfactual scenarios. First, we counterfactually decrease each firm's age by approximately one half of its standard deviation (i.e., four years) to simulate successful entrepreneurship policies, which aim at increasing market entry of new firms. Over time, these policies might lead to a decrease in average firm age.<sup>16</sup>

Second, we increase current market entry rates by one standard deviation. Besides the above already discussed focus of entrepreneurship policies on increasing entry rates, this counterfactual scenario could also be the result of Europe-wide competition policies aiming at facilitating market entry. Moreover, financial liberalization might also contribute to an increase in market entry (see, e.g., Kerr and Nanda 2010).

Third, we increase industry specific market growth by one standard deviation. This could result from fiscal and monetary stabilization policies as well as sectoral growth policies. Consequently, this counterfactual policy scenario could be useful to assess the impact of an economic boom on the distribution of (net) job creation across different types of firms and on the prevalence of high growth firms. In line with recent literature on the impact of macroeconomic aggregates on firm behavior, we assume that market growth exerts a causal impact on the individual firms' growth performance (see, e.g., Oberhofer 2012).

Finally, we increase a firm's birth size by one employee as this could again be the result of financial liberalization policies providing additional finance for young firms (Kerr and Nanda 2010). But also other policies and regulations could affect the entry size of firms. To give one example, Da Rin *et al.* (2010) demonstrate that variation in effective corporate tax rates is able to explain differences in entry size. Moreover, this last experiment also allows to analyze a potential trade-off between initial firm size and firm growth. As discussed above, firms with a larger birth size increase the startup job creation rate while they might exhibit lower post-start-up growth

<sup>&</sup>lt;sup>16</sup>Moreover, according to policy discussions some authors argue that, in comparison to the US, innovation in the European Union remains weak because of a smaller share of young (and large) innovative firms (see. e.g, Veugelers and Cincera 2010).

rates.

Table 4 presents the main results of our counterfactual scenario analysis. The upper part of this table 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 38.1%, while the smallest but oldest firms exit the market with a 37.4% probability. Contrary to this, the largest but youngest firms (in the right hand side panel) exhibit an exit probability of approximately 32.8% while for the largest and oldest firms the respective value is given by 21.4%.

Overall, the upper part of Table 4 shows that firms are most likely to stay in their size class from 1999 to 2004. In fact, the staying probabilities range from 51.0% to 60.3% and increase with firm age. Put differently, more than half of all initially smallest and largest firms in 1999 are still in in the same size cohort in 2004. Market exit constitutes the second most likely event for both the smallest and largest firms. Moreover, exit hazards tend to decrease with firm age. Here the only exception are firms in the smallest and oldest firm group which face a slightly increased exit hazards. In comparison to the group of the smallest firms the initially largest firms face lower exit hazards.

In this exercise we measure the frequency of high growth firms by the probability for the initially smallest firms to transit from the smallest firm size class to the third or fourth firm size quartile (i.e., from small to mediumlarge) during our observational period of five years. Table 4 indicates that the average probability to be a high growth firm is 2.9%. This effect, however, is heterogeneous across firm age groups. Accordingly, for an initially smallest but youngest firm the probability to be a high growth firm is 4.3% while for a very old firm with the same size this probability is reduced to only 1%. By contrast, the probability to transit from the 4th to the 2nd/1st quartile for the initially largest firms is 6.7% (i.e., from large to medium-small), on average, and tends to increase with firm age. Large firms which are also old are, therefore, more likely to dramatically reduce their number of employees

IS	gest Firms Overall	$\Delta$ Jobs $\Delta$ Jobs		$\begin{array}{rrrr} -2,821 & -3,163 \\ -13,161 & -16,978 \\ -24,681 & -32,659 \\ -12,327 & -18,779 \end{array}$	-52,990 -71,579	Counterfactual Changes in ∆ Jobs		$\begin{array}{cccc} 2,710 & 3,979 \\ 4,042 & 8,691 \\ -3,870 & -2,165 \\ -2,674 & -2,716 \end{array}$	209 7,789		-29 -58 -90 -193 -91 -202 -57 -141	-266 -594		$\begin{array}{cccc} 102 & 196 \\ 464 & 833 \\ 949 & 1,390 \\ 744 & 1,071 \end{array}$	2,259 $3,490$		-77 -353 434 -3175	-805 $-3,336-386$ $-1,896$	1 709
ges for all Firr.	Smallest Firms Larg	$\Delta$ Jobs		-87 -1,151 -1,066 -737	-3,040			662 1,920 306 5	2,892		-17 -44 -16 -10	-87		53 149 31	290		-183 876	-524 -251	1 83.4
ual Chang	S (6661					$\chi^2$ -Stat. <sup>c</sup>		$203.83^{***}$ $34.70^{***}$ 2.00 0.02	$32.53^{***}$		$\begin{array}{c} 0.10\\ 0.44\\ 0.85\\ 0.70\end{array}$	2.08		$\begin{array}{c} 0.13\\ 0.61\\ 1.19\\ 0.95\end{array}$	2.86		0.03	0.92	100
terfact	4th qrt, in	$\operatorname{Med.}_{p}$		$\begin{array}{c} 0.042 \\ 0.060 \\ 0.074 \\ 0.067 \end{array}$	0.067			-0.038 -0.013 0.000 0.000	-0.004		-0.001 -0.001 -0.001 -0.001	-0.001		-0.002 -0.003 -0.003 -0.003	-0.003		-0.002	-0.006	0.005
redictions and Count	est Firms (	Medium		$\begin{array}{c} 0.095 \\ 0.114 \\ 0.126 \\ 0.117 \end{array}$	0.119			-0.073 -0.009 0.002 -0.001	-0.004		-0.002 -0.002 -0.002	-0.002		-0.002 -0.002 -0.002	-0.002		-0.004	-0.006	0.005
	ially Large	Large		$\begin{array}{c} 0.535\\ 0.555\\ 0.568\\ 0.603\end{array}$	0.576			-0.344 -0.093 -0.020 -0.002	-0.041		-0.013 -0.011 -0.010 -0.009	-0.010		$\begin{array}{c} 0.019\\ 0.018\\ 0.017\\ 0.017\end{array}$	0.017		0.006	0.014	010 0
	Init	Exit		$\begin{array}{c} 0.328 \\ 0.272 \\ 0.231 \\ 0.214 \end{array}$	0.237			$\begin{array}{c} 0.455\\ 0.115\\ 0.018\\ 0.002 \end{array}$	0.050		$\begin{array}{c} 0.015\\ 0.014\\ 0.013\\ 0.012\end{array}$	0.013		-0.014 -0.013 -0.012 -0.011	-0.012		0.000	-0.002	0000
eline P <sub>1</sub>	Mobility	$\operatorname{Index}^a$			0.504				0.508			0.494			0.510				0
ies: Base	1999)					$\chi^2$ -Stat. <sup>c</sup>		$163.01^{***}$ $40.99^{***}$ $3.36$ $0.76$	87.11***		$\begin{array}{c} 0.34 \\ 0.93 \\ 0.38 \\ 0.23 \end{array}$	1.88		$\begin{array}{c} 0.63 \\ 1.71 \\ 0.62 \\ 0.35 \end{array}$	3.28		8.65** 20 R1***	6.19 3.29	$\begin{array}{cccccccccccccccccccccccccccccccccccc$
babilit	lst qrt, in	$\mathrm{Med.}^-$ Large <sup>b</sup>		$\begin{array}{c} 0.043 \\ 0.033 \\ 0.017 \\ 0.010 \end{array}$	0.029			-0.033 -0.004 0.003 0.001	-0.007		-0.002 -0.001 -0.001 0.000	-0.001		$\begin{array}{c} 0.006 \\ 0.005 \\ 0.003 \\ 0.002 \end{array}$	0.004		0.021	0.006	
ion Prc	est Firms (	Medium		$\begin{array}{c} 0.065\\ 0.057\\ 0.037\\ 0.026\end{array}$	0.050	bilities		$\begin{array}{c} 0.021 \\ -0.019 \\ -0.017 \\ -0.008 \end{array}$	0.013		-0.002 -0.002 -0.001 -0.001	-0.002		$\begin{array}{c} 0.005 \\ 0.005 \\ 0.004 \\ 0.003 \end{array}$	0.004		0.019	0.013	0 T C C
able 4: Transit	ially Small	Small		$\begin{array}{c} 0.510 \\ 0.550 \\ 0.588 \\ 0.590 \end{array}$	0.556	tion Probal		-0.207 -0.072 -0.010 0.005	-0.072	dev.	-0.011 -0.011 -0.012 -0.012	-0.011	l Std. dev.	$\begin{array}{c} 0.003\\ 0.004\\ 0.007\\ 0.008\end{array}$	0.005	ployee	-0.039	-0.013	100 0
	Init.	Exit		$\begin{array}{c} 0.381 \\ 0.359 \\ 0.358 \\ 0.374 \end{array}$	0.365	es in Transit	2 Std. dev.	$\begin{array}{c} 0.284 \\ 0.086 \\ 0.003 \\ -0.008 \end{array}$	060.0	rate+1 Std.	$\begin{array}{c} 0.014\\ 0.014\\ 0.014\\ 0.014\end{array}$	0.014	t Growth +1	-0.014 -0.013 -0.013 -0.013	-0.013	Size + 1 Em	-0.002	-0.010	000 0
Ta		Age group	Baseline probabilities	Young Mid-young Mid-old Old	Total	Counterfactual change	Experiment 1: age-1/	Young Mid-young Mid-old Old	Total	Experiment 2: Entry	Young Mid-young Mid-old Old	Total	Experiment 3: Market	Young Mid-young Mid-old Old	Total	Experiment 4: Birth 5	Young	Mid-old Old	Totol

inducing significant job destruction.

The last three columns of Table 4 allow to quantify the impact of the intradistribution dynamics of the firm size distribution on overall job creation. Correspondingly, for the time period from 1999 to 2004, we separately report the estimated number of created or destroyed jobs for the groups of the initially smallest firms, the initially largest firms and the overall job creation across all firms (including medium sized firms). Unsurprisingly, we estimate an overall loss of 71,579 jobs in Austrian manufacturing firms during our observation period. Thereby, the group of 'mid-old' (i.e., the third quartile of the firm age distribution) firms are responsible for approximately 45% (i.e., 32,659) of all destroyed jobs. By contrast, our estimates indicate that in the group containing the youngest firms only 3,163 jobs are destroyed. In a similar vein, approximately three quarters of all destroyed jobs are lost in the group of the initially largest firms while the initially smallest firms only account for less than five percent of all destroyed jobs (i.e., 3,040).

In order to analyze the impacts of counterfactual scenarios, as discussed above, the lower parts of of Table 4 report the changes in the transition probabilities due to changes in firm age, entry rate, market growth and birth size in our system of equations. Additionally, we also report changes in the job creation estimates which are induced by our counterfactual scenarios.

To start with, we discuss the Prais mobility index (see, Table 3 for a formal definition) which is an overall measure of the intra-distribution dynamics in the firm size distribution from 1999 to 2004.<sup>17</sup> This 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. The Prais mobility index for the baseline estimation is given by 0.504, while an increase in the market growth rate or an increase in the firms' birth size increases the mobility index only marginally to approximately 0.510, respectively. On the contrary, an increase in the industry-wide entry rate by one standard deviation slightly reduces the Prais mobility index to 0.494.

<sup>&</sup>lt;sup>17</sup>In our application we have a  $(4 \times 5)$  transition matrix with exit as additional (absorbing) state in the final period. For this reason we are not able to calculate alternative mobility indices as discussed in e.g., Shorrocks (1978) and Geweke *et al.* (1986) because these measures commonly rely on symmetric transition matrices.

With regard to changes in transition probabilities more substantial results can be obtained. Focusing on experiment 1, a decrease in each firm's age by one half of a standard deviation (which corresponds to approximately 4 years) increases the exit hazard for the youngest firms, irrespective of whether they are small or large in 1999. Moreover, staying probabilities are substantially reduced for both the largest and smallest youngest firms. The probability that one of the smallest firms transits to the third or fourth quarter in the firm size distribution also decreases by 3.3%. By contrast, conditional on survival the downsizing probabilities for the largest and youngest firms are substantially reduced. Table 4 indicates that these intra-distribution dynamics for the group of the youngest firms are statistically significantly different from zero as indicated by  $\chi^2$ -test statistics following the multinomial test idea proposed by Anderson and Goodman (1957).

Qualitatively, similar results can be obtained for the cohort of the midyoung firms although in magnitude the corresponding effects are considerably smaller. Accordingly, for the initially smallest mid-young firms a counterfactual reduction in firm age exerts only a small impact on the probability to be fast growing. For the cohorts of mid-old and old firms, the intra-distribution dynamics triggered by our firm age experiment are not statistically significant. Put differently, their transition probabilities are not altered in any serious manner. Finally, focussing on the counterfactual change in job creation, a decrease in firm age by one half of a standard deviation would increase the overall number of jobs by 7,789. Thus, instead of 71,579 lost jobs this counterfactual situation would lead to an overall employment loss of only 63,790. A closer look at the counterfactual changes in job creation by firm age reveals that with regard to the former younger firms would create additional jobs while in mid-old and old firms even more jobs would be lost. On the contrary, both groups of the initially smallest and initially largest firms are estimated to create more jobs in the counterfactual situation of younger firm age. In terms of (net) job creation, the increased firm growth of surviving firms, thus, seems to outweigh the negative impact of the increased exit hazard.

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, in quantitative terms both experiments only induce very small effects. This is also confirmed by non-significant test statistics for changes in the transition probabilities throughout. Consequently, from this counterfactual policy scenarios we can infer that neither an increase in market entry rates nor changes in the overall macroeconomic conditions significantly alter the intra-distribution dynamics of the firm size distribution. A closer inspection of the changes in transition probabilities due to these two counterfactual scenario reveals that both, the initially smallest and largest firms seems to be symmetrically affected by these experiments and thus intra-distribution dynamics are relatively small. To some extent this result contradicts earlier literature on firm survival which argued that market entry and macroeconomic conditions are especially crucial for the survival of the youngest firms (see, e.g., Caballero and Hammour 1994). On the contrary, our results also indicate that neither policies directed towards increasing market entry rates nor growth promoting policies are suitable to substantially increase the share of high growth firms.

Finally, scenario 4 analyzes the effects of a counterfactual increase in the birth size of firms by one employee. To start with, the lowest panel of Table 4 indicates that the transition probabilities of only the smallest firms in 1999 are significantly affected by this experiment. In particular, the youngest two cohorts of initially small firms exhibit a significant increase in their probability to be high growth firms. Consequently, these firms become less likely to exit the market and to stay small. With this result at hand, one might conclude that policies directed towards increasing start-up firm size might successfully lead to more high growth firms. By contrast, this counterfactual scenario even further enhance the job destruction tendencies in Austrian manufacturing firms. This additional job loss is due to the indirect effects of an increase in the birth size of all firms. Initially larger firms exhibit lower post-start-up growth rates contributing to further (net) job destruction. From a job creating policy perspective, this result would imply that only the very smallest start-up firms should be supported in order to increase their birth size.

#### 5 Conclusions

This paper formulates an econometric model which simultaneously examines initial firm size, firm survival and (average) firm growth to estimate firmspecific transition probabilities between size classes (such as the probability to be a high growth firm) and to explore the determinants of (net) job creation. This approach also allows to assess the impact of different (counterfactual) scenarios on the intra-distribution dynamics of the firm size distribution and to disentangle potentially countervailing effects of various policy measures. Some policies might, for example, increase the survival probability of some firms but on the other hand could lower overall firm growth. In such cases the overall effect of the policy measure at hand might be ambiguous. Moreover, this approach allows to compare the overall effects of alternative policy measures. Investigating the impact of small business and entrepreneurship policies, competition policy and growth oriented policies we indeed find that all of these policies have important structural implications.

In particular, a counterfactual scenario which decreases (average) firm age increase the exit hazards for both initially small and large firms and especially reduces the probability to be a high growth firm for the group of small and young firms. By contrast, an increase in the entry rate of new firms and increased market growth has virtually no impact the intra-distribution dynamics of the firm size distribution and thus is not able to successfully increase the frequency of high growth firms. Finally, a counterfactual increase in a firm's birth size positively affects the smallest and youngest firms. Accordingly, they become more likely to be fast growing firms. From an overall job creation point of view this latter scenario, however, leads to further job destruction which is due to lower post-start-up job creation in initially larger firms.

From a policy perspective our results imply a number of 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 in later periods. Our method allows us to quantify these trade-offs as well as to distinguish the structural effects of different policies on firms in different size and age cohorts. 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 high growth firms in an economy. By contrast, policies aiming at increasing the birth size of the initially smallest firms are likely to increase the share of fast growers. Clearly, for policy makers which focus on net job creation it is important to understand these structural interactions when it comes to designing efficient SME policies.

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#### 6 References

- Amemiya, Takeshi (1974), Multivariate Regression and Simultaneous Equation Models when the Dependent Variables are Truncated Normal, Econometrica 42(6), pp. 999-1012.
- Anderson, Theodore W. and Leo A. Goodman (1957), Statistical Inference about Markov Chains, Annals of Mathematical Statistics 28(1), pp. 89-110
- 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.
- 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.
- Brüderl, Josef and Rudolf Schüssler (1990), Organizational Mortality: The Liabilities of Newness and Adolescence, Administrative Science Quarterly 35(3), pp. 530-547.
- 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.
- Coad, Alex and Werner Hölzl (2012), Firm Growth: Empirical Analysis in Dietrich Michael and Jackie Krafft (eds.) Handbook on the Economics and Theory of the Firm, 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 (2012), 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.
- Geweke, John, Robert C. Marshall and Robert C. Zaekin (1986), Mobility Indices in Continuous Time Markov Chains, Econometrica 54(6), pp. 1407-1423.

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 (2012), Who Creates Jobs? Small vs. Large vs. Young, Review of Economics and Statistics, forthcoming.
- Hamermesh, Daniel S. and Gerard A. Pfann (1996), Adjustment Costs in Factor Demand, Journal of Economic Literature 34(3), pp. 1264-1292.
- 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, Harald Oberhofer and Michael Pfaffermayr (2011), Job Creation and the Intra-distribution Dynamics of the Firm Size Distribution, WIFO Working Papers No. 395, Austrian Institute of Economic Research.
- 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.

- Kerr, William R. and Ramana Nanda (2010), Banking Deregulations, Financing Constraints and Firm Entry Size, Journal of the European Economic Association 8(2-3), May, pp. 582-593.
- 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 (2012), Firm Growth, European Industry Dynamics and Domestic Business Cycles, Scottish Journal of Political Economy, forthcoming.
- Oberhofer, Harald and Michael Pfaffermayr (2012), Firm Growth in Multinational Corporate Groups, Empirical Economics, forthcoming.
- 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  $\sigma$ -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.
- Da Rin, Marco, Alessandro Sembenelli and Marina Di Giacomo (2010), Corporate Taxation and the Size of New Firms: Evidence from Europe, Journal of the European Economic Association 8(2-3), pp. 606-616.
- Scherer, Frederic M. and David Ross (1990), Industrial Market Structure and Economic Performance, Houghton Mifflin.

- Schöberl, M. (2004). Das Datenverarbeitungssystem der WIFO-Arbeitsmarktanalyse auf der Basis von Individualdaten (WABI), manuscript, WIFO, Vienna.
- Shorrocks, Anthony F. (1978), The Measurement of Mobility, Econometrica 46(5), pp. 1013-1024.
- 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.
- Sutton, John (1997), Gibrat's Legacy, Journal of Economic Literature, 35(1), pp. 40-59.
- 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.
- Veugelers, Reinhilde and Michele Cincera (2010), Young Leading Innovators and EU's R&D Intensity Gap, Bruegel Policy Contribution, 2010/09.
- 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.

#### A Estimation of the Three Equation System

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  $\mathbf{x}_{id} = [\mathbf{x}_i, \mathbf{x}_{iT1}, \mathbf{x}_{i11}, \mathbf{x}_{id}]$  so that the econometric model can be rewritten as

$$y_{iT}^* = \lambda y_{i1} + \mathbf{x}_i' \beta_T + \mathbf{x}_{iTT}' \beta_{TT} + u_i \tag{4}$$

$$y_{i1} = \mathbf{x}'_{i}\beta_{1} + \mathbf{x}'_{i11}\beta_{11} + v_{i}$$
(5)

$$d_i^* = \mathbf{x}_i' \beta_d + \mathbf{x}_{iT1}' \beta_{dT} + \mathbf{x}_{i1}' \beta_{d1} + \mathbf{x}_{id}' \beta_{dd} + w_i$$
(6)

$$d_i = 1$$
 if  $d_i^* > 0$   
 $y_{iT} = y_{iT}^*$  if  $d_i = 1$ .

Note  $y_{i1}$  is always observed, while  $y_{iT}$  is only observed if firms survive up to period T so that  $d_i^* > 0$ . For each firm i the error terms are assumed to follow a trivariate normal distribution given by

$$\begin{bmatrix} u_i \\ v_i \\ w_i \end{bmatrix} \sim iid \ N \left( \mathbf{0}, \begin{bmatrix} \sigma_u^2 & 0 & \rho_{uw}\sigma_u \\ 0 & \sigma_v^2 & \rho_{vw}\sigma_v \\ \rho_{uw}\sigma_u & \rho_{vw}\sigma_v & 1 \end{bmatrix} \right).$$
(7)

The parameters  $\rho_{uw}$  and  $\rho_{vw}$  are correlations obeying the condition  $\rho_{uw}^2 + \rho_{vw}^2 < 1$ , which guarantees a positive variance of  $d_i^*$ . The log likelihood of the trivariate sample selection model 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):

$$d_i^* | y_{iT}^*, y_{i1} \sim N(\mathbf{x}_i' \beta_d + \frac{\rho_{uw}}{\sigma_u} (u_i + \lambda v_i) + \frac{\rho_{vw}}{\sigma_v} v_i, 1 - \rho_{uw}^2 - \rho_{vw}^2).$$
(8)  
$$d_i^* | y_{i1} \sim N(\mathbf{x}_{id}' \beta_d + \frac{\rho_{vw}}{\sigma_v} v_i, 1 - \rho_{vw}^2).$$

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

$$\ln L = \sum_{\{d_i=0\}} \left( \ln \Phi \left( -\frac{\mu_{id} + \frac{\rho_{vw}}{\sigma_v} v_i}{\sqrt{1 - \rho_{vw}^2}} \right) + \sum_{\{d_i=1\}} \ln f(y_{i1}) \right)$$

$$+ \sum_{\{d_i=1\}} \left( \ln \Phi \left( \frac{\mu_{id} + \frac{\rho_{uw}}{\sigma_u} (u_i + \lambda v_i) + \frac{\rho_{vw}}{\sigma_v} v_i}{\sqrt{1 - \rho_{uw}^2 - \rho_{vw}^2}} \right) + \ln f(y_{iT}^*; y_{i1}) \right)$$
with
$$(9)$$

$$\ln f(y_{iT}^*, y_{i1}) = -\frac{1}{2} \ln(2\pi^2) - \ln(\sigma_u \sigma_v) - \frac{1}{2} \left(\frac{y_{iT} - \lambda y_{i1} - \mu_{iT}}{\sigma_u}\right)^2 - \frac{1}{2} \left(\frac{y_{i1} - \mu_{i1}}{\sigma_v}\right)^2$$
$$\ln f(y_{i1}^*) = -\frac{1}{2} \ln(2\pi) - \ln(\sigma_v) - \frac{1}{2} \left(\frac{y_{i1} - \mu_{i1}}{\sigma_v}\right)^2,$$

where we denote  $\mu_{id} = \mathbf{x}'_i \beta_d + \mathbf{x}'_{iT1} \beta_{dT} + \mathbf{x}'_{i1} \beta_{d1} + \mathbf{x}'_{id} \beta_{dd}$ ,  $\mu_{i1} = \mathbf{x}'_i \beta_1 + \mathbf{x}'_{i11} \beta_{11}$ and  $\mu_{iT} = \mathbf{x}'_i \beta_T + \mathbf{x}'_{iTT} \beta_{TT}$ . Using this structural form representation we can write the system (1)-(3) in matrix form as

 $\mathbf{Y}\boldsymbol{\Gamma} + \mathbf{R}\mathbf{B} = \mathbf{q}$ 

with

$$\mathbf{Y} = \begin{bmatrix} y_{1T}^* & y_{11} & d_1^* \\ \vdots \\ y_{NT}^* & y_{N1} & d_N^* \end{bmatrix}, \ \mathbf{R} = -\begin{bmatrix} \mathbf{r}_1' \\ \vdots \\ \mathbf{r}_N' \end{bmatrix}, \ \mathbf{r}_i' = \begin{bmatrix} \mathbf{x}_i' & \mathbf{x}_{iTT}' & \mathbf{x}_{i11}' & \mathbf{x}_{id}' \end{bmatrix}$$
$$\mathbf{\Gamma} = \begin{bmatrix} 1 & 0 & 0 \\ -\lambda & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}, \ \mathbf{B} = \begin{bmatrix} \beta_T & \beta_1 & \beta_d \\ \beta_{TT} & \mathbf{0} & \beta_{dT} \\ \mathbf{0} & \beta_{11} & \beta_{d1} \\ \mathbf{0} & \mathbf{0} & \beta_{dd} \end{bmatrix}, \ \mathbf{q}_i' = \begin{bmatrix} u_i \\ v_i \\ w_i \end{bmatrix}.$$

The reduced form of the system is given by

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

with

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

Therefore, the joint distribution of the reduced form model is a 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  $\theta_{id} = \mathbf{x}'_i \beta_d + \mathbf{x}'_{iT} \beta_{dT} + \mathbf{x}'_{i1} \beta_{d1} + \mathbf{x}'_{id} \beta_{dd}$ .

The expectation 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) this conditional exception can be written as

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

# B The Calculating of Transition Probabilities

In order to estimate the probability that a firm changes its position in the firm size distribution, we consider the quartiles of the initial and final firm size distribution. Specifically, for periods 1 and T, the quartiles are defined by the bounds  $y_{1,l}$ , with  $l = 1, \ldots, 4$  and  $y_{T,k}$  with  $k = 1, \ldots, 4$ , respectively. By definition the bounds for k = l = 4 are infinity. In the final period T there is the additional group of 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 using the reduced form specification. In particular, we estimate firm specific probabilities

$$\widehat{q}_{i,k,l} = P(\widehat{y}_{iT} + u_i \leq y_{T,k}, \ \widehat{y}_{i1} + v_i \leq y_{1,l}, \ w_i \leq \widehat{d}_i^*) \quad (10)$$

$$= \Phi\left(y_{T,k} - \widehat{y}_{iT}, y_{1,l} - \widehat{y}_{i1}, \widehat{d}_i^*; \widehat{\Sigma}\right), \ k, l = 1, ..., 4$$

$$\widehat{q}_{i,l,e} = P(\widehat{y}_{i1} + v_i \leq y_{1,l}, \ w_i \leq -\widehat{d}_i^*)$$

$$= \Phi\left(\frac{y_{1,l} - \widehat{y}_{i1}}{\widehat{\sigma}_v}, -\widehat{d}_i^*; \widehat{\rho}_{vw}\right), \ l = 1, ..., 4,$$

where a 'hat' over a variable indicates an estimate and  $\hat{\Sigma}_i$  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)which we refer to as initially small and initially large firms, respectively. From the estimated  $\hat{q}_{i,k,l}$  and  $\hat{q}_{i,l,e}$ , the transition probabilities are calculated recursively as

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

Note,  $\sum_{k=1}^{4} \sum_{l=1}^{4} \hat{p}_{i,k,l} + \sum_{l=1}^{4} \hat{p}_{i,l,e} = 1$ . 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 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 scenario, we calculate the predictions of the unconditional expectation, transform them to levels and aggregate them into groups. In particular, at known parameters it follows that (see, Cameron and Trivedi 2005)

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

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