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## Abstract

We address the post-entry performance of new Portuguese firms by investigating the structural characteristics of the hazard and survival functions, using non-parametric survival analysis. In order to approach prevalence of some stylized facts and determinants of new firm survival, we produced a new entrepreneurship database, using the administrative data of *Quadros de Pessoal,* following the Eurostat/OECD´s internationally comparable business demography methodology. This allowed the computation of a comprehensive array of entrepreneurship indicators on employer enterprise and survival dynamics in Portugal, over a period of 18 years, disaggregated in dimensions such as sectors, regions and size classes

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# BUSINESS DEMOGRAPHY DYNAMICS IN PORTUGAL: A NON-PARAMETRIC SURVIVAL ANALYSIS[1]

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## 1. Introduction

Most empirical studies on regional variations in entry and exit rates at the international level are either based on survey data like the Global Enterpreneurship Monitor (Acs et al., 2008), business data (Hoffman and Junge, 2006), business registration data (Klapper et al., 2008; Klapper et al., 2009; Sarmento and Nunes, 2010c) or a combination of the previous (Baterlsman et al., 2005; Scarpetta et al., 2002; Ahn, 2001; Eurostat, 2009; OECD/Eurostat, 2009 and 2008). Moreover, most only take into account the manufacturing sector. There is scarce evidence of studies on entrepreneurial activity that encompass simultaneously all sectors, regions and countries. Portugal is somehow an exception, where extensive research has been done in firm dynamics using mostly *Quadros de Pessoal* (Geroski, Mata and Portugal, 2010; Mata and Portugal, 1994; Mata et al., 1995; Mata, 1993; Mata and Machado, 1996; Görg et al., 2000; Baptista et al., 2008; Cabral, 2007; Cabral and Mata, 2003; Baptista and Carias, 2007; Baptista and Mendonça, 2007; Sarmento and Nunes, 2010b).

Portugal suffers from a considerable degree of firm churn, related to the composition and characteristics of its enterprise fabric, namely the small average size of its firms and newborn firms (Eurostat 2009; Geroski et al, 2010; Sarmento and Nunes, 2010a and 2010b), the increasing dominance of the service sector (Sarmento and Nunes, 2010a), the dependence of the economic cycle (Geroski et al, 2010) and possibly the impact of Structural Funds (Sarmento and Nunes, 2010d), which motivated the “peaks” of new firm creation and the reactivation of existing units into the formal market. Founding factors such as the above mentioned firm size and the economic cycle, but also human capital and entry rates have also been found to have relatively long-lived effects on firm survival by Geroski, Mata and Portugal (2010).

The contributions of this work are twofold. One the one hand, this analysis consists of the application of a Eurostat/OECD recent methodology for business demography, which grants comparability and the international and regional level. We then used this analytical arsenal to provide a multidimensional overview of firm and survival dynamics in Portugal. Over a period of eighteen years (with data ranging from 1985 to 2007), firm and survival disaggregation is provided, in dimensions such as sectors, regions and size classes, while guaranteeing comparability with other datasets, namely with those that consider employer enterprises, recently developed jointly by the Eurostat and the OECD within the Entrepreneurship Indicators Programme (OECD/Eurostat, 2009 and 2008).

A second contribution is related to the estimation of the behaviour of median hazard estimates which allows comparative considerations regarding survival performance of Portuguese firms vis-à-vis with other countries. By acknowledging that firms in Portugal face specific challenges and by better understanding the underlying motivations of why employer enterprises have a shorter average life than their European counterparts, can help the design of more efficient policies at the right moment of their life-cycles.

The paper proceeds as follows. Following a brief outline of the methodology and the dataset, we describe the performance dynamics of firm entry, exit and survival in Portugal across seven regions, four broad sectors and six size classes. Section 4 is dedicated to the determinants of new firm survival using non-parametric methods, which relate firm age with survival ability, through life tables across the same dimensions of the previous section. Finally, the last section offers concluding remarks.

## 2. Description of the dataset and methodology

This work is based on the application of the entrepreneurship definitions and methodology of the "Manual on Business Demography Statistics" (Eurostat/OECD, 2007) to the *Quadros de Pessoal* dataset (Employment Administrative Records) of the *Gabinete de Estratégia e Planeamento* (GEP) of the Portuguese Ministry of Labour and Social Security (MTSS), which contains enterprises whose employees are formally registered in the Portuguese Social Security System. *Quadros de Pessoal*, is an annual mandatory survey, which provides a rich matched dataset. Its relevance derives not only from its national coverage and therefore comprehensiveness at the microeconomic level, but also from the fact that it is a linked data source, allowing the matching of firms with its employees and the establishments in which they operate, throughout time.

This resulted in the creation of a specific entrepreneurship micro-dataset, in which the population of enterprises is restricted solely to the active enterprises with at least one paid employee, the so-called employer enterprise population. A whole array of entrepreneurship performance indicators were then calculated, namely births, deaths, churn and survival rates. After the application of the Eurostat/OECD´s methodology, the database contains an annual average of 215 903 active employer enterprises over the period 1985 to 2007, with an annual average of 36 803 births and 23 743 deaths.

The survival analysis provided in the following sections, will take place over this new entrepreneurship dataset, where only real births and deaths are accounted for. The core measure of births reflects the concept of employer enterprise birth. A birth amounts to the "creation of a combination of production factors with the restriction that no other enterprises are involved in the event" (Eurostat/OECD, 2007). A birth occurs when and enterprise starts from scratch and actually starts activity. Births do not include entries into the population which result from break-ups, spit-offs, mergers, restructuring of enterprises or reactivations of units which are dormant within a period of two years. If a dormant unit is reactivated within two years, this event is not considered a birth. This caused enterprise births to be effectively accounted for from 1987 onwards, instead of 1985. This population thus consists of enterprises that have at least one paid employee in its birth year and also of enterprises that, despite existing before the year in consideration, were below the one employee threshold.

An employee enterprise death occurs when an employer enterprise stops having employees. Deaths do not include exits from the population due to mergers, take-overs, break-ups or restructuring of a set of enterprises. Moreover, deaths do not include exits from a sub-population if it results from a change of activity. We have tried to identify those situations[2] in order to remove them from the population, according to the Eurostat/OECD´s methodology. Therefore, a death can occur because the enterprise ceases to trade or because it shrinks below the one employee threshold. The manual recommends waiting for two years after the reference period to allow for reactivations, before deaths are calculated. Thus, deaths were calculated only up to 2005, instead of 2007, the final year for the data.

[2] According to Geroski et al. (2010) and their analysis of Portuguese firm registrars, only around one per cent of the total number of liquidations is either due to mergers or acquisitions, so that the effect of not being able to trace some of them being thus negligible.

## 3. Brief overview of entrepreneurship performance and survival in Portugal

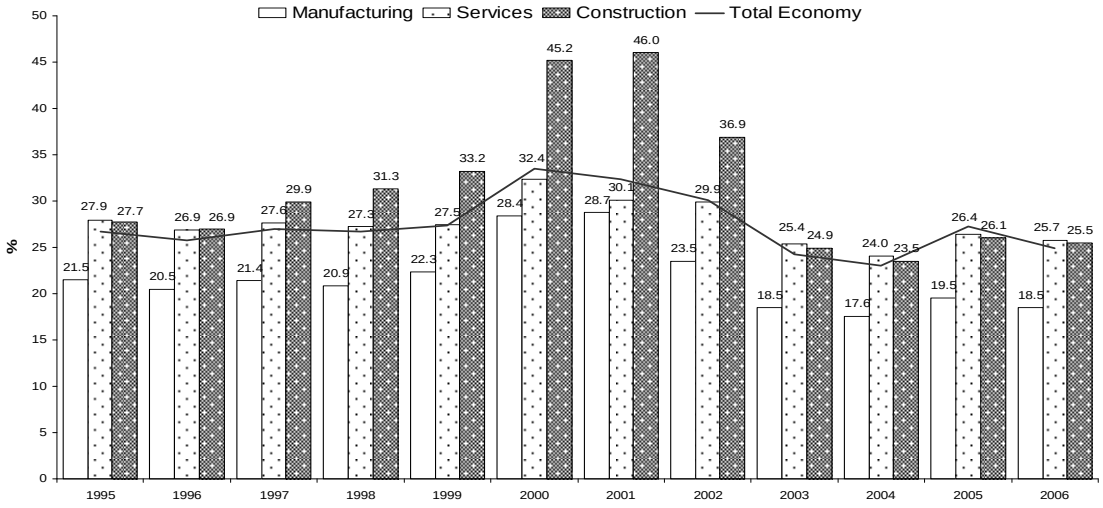
Turbulence is a natural consequence of the chase for new business opportunities as resources are rapidly reallocated from unsuccessful to successful enterprises and to growing areas of business, therefore being considered a natural source of dynamism. These firm dynamics, that is, the pace at which firms are starting up and closing down is a commonly used measure of the level of entrepreneurial activity in an economy. This reflects the Schumpeterian notion of "creative destruction", that is, the level of turbulence in the economy that leads to the commercialisation of new innovative ideas and thus to economic growth. The churn rate is one type of indicator used for the measurement of turbulence. It is viewed as an economy's ability to expand and adjust its structure of production to the market's changing needs and is given by the sum of birth and death rates (Eurostat/OECD, 2007).

One of the most robust stylized facts of competitive industry dynamics is that there is a high level of entry and exit, which occurs simultaneously in any given year. In particular, for markets where entry occurs more intensively, exit flows tend to be more prominent, as well as churning at the bottom of the size distribution (Geroski, 1995). Portugal traditionally exhibits some of the highest levels of entry and exit rates in Europe (Eurostat, 2009; INE, 2009; Scarpetta et al., 2002; Cabral, 2007). More than a quarter of firms in a given year are either being created or destroyed. According to Table 2, during the period 1987-2005, the average churn rate has been 28.5 per cent.

Churn rates vary significantly across sectors in most countries (Bartelsman et al., 2005), as industry structure is likely to influence significantly the rate of start-ups and close-downs. An economy heavily based in services, such as Portugal, is more likely to have higher start-up and close-down rates due to a generally higher number of small enterprises in the economy. The period 2001 to 2005 indicates a stabilisation towards less turbulence, as a consequence of the reduction of both total birth and death rates (Table 1).

Another widely known stylized fact is that the churn rate is greater in the service sector than in manufacturing, especially if weighted by employment. This behaviour is also observed for Portugal (Figure 1) in line with other countries (Bartelsman et al., 2005) and Spain (López-Garcia and Puente, 2006; Núñez, 2004). During this period, the change of economic structure towards the service sector and the smaller average size of entrants can explain part of this dynamics (Sarmento and Nunes, 2010a).

Figure 1: Churn rate by broad sectors




Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.

Throwing additional light on cross-sectional differences in market conditions, Table 1 reveals that entry and exit rates are highly correlated across industries. Thus, industries with higher than average entry rates also exhibit higher than average exit rates (Cabral, 2007), corroborating the idea that "entry barriers are exit barriers" (Mata et al., 1995). We find that across all sectors, at the one letter level of the Portuguese Classification of Economic Activities, there is a considerably high correlation for the period 1995-2005, with the exception of the sector "Production and distribution of electricity, gas and water", due to its particular market structure where heavily regulation and legal monopolies are often common. We can also observe in Table 1 the overall decrease in birth, death and churn rates occurring after 2000.

Table 1: Average births and death rates and correlations of births and deaths by sector[3]

| Sectors at one letter (Classification of Portuguese Activities - CAE Rev.2.1) | Period 1995-2005 | | | | Period 2001-2005 | | | |
|---|---|---|---|---|---|---|---|---|
| | Average churn rate | Average birth rate | Average death rate | Pearson correlation | Average churn rate | Average birth rate | Average death rate | Pearson correlation |
| | % | | | | % | | | |
| Agriculture, farming of animals, hunting and forestry | 34.1 | 20.8 | 13.2 | 97.8 *** | 37.0 | 23.7 | 13.2 | 99.2 *** |
| Fishing | 48.5 | 33.1 | 15.4 | 98.9 *** | 55.9 | 40.9 | 15.0 | 99.3 *** |
| Mining and quarrying | 20.4 | 11.7 | 8.7 | 67.7 ** | 19.9 | 10.8 | 9.1 | 94.5 ** |
| Manufacturing | 22.2 | 11.9 | 10.2 | 67.3 *** | 21.6 | 11.4 | 10.2 | 93.2 ** |
| Production of electricity, gas and water supply | 24.4 | 16.6 | 7.8 | 45.5 | 25.5 | 174.0 | 8.1 | 11.4 |
| Construction | 32.3 | 19.2 | 13.1 | 84.7 *** | 31.3 | 17.9 | 13.4 | 95.6 *** |
| Wholesale and retal trade, repairs of motor vehicles, motorcyces and personal and household goods | 25.8 | 14.6 | 11.2 | 87.9 *** | 25.2 | 14.0 | 11.2 | 66.3 |
| Hotels and restaurants | 31.4 | 17.8 | 13.6 | 93.1 *** | 30.3 | 16.9 | 13.4 | 75.2 |
| Transport, storage and communication | 28.9 | 18.4 | 10.5 | 79.2 *** | 28.1 | 17.8 | 10.3 | -36.9 |
| Financial intermediaton | 23.7 | 14.9 | 8.7 | 71.7 ** | 22.8 | 14.6 | 8.2 | -33.8 |
| Real estate, renting and business activities | 31.2 | 20.0 | 11.1 | 97.8 *** | 30.2 | 19.1 | 11.1 | 95.4 ** |
| Public administration and defence, compulsory social security | 59.6 | 43.8 | 15.8 | 99.7 *** | 71.2 | 53.7 | 17.5 | 99.8 *** |
| Education | 24.1 | 15.9 | 8.2 | 90.2 *** | 25.9 | 17.7 | 8.2 | 97.0 *** |
| Health ansd social work | 20.4 | 14.1 | 6.3 | 90.6 *** | 18.6 | 12.8 | 5.8 | 49.1 |
| Other community, social and personal service actvities | 29.6 | 18.3 | 11.4 | 96.2 *** | 29.2 | 18.1 | 11.2 | 90.4 ** |

Note: *** 1% significance level, ** 5% significance level and * 10% significance level
Source: Own calculations based on Quadros de Pessoal, GEP, MTSS.

In line with other countries, the rotation of firms also decreases with firm's size, where smaller firms tend to have more volatile dynamics. Churn rates for small enterprises are at least three times larger than those of medium sized enterprises and always larger than the total economy's churn rate over the whole period considered.

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[3] At one level letter (A-O) of the Classification of Portuguese Activities, revision 2.1 (compatible with ISIC Rev. 3).

Table 2: Churn and average churn rates according to size class

| Years | Churn rate | | | |
|---|---|---|---|---|
| | Small enterprises (<50 employees) | Medium enterprises (50-249) | Large enterprises (>250) | Churn rate (total economy) |
| | % | | | |
| 1987 | 29.2 | 6.3 | 2.9 | 28.0 |
| 1988 | 32.1 | 6.6 | 4.8 | 30.9 |
| 1989 | 34.7 | 7.5 | 4.0 | 33.4 |
| 1990 | 29.8 | 7.1 | 4.4 | 28.7 |
| 1991 | 29.8 | 8.2 | 6.7 | 28.8 |
| 1992 | 29.2 | 8.8 | 4.0 | 28.2 |
| 1993 | 32.2 | 10.7 | 5.1 | 31.4 |
| 1994 | 35.3 | 9.4 | 8.3 | 34.4 |
| 1995 | 27.3 | 6.8 | 4.1 | 26.7 |
| 1996 | 26.4 | 6.5 | 3.8 | 25.8 |
| 1997 | 27.6 | 7.1 | 4.4 | 26.9 |
| 1998 | 27.3 | 6.5 | 5.2 | 26.7 |
| 1999 | 27.9 | 7.0 | 6.4 | 27.3 |
| 2000 | 34.2 | 8.1 | 5.6 | 33.5 |
| 2001 | 33.0 | 9.3 | 7.1 | 32.4 |
| 2002 | 30.6 | 6.8 | 6.5 | 30.0 |
| 2003 | 24.6 | 6.9 | 5.2 | 24.2 |
| 2004 | 23.4 | 6.2 | 5.2 | 23.0 |
| 2005 | 27.7 | 7.9 | 5.9 | 27.3 |
| | Average churn rate | | | |
| 1987-2005 | 29.2 | 7.6 | 5.3 | 28.5 |
| 1987-2000 | 30.1 | 7.6 | 5.0 | 29.3 |
| 2001-2005 | 27.8 | 7.5 | 6.0 | 27.3 |

Source: Own calculations based on Quadros de Pessoal, GEP, MTSS.

At the regional level, the churn rate is also decreasing especially after 2001, for most regions (29.3 per cent for 1987-2000 and 24.8 per cent from 2001-2005). The churn rate is the highest in the Algarve, Alentejo, Açores and Norte (Table 3).

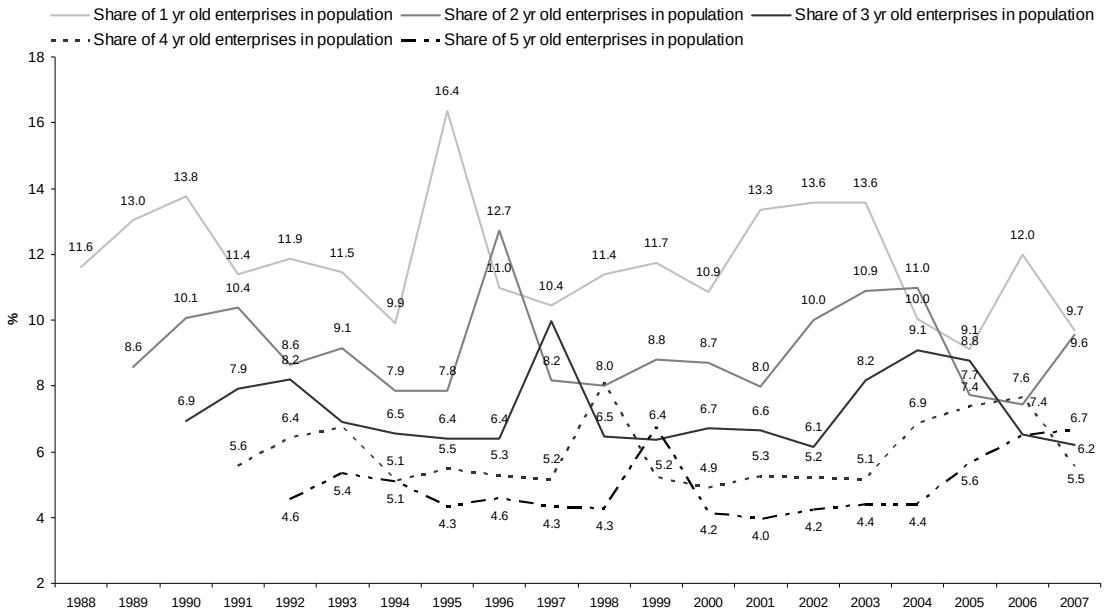
Table 3: Average churn rates by region (%)

| Regions | 1987-2005 | 1987-2000 | 2001-2005 |
|---|---|---|---|
| Norte | 29.9 | 30.1 | 29.4 |
| Centro | 27.3 | 28.8 | 25.1 |
| Lisboa | 26.8 | 27.1 | 26.2 |
| Alentejo | 29.9 | 31.8 | 26.6 |
| Algarve | 32.5 | 34.7 | 29.4 |
| Açores | 27.1 | 28.0 | 25.5 |
| Madeira | 28.6 | 29.4 | 27.3 |
| Total | 28.5 | 29.3 | 27.3 |

Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.

As survival rates tend to be related to firm size and firm age, we now turn to the analysis of the annual share of different enterprise cohorts according to longevity. In Figures 2 and 3 it is possible to observe the influence of enterprise's birth and death cycles in Portugal, particularly the effects of the enterprise creation "peaks" of 1989, 1994 and 2000 (Sarmento and Nunes, 2010b), on ageing and survival. In fact, firms that are born in these "peak" years seem to last in the population and have almost permanently higher survival rates.

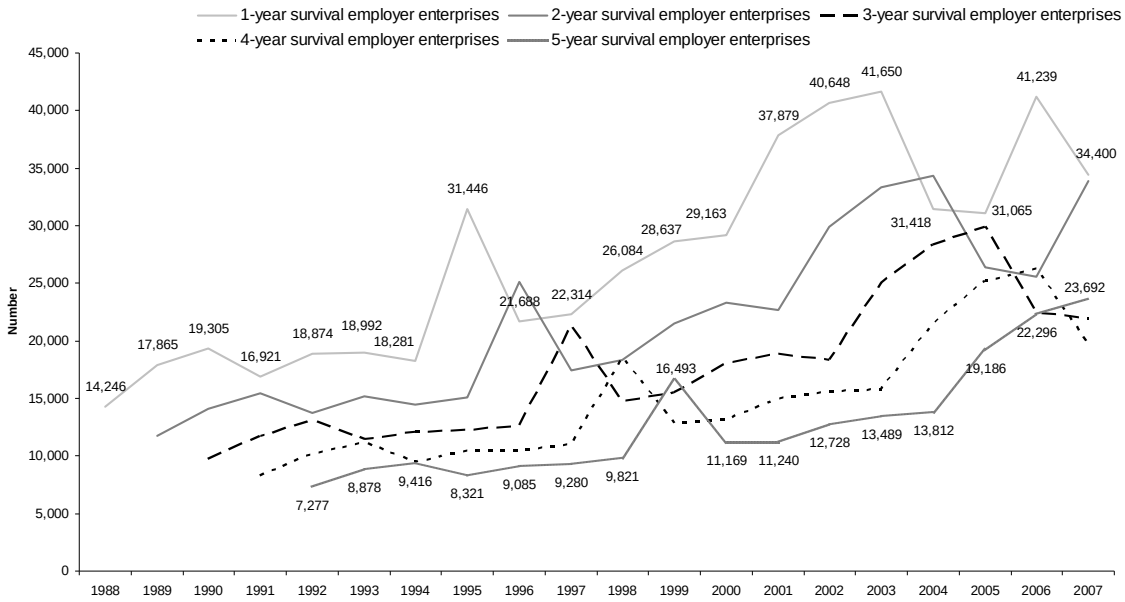
Figure 2: Share of 1 to 5 year old enterprises in total population (%)




Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.

Survival rates of Portuguese start-ups have been rising, in particular since the late 1990s, given the decreasing turbulence in enterprise dynamics.

Figure 3: Employer Enterprises Survival rates




Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.

The Eurostat (2009) reported that for a group of 16 countries, including Portugal, an average of 50 per cent of all enterprises born in 2001, managed to survive until 2006. According to *Quadros de Pessoal* data, the survival rate is lower than Eurostat´s reported average. Only 41.1 per cent of firms born in 2001 survived through 2006. The 5-year survival rate for enterprises born in 2002 and still active in 2007 in Portugal was 43.3 per cent and the 1-year survival rate for enterprises born in 2006 which survived through 2007 was 78.2 per cent (Table 4).

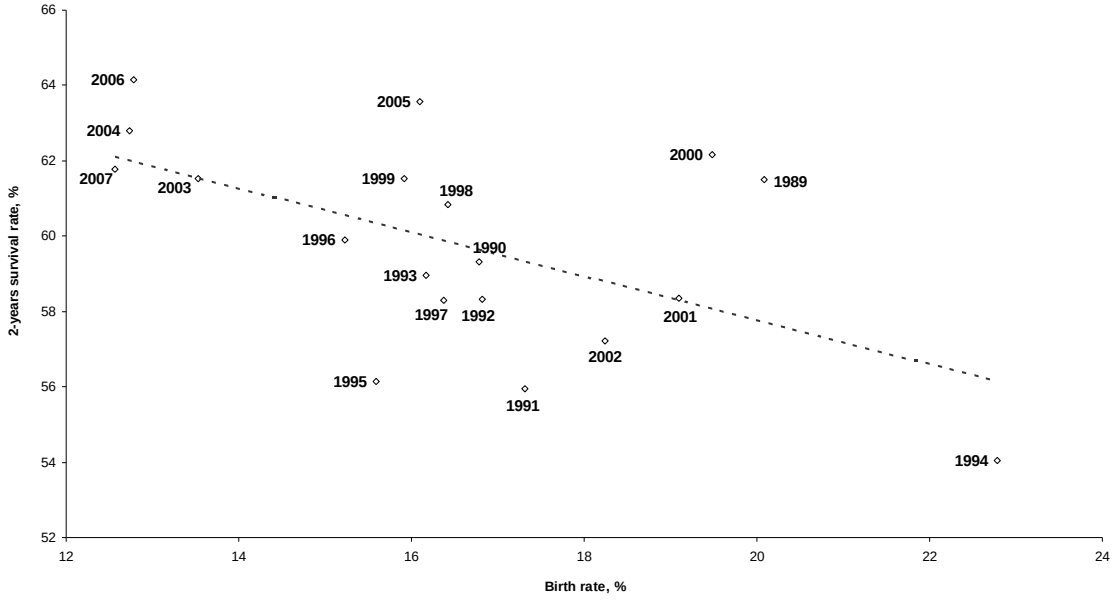
Table 4: Survival rates for employer enterprises according to the birth year

| | Survival rate (%) for births in year | | | | |
|---|---|---|---|---|---|
| | 2002 | 2003 | 2004 | 2005 | 2006 |
| 1-year survival | 76.1 | 75.8 | 77.9 | 75.2 | 78.2 |
| 2-year survival | 62.8 | 63.6 | 64.1 | 61.8 | |
| 3-year survival | 54.6 | 54.2 | 55.2 | | |
| 4-year survival | 48.1 | 47.5 | | | |
| 5-year survival | 43.3 | | | | |

Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.

For most European Union (EU) member states, higher birth rates, bring about lower survival rates and vice-versa (Eurostat, 2009). Over time, we can observe the same effect in Portugal (Figure 4), in particular after 2000, when decreasing birth rates were accompanied by increasing survival rates. This result is also verified for all survival years up to the 5 year limit considered in this analysis.

Figure 4: Enterprise birth rates and 2-years survival rates, 1989-2007




Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.

## 4. Non-parametric analysis of survival

The next section consists of an econometric analysis of new firm survival, which draws extensively on the survival analysis literature in industrial economics. The positive and high observed correlation between birth and death rates (Table 1) may be the result of new firms displacing old obsolete enterprises, in the so-called creative destruction process. But it could also be the result of higher failure rates amongst newly born enterprises during their first years of activity, as a consequence of the natural market selection, which rewards the more efficient firms. Such hypothesis, also previously studied for Portugal (Mata et al., 1995; Geroski et al., 2010), Italy (Giovannetti, 2007) and Spain (Lopez-Garcia and Puente, 2006), will be tested by applying a survival analysis which estimates survival and hazard rates over time.

### 4.1. Modelling survival and hazard functions

The survivor function reports the probability of a firm of surviving beyond time *t* (the moment of observation), that is the probability that there is no failure event (a "death") prior to *t*. The function is equal to one at time *t*=0 and decreases towards zero as time (*t)* goes to infinity. Considering *T* a non-negative variable, denoting the time to a failure event ("death"), in this case given by the time taken by an enterprise to exit the market from the moment of entry. The survivor function is thus represented by:

$$S(t) = 1 - F(t) = \Pr(T > t)$$

With $F(t) = \Pr(T \leq t)$ being the cumulative distribution function.

The hazard function or the conditional failure rate is the instantaneous rate of failure. It is the (limiting) probability that the failure event ("death") event occurs in a given interval, conditional upon the subject having survived to the beginning of that interval, divided by the width of the interval:

$$h(t) = \lim_{\Delta t \to 0} \frac{\Pr(t + \Delta t > T > t \mid T > t)}{\Delta t} = \frac{f(t)}{S(t)},$$

Where $f(t) = \frac{dF(t)}{dt} = \frac{d\{1 - S(t)\}}{dt} = -S'(t)$ is the density function.

The hazard rate measures the rate at which risk is accumulated and can vary from zero (no risk at all) to infinity. The integral from 0 to *t* of the hazard rates is known as the cumulative hazard function ($H(t)$). It records the number of times failures were observed over a given time period.

In practice, to estimate the survivor function, $S(t)$, that is the probability of survival past time *t* or, equivalently, the probability of failure after *t*, the non-parametric Kaplan-Meier estimator was applied. For a dataset with observed failure times, $t_1, ..., t_k$, where *k* is the number of distinct failure times observed in the data, the Kaplan-Meier estimate at any time *t* is given by:

$$\hat{S}(t) = \prod_{j \mid t_j \leq t} \left( \frac{n_j - d_j}{n_j} \right)$$

Where $n_j$ is the number of enterprises at risk at time $t_j$ and $d_j$ is the number of failures at time $t_j$. The product is done for all the failure periods, departing from time *t*.

The most common estimator for the cumulative hazard rate is the non-parametric Nelson-Aalen estimator, which is defined by the sum of the instantaneous ratio of the failures over the number of enterprises at risk. This estimator is thus given by:

$$\overline{H}(t) = \sum_{j \mid t_j \leq t} \frac{d_j}{n_j}.$$

The idea behind the former estimator is simple. If the estimator cumulates together all the "hazards" that exists at all possible instants between $t_0$ and $t_j$ a reasonable estimate would total the estimated hazard that exists between these points in time. So, by definition the estimator begins at 0 and rises over time. In practice the estimator does not have a directly interpretable metric (and should not be interpreted as a probability).

Although the cumulative hazard function is informative when concerning the estimation of continuous time hazard functions, it is important to visualize the shape of the hazard function over continuous time. The kernel smoothing is one of the most common solutions adopted since it converts any set of erratic point estimates into a smoother, well-behaved functional form.

## 4.2. Survival and hazard functions across regions, size class and sectors

Our analysis is now designed to observe how failure rates relate to location, dimension or industry membership of the firm. The usage of life tables allows a structured method of analysis of the number of firms

that "die", conditional on their age, that is, it represents the probability of failure given that the firm has survived a certain given number of years (Table 5).

There is extensive evidence in the literature that failure rates decline with age (Mata et al., 1995; Dunne et al., 1989; Mahmood, 1992; Audretsch and Mahmood, 1994 and 1995). In Portugal, during the period 1987-2005, approximately 86 per cent of all the employer enterprise births remained active after one year of "life". These results are in line with the OECD´s estimates, where around 60 per cent to 80 per cent of birth enterprises survive beyond the first two years of activity, and only around 40 per cent to 50 per cent of total birth enterprises survive beyond the seventh year of activity. Eurostat (2009) also reported for the whole business economy, that roughly half of the enterprises survive during their first 5 years.

A more detailed look into our survival data, shows that the estimated median duration of a new born enterprise lies between 5 and 6 years. After 18 years of activity, only 22 per cent of employer enterprise start-ups were still alive or equivalently, almost 78 per cent had already exited the market.

Table 5: Life Table for Employer Enterprise Births, 1987-2005

| Time | Observations | Deaths | Censured Observations (a) | Kaplan-Meier | | Nelson Aalen | |
|---|---|---|---|---|---|---|---|
| | | | | Survivor Function | Failure Function | Hazard Rate | Cumulative Hazard Rate |
| Years | Nº | Nº | Nº | % | % | % | % |
| 1 | 451 041 | 63 088 | 24 000* | 86.0 | 14.0 | 14.0 | 14.0 |
| 2 | 364 233 | 46 351 | 22 000* | 75.1 | 24.9 | 12.7 | 26.7 |
| 3 | 295 786 | 32 973 | 28 000* | 66.7 | 33.3 | 11.2 | 37.9 |
| 4 | 235 002 | 23 655 | 24 000* | 60.0 | 40.0 | 10.1 | 47.9 |
| 5 | 187 102 | 17 353 | 19 000* | 54.4 | 45.6 | 9.3 | 57.2 |
| 6 | 150 840 | 12 966 | 12 000* | 49.7 | 50.3 | 8.6 | 65.8 |
| 7 | 125 525 | 10 059 | 11 000* | 45.8 | 54.2 | 8.0 | 73.8 |
| 8 | 104 121 | 7 735 | 9 613 | 42.4 | 57.6 | 7.4 | 81.2 |
| 9 | 86 773 | 6 089 | 7 943 | 39.4 | 60.6 | 7.0 | 88.3 |
| 10 | 72 741 | 5 068 | 7 491 | 36.6 | 63.4 | 7.0 | 95.2 |
| 11 | 60 182 | 4 172 | 11 000* | 34.1 | 65.9 | 6.9 | 102.2 |
| 12 | 45 130 | 3 037 | 6 150 | 31.8 | 68.2 | 6.7 | 108.9 |
| 13 | 35 943 | 2 422 | 5 626 | 29.7 | 70.3 | 6.7 | 115.6 |
| 14 | 27 895 | 1 681 | 5 546 | 27.9 | 72.1 | 6.0 | 121.7 |
| 15 | 20 668 | 1 133 | 4 733 | 26.4 | 73.7 | 5.5 | 127.1 |
| 16 | 14 802 | 805 | 5 361 | 24.9 | 75.1 | 5.4 | 132.6 |
| 17 | 8 636 | 490 | 4 418 | 23.5 | 76.5 | 5.7 | 138.2 |
| 18 | 3 728 | 228 | 3 500 | 22.1 | 77.9 | 6.1 | 144.4 |

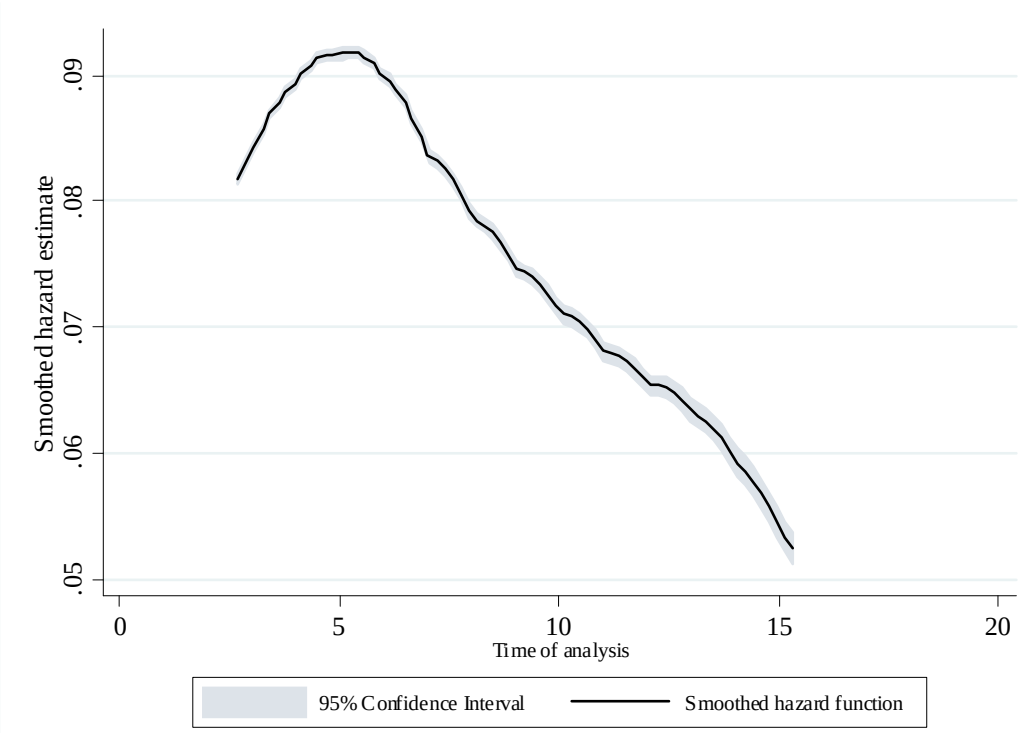
Notes: (a) Censured observations correspond to cases where the event (in our case, "death") is not observed during the time of analysis; * Approximate values

Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.

The smoothed hazard estimate or unconditional hazard function for the total economy presents an inverted U-shape with its maximum around the sixth year of activity (Figure 5). After firms' entry into the market, the conditional probability of failure increases continuously until the sixth year, with hazard rates declining steeply thereafter. Young new firms are posited to be less efficient and are thus more likely to fail

than firms that have acquired market experience. Such pattern is similar to that found in other economies, such as Italy (Audretsch et al., 1999), the UK (Bhattacharjee, 2005), Germany (Wagner, 1994), UK, Italy and the US (Bartelsman et al., 2005) and Spain (López-Garcia and Puente, 2006). In all these cases, the maximum of the unconditional hazard function is reached before the sixth year, indicating that Portuguese firms keep on failing for a longer period, before the hazard rate starts declining.

Figure 5: Smoothed hazard estimate for the total economy, 1987-2005




Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.

### 4.2.1. Survival and hazard functions across regions

Table 6 presents the results for the non-parametric estimation, for each of the seven Portuguese NUTII regions. This framework explores the relationship between age and the regional hazard of exit.

In line with the results shown previously for the total economy, over 85 per cent of newly born employer enterprises remain active during their first year of activity in all regions. The one-year survival rate varies from a low of 85 per cent in the Açores, to a high of 87.5 per cent in the Centro region, meaning that the new born enterprises died more prematurely in Açores than in other Portuguese regions.

Table 2 also reveals that the survival gap between the two extreme regions, Norte and Centro, grows systematically with time. Norte is the region with the highest number of births and share of active enterprises in the country. This region is also responsible for most of the enterprises exits, showing an average share of 35,4% through a 21 year period, facing a clear cut rise from 2002 onwards (Sarmento and Nunes, 2010b). Within 6 years of activity, the region Norte is the only with less than 50 per cent of enterprise survival probability, lagging behind all others in terms of enterprise survival. On the other hand, Centro has a higher

survival rate than the economy's average. It is the region where more firms manage to survive longer throughout the period considered in this study.

There are also clear disparities between regions, in terms of median duration survival. At the end of the analysis period, Norte is the region that presents the lowest survival rate, with only 20.7 per cent of the firms' population managing to survive after eighteen years of activity. Centro, in turn, has 27.4 per cent of start-ups still active after 18 years.

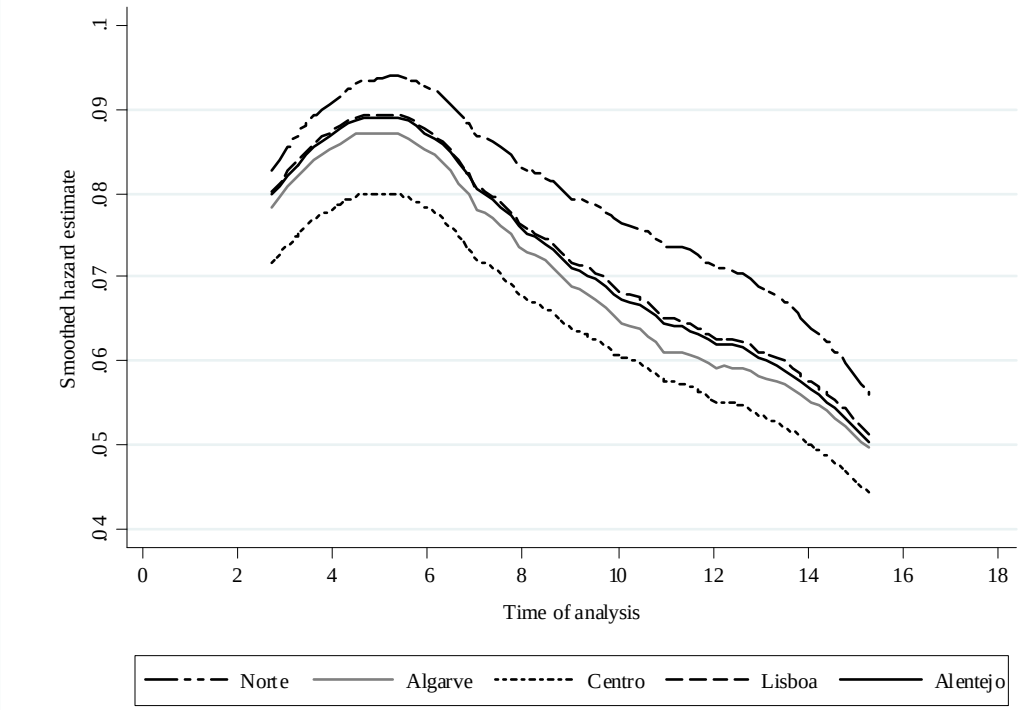
Table 6: Survival Table for Employer Enterprise Births by NUTII region, 1987-2005

| Time | Regions | | | | | | |
|---|---|---|---|---|---|---|---|
| | Norte | Centro | Lisboa e Vale do Tejo | Alentejo | Algarve | Açores | Madeira |
| Years | % | | | | | | |
| 1 | 85.6 | 87.4 | 85.5 | 85.8 | 85.6 | 85.1 | 86.1 |
| 2 | 75.1 | 77.7 | 75.1 | 75.5 | 75.5 | 74.2 | 76.0 |
| 3 | 66.5 | 70.1 | 67.0 | 67.0 | 67.7 | 67.0 | 68.3 |
| 4 | 59.8 | 64.0 | 60.5 | 60.4 | 61.2 | 59.9 | 61.3 |
| 5 | 54.1 | 58.9 | 55.0 | 54.9 | 55.8 | 54.5 | 56.2 |
| 6 | 49.4 | 54.5 | 50.4 | 50.7 | 51.1 | 50.5 | 51.6 |
| 7 | 45.3 | 50.7 | 46.6 | 46.9 | 47.2 | 46.7 | 47.5 |
| 8 | 41.7 | 47.5 | 43.2 | 43.4 | 44.2 | 43.7 | 44.6 |
| 9 | 38.7 | 44.5 | 40.2 | 40.5 | 41.1 | 41.2 | 41.7 |
| 10 | 35.8 | 41.9 | 37.6 | 37.7 | 38.5 | 38.9 | 38.6 |
| 11 | 33.0 | 39.5 | 35.1 | 35.2 | 36.2 | 36.3 | 36.6 |
| 12 | 30.5 | 37.4 | 32.8 | 33.0 | 34.0 | 33.9 | 34.3 |
| 13 | 28.1 | 35.3 | 30.8 | 31.0 | 32.0 | 31.3 | 31.7 |
| 14 | 26.4 | 33.4 | 29.0 | 29.3 | 30.2 | 29.4 | 29.9 |
| 15 | 24.8 | 31.8 | 27.4 | 27.8 | 29.0 | 28.2 | 28.2 |
| 16 | 23.2 | 30.4 | 26.1 | 26.2 | 27.8 | 26.4 | 26.9 |
| 17 | 21.9 | 28.9 | 24.6 | 24.9 | 25.4 | 25.4 | 26.6 |
| 18 | 20.7 | 27.4 | 22.9 | 23.2 | 23.9 | 23.8 | 25.4 |

Source: Own calculations based on Quadros de Pessoal, GEP, MTSS

The median duration of firms at the regional level (Figure 6), is below seven years for most regions, except for Centro (around the eight year).

Figure 6: Smoothed hazard estimate by NUTII, 1987-2005




Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.

The disparities among the Portuguese regions are confirmed by equality tests. Both Log-rank and Wilcoxon (Breslow) tests allow for the rejection of the hypothesis of survival equality among regions[4].

### 4.2.2. Survival and hazard functions across size classes

A general finding in the literature is that most firms start small, live small and die small. According to Eurostat (2009), Portugal has the highest share of enterprise births in the 1 to 4 employees' size class. Small firms in Portugal are also being created at a faster pace than larger firms, gaining share in both enterprise and employment (Sarmento and Nunes, 2010a and 2010b).

We find that smaller firms[5] exhibit the lowest survival probability (Table 7). More than 15 per cent of micro firms with fewer than 5 employees "die" in their first year of activity (only around 85 per cent manage to survive), whereas large firms with over 250 employees, have a much higher survival rate, of 93.9 per cent. Differences between size classes are significant. Conditional on overcoming the first ten years, the smallest

[4] The hypothesis being tested considers that there are no subgroup differences in survivor functions. We find the probability that the observed differences occur by chance is below 0.0.

[5] Firm size is measured by employment, that is, the number of workers.

sized firms are the only ones to have a survival probability below 50 per cent (31 per cent, which represents half of the biggest size class firms). Over time, the gap between the smallest and the largest firms' survivor rates widens. The bigger the firm, the higher the probability of survival. Geroski et al. (2010) find that firms whose start-up size is larger, survive longer and that this might have a permanent effect, although subsequent increases in size are still able to improve survival chances.

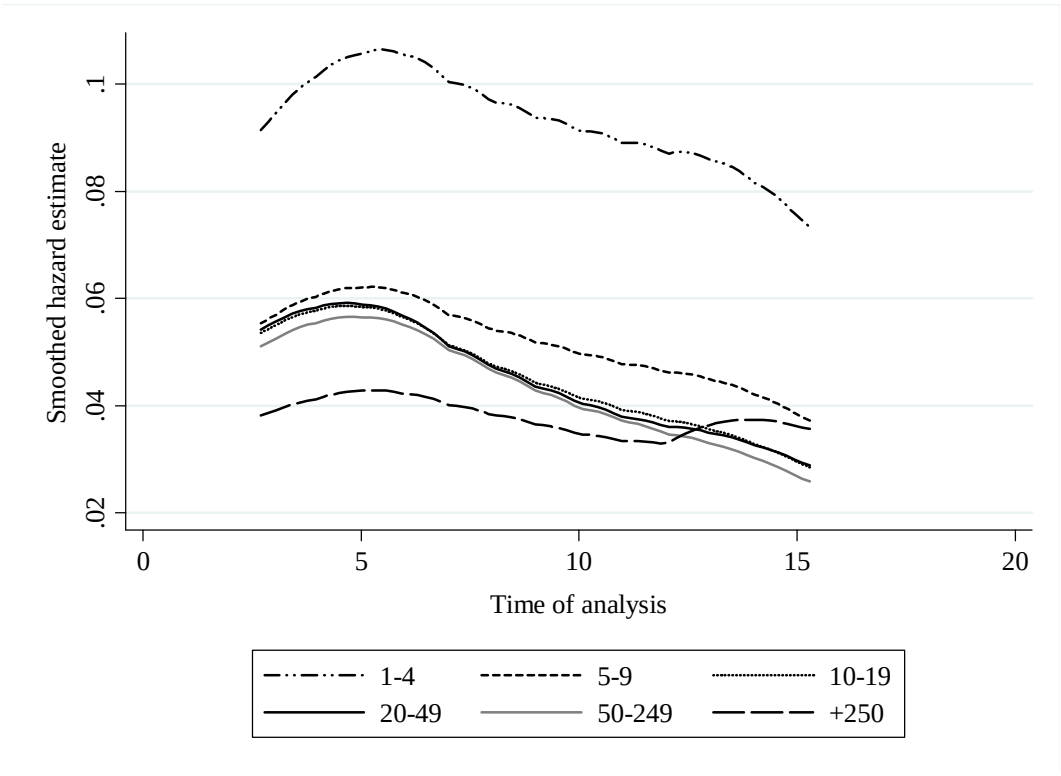
Table 7: Survival Table for Employer Enterprise Births by size class, 1987-2005

| Time | Size Class | | | | | |
|---|---|---|---|---|---|---|
| | 1-4 | 5-9 | 10-19 | 20-49 | 50-249 | +250 |
| Years | % | | | | | |
| 1 | 84.9 | 90.0 | 90.1 | 89.8 | 92.0 | 93.9 |
| 2 | 73.4 | 82.6 | 82.8 | 82.7 | 84.7 | 87.6 |
| 3 | 64.3 | 76.5 | 76.9 | 76.6 | 78.6 | 82.8 |
| 4 | 57.0 | 71.2 | 71.7 | 71.3 | 73.2 | 78.9 |
| 5 | 51.0 | 66.7 | 67.2 | 66.8 | 68.9 | 74.6 |
| 6 | 45.8 | 62.9 | 63.5 | 62.9 | 64.8 | 71.9 |
| 7 | 41.3 | 59.5 | 60.6 | 60.3 | 62.0 | 70.7 |
| 8 | 37.5 | 56.5 | 58.0 | 57.7 | 59.7 | 69.1 |
| 9 | 34.1 | 53.8 | 55.7 | 55.4 | 57.1 | 65.8 |
| 10 | 31.0 | 51.1 | 53.5 | 53.2 | 55.0 | 62.4 |
| 11 | 28.2 | 48.6 | 51.4 | 51.3 | 52.8 | 60.6 |
| 12 | 25.7 | 46.2 | 49.4 | 49.5 | 51.1 | 57.6 |
| 13 | 23.4 | 43.9 | 47.5 | 47.4 | 49.1 | 55.9 |
| 14 | 21.4 | 42.0 | 45.8 | 46.0 | 47.8 | 54.7 |
| 15 | 19.7 | 40.5 | 44.4 | 44.5 | 46.4 | 54.0 |
| 16 | 18.2 | 39.0 | 42.9 | 43.5 | 44.9 | 52.2 |
| 17 | 16.7 | 37.4 | 41.9 | 41.9 | 44.0 | 50.6 |
| 18 | 15.1 | 35.8 | 40.8 | 40.4 | 42.9 | 43.8 |

Source: Own calculations based on Quadros de Pessoal, GEP, MTSS

Differences in hazard rates across firm size classes are particularly evident in the early stages of a firm's life (Figure 7). The regional disparity, observed in the previous section, is also confirmed among different size classes. The equality tests performed allow the acceptance of the hypothesis that firms present distinct survive performances according to their dimension. The largest size class reveals some deterioration in its survival capacity after the 12$^{th}$ year of activity, depicted by the "overshooting" of the smoothed hazard estimation function.

Figure 7: Smoothed hazard estimate by size class, 1987-2005




Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.

### 4.2.3. Survival and hazard functions across broad sectors

Our analysis now turns to the question of whether failure rates vary according to industry membership. Table 8 shows survival rates at different lifetimes across broad sectors for a period of ten years[6].

Enterprises operating in the construction sector have the lowest survival probabilities over all this time period and show the greatest survival gap between the first and its tenth year of activity (a decrease of 55.1 percent points). Its hazard peak is reached within the first 4 years of activity (Figure 4), but survival tends to decline faster than in other sectors. On the other hand, the agricultural sector has the highest survival rates up to the fourth year of activity.

[6] We consider a period of ten years only, after 1995 due to the start of European System of Accounts of 1995, and up to 2006 due to the problems of compatibility with Classification of Economic Activities Revision 3, introduced in 2007.

Table 8: Survival table for employer enterprise births by broad sectors, 1995-2006

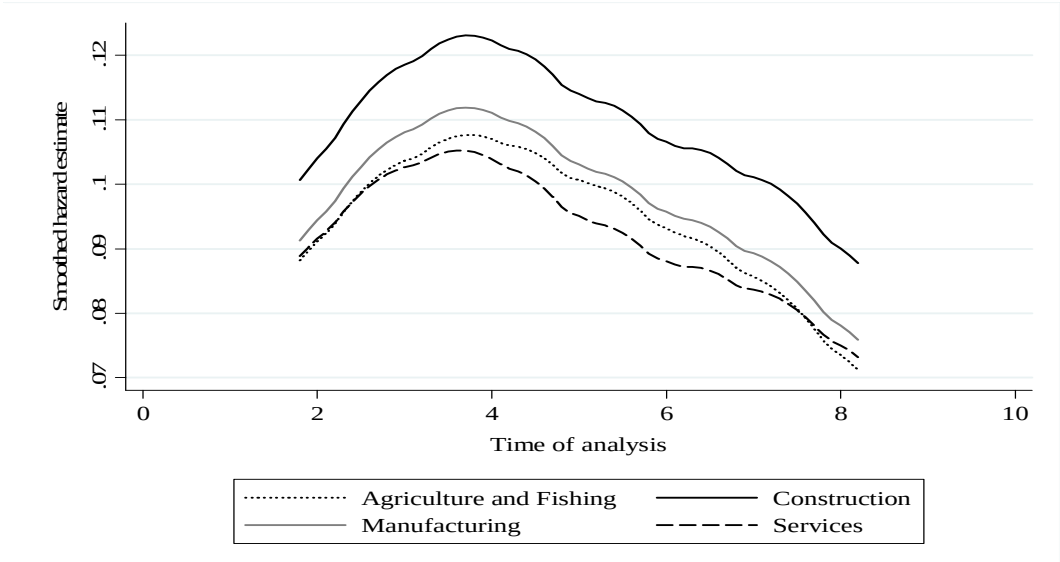
| Time | Broad Sectors | | | |
|---|---|---|---|---|
| | Agriculture and Fishing | Construction | Manufacturing | Services |
| Years | % | | | |
| 1 | 86.5 | 84.8 | 86.4 | 85.9 |
| 2 | 76.1 | 73.3 | 75.7 | 75.4 |
| 3 | 67.9 | 63.8 | 66.9 | 66.9 |
| 4 | 60.3 | 56.0 | 59.4 | 60.1 |
| 5 | 54.3 | 49.4 | 52.8 | 54.5 |
| 6 | 49.3 | 44.2 | 47.7 | 49.8 |
| 7 | 44.8 | 39.8 | 43.9 | 45.7 |
| 8 | 40.9 | 36.3 | 40.4 | 42.3 |
| 9 | 38.8 | 33.1 | 37.2 | 39.1 |
| 10 | 36.1 | 29.7 | 34.2 | 35.7 |

Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.

The smoothed hazard estimate shows that in the service sector, the probability of "death" increases steeply within the first three years, but the hazard peak is reached sooner than in other sectors. Following this point, an increase in age, brings about a flatter probability of failure at the lower end of the distribution (Figure 8).

The existence of disparities among the Portuguese regions is also confirmed by the equality tests performed. Both Log-rank and Wilcoxon (Breslow) tests allow for the rejection of the hypothesis of survival equality across broad sectors.

Figure 8: Smoothed hazard estimate by broad sectors




Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.

## 5. Final remarks

Portugal is characterised by a considerable level of firm churn. More than a quarter of firms is either being created or destroyed in most years over this eighteen year period. The decrease in turbulence in the market, in particular after 2001, visible in all broad sectors, regions and most size classes seems to have drawn survival rates towards an upward trend.

In the non-parametric analysis, we find that around 25 per cent of enterprises entering the market fail within the first 2 years of activity and that more than 50 per cent fail within a period of six years. The instantaneous probability of exit is monotonically decreasing with age. After entry, the conditional probability of failure increases continuously up to the sixth year of activity.

Breaking down by region, sector and class dimension, we identify statistically significant disparities. As for the regional dimension, it is worth noting the disparities in terms of median duration survival, in particular between the NUT II regions of Norte and Centro. Within the first 6 years of activity, the Norte is the only region registering less than 50 per cent of enterprise survival probability, lagging behind all other regions in terms of enterprise survival, while Centro is the region where firms survive longer throughout the period considered. We also observed that the survival gap between the Norte and Centro has increased systematically during this period.

As for the firm dimension, we found a significant relationship between size and the probability of survival. Although firm size is insufficient in itself to capture all the characteristics and thus reflect the heterogeneity of firms, this founding condition is seen as a determinant factor in the variation of survival rates. This is particularly observable for new start-ups, who face the greatest uncertainty regarding market conditions.

At the sectoral level, we find that firms in the construction sector, which have been facing an activity slowdown during the last decade, exhibit the highest risk of failure. Firms in the service sector, in turn, display the highest survival rates. The services sector also exhibits a tendency for the hazard peak to be reached sooner, which means that survival prospects related to firm age, start increasing sooner than in other broad sectors.

In fact, founding and location conditions, such as firm size, sector of origin and region contribute to explain the observed heterogeneity in firm survival rates, even after several years of firm activity.

We consider the level of churn in the economy to be heavily related to the relatively lower estimated median duration of a newborn enterprise. In Portugal the probability of an employer enterprise closure keeps on increasing up to the sixth year of activity, while in countries such as Spain, Italy, UK, Germany and the US, the probability of failure starts decreasing before the sixth year.

For policy-makers, these results bring additional food for thought. By acknowledging that firms in Portugal face specific challenges and by better understanding the underlying motivations of why employer enterprises have a shorter average life than their European counterparts, firm support can be better targeted for the right moment of firms´ life-cycle. If one admits that founding effects persist and are, to a certain extent, beyond policy-makers control, there is scope to consider the benefits of postnatal policies that are able to impact directly on firm survival. This implies taking a different view concerning the dominant entrepreneurship policy in Portugal, where support has traditionally targeted newborn and smaller sized firms. Understanding the conditions of why firms fail more on average in Portugal than in other countries, can help design policies and instruments that can make a better usage of market turbulence.

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