Faculdade de Economia
da Universidade de Coimbra

Grupo de Estudos Monetários e Financeiros
(GEMF)
Av. Dias da Silva, 165 – 3004-512 COIMBRA,
PORTUGAL

ALCINA NUNES & ELSA DE MORAIS
SARMENTO

Business Survival in Portuguese Regions

ESTUDOS DO GEMF
N.º 22   2010

BUSINESS SURVIVAL IN PORTUGUESE REGIONS

Alcina Nunes

Instituto Politécnico de Bragança[1]

Elsa de Morais Sarmento

Universidade de Aveiro[2]

Abstract: This work addresses the post-entry performance of employer enterprises for seven regions in Portugal, at the NUT II level, by investigating the structural characteristics of survival, using non-parametric and semi-parametric methods, during the period 1985 to 2007. The last decades of the 20th century were characterized by a period of creative destruction in Portugal. In particular, regions such as Norte, Algarve and Madeira show the highest growth rates in enterprise births, deaths and firm churn. After 2000, firms´ births and deaths get relatively less turbulent. In the non-parametric analysis, we identify statistically significant disparities among regions. Norte has the lowest survival rate and Centro holds the longest surviving firms and the survival gap between the former two regions gets amplified over time. Concerning the semi-parametric analysis, firm's current size dimension is a strong determinant for the probability of survival, particularly in the Norte and Açores. In industries characterized by high entry rates at the moment of a firm's birth, post-entry survival becomes harder, especially in the south and in the Portuguese archipelagos, the regions with the lowest number of active employer enterprises. A higher entry rate combined with fast growth rates for any given industry also generates a shorter duration of firms. Manufacturing is the sector where more firms are more likely to abandon the market, particularly in Madeira and Norte. But it is turbulence, given by the sum of firms´ entry and exit rates that exhibits the most significant effect on survival. For every region, except for the Açores, where there is no statistical significance, those that have the highest record of firm turbulence, also display the lowest business survival probabilities. Turbulence decreases severely the survival probabilities of firms located in Madeira and Norte and to a lesser extent in the Algarve.

Keywords: Duration Analysis, Firm dynamics, Entrepreneurship, Regional Analysis

JEL Classification Codes: C14, C41, L25, L26, R11

---

[1] Escola Superior de Tecnologia e Gestão do Instituto Politécnico de Bragança, Campus de Sta Apolónia, Apartado 1134, 5301-857 Bragança, Portugal. Email: alcina@ipb.pt.

[2] Departamento de Economia e Gestão da Universidade de Aveiro. Campus Universitário de Santiago, 3810-193 Aveiro, Portugal; Email: esarmento@ua.pt.

1. Introduction

Regional development has been a source of interest among academics and policymakers, especially in the context of endogenous growth theories and the new economic geography framework. Regional growth theory has become over the years an important branch of modern economic growth analysis. The knowledge society has brought about features such as innovation and creativity as the basis of regional dynamics and competitiveness. Business performance and the renewal of enterprises, which have been considered as engines of regional innovation, employment creation and growth, have thus aroused great interest.

The phenomena of enterprise birth, growth, contraction and death has become an important field of research in the so-called firm demographics (Bartelsman et al., 2005a and 2005b; Caves, 1998; Colantone and Sleuwaegen, 2008; Geroski, 1995; Masso et al., 2004; Robinson et al., 2006; Sharpe and Currie, 2008). The demography of firms approach is already a rather well established field of study for economic geographers and regional economists (Van Dijk and Pellenbarg, 1999; Pellenbarg and van Steen, 2003; Baptista et al., 2008; Baptista and Carias, 2007). It has developed into a research field that has close links to industrial organisation and organisational ecology but also to the evolutionary approach of spatial-economic development (Nelson and Winter 1982; Hannan and Freeman 1989; Boschma and Frenken, 2002 and 2006).

Most empirical studies on regional variations in entry and exit rates at the international level are either based on survey data like the Global Entrepreneurship Monitor (Acs et al., 2008), business registration data (Klapper et al., 2008; Klapper et al., 2009; Sarmento and Nunes, 2010b), administrative data or a mix of the previous (Baterlsman et al., 2005a; Baterlsman et al., 2005b; Eurostat, 2009; OECD/Eurostat, 2009). In Portugal, extensive research has been done in firm dynamics using administrative data from a linked employer-employee micro-dataset known as *Quadros de Pessoal* (Mata and Portugal, 1994; Mata et al., 1995; Mata, 1993; Mata and Machado, 1996; Baptista et al., 2008; Cabral, 2007; Cabral and Mata, 2003; Baptista and Carias, 2007; Baptista and Mendonça, 2007; Nunes and Sarmento, 2010a and 2010b; Sarmento and Nunes, 2010c). The diverse administrative regional breakdowns made possible by *Quadros de Pessoal,* rapidly made a stand in the field of regional economics. The possibilities of combining microeconomic data with more aggregate macroeconomic and regional data, helped regional economists to shed light onto the development of regional patterns in Portuguese regions. The work of Baptista, Escária and Madruga (2008) is a recent example of research work conducted on firm demography at a regional level. Still, the predominant orientation of new firm formation studies tends to neglect the spatio-temporal dynamics of incumbent firms, in particular their process of survival, growth and decline (Fischer and Nijkamp, 2009).

Our work addresses the post-entry performance of new Portuguese firms by investigating the regional structural characteristics of the hazard and survival functions, by applying non-parametric and semi-parametric survival analysis to the active employer enterprises of *Quadros de Pessoal*. The main contribution of this work is the application of a recent internationally comparable methodology for entrepreneurship and the usage of this analytical arsenal to provide firm and survival disaggregation from a regional perspective, over a period of eighteen years.

This work is structured as follows. The next section introduces the data and methodology and the following provides an overview of regional business dynamics in Portugal. Section four presents the non-parametric survival analysis while section five proceeds with complementary semi-parametric survival methods, where estimations for the NUT II Portuguese regions survival determinants are provided. Finally, the last section concludes.

2. Data and methodology

This work is based on the datset *Quadros de Pessoal* (Employment Administrative Records), which is the main data source in Portugal for the universe of active employer enterprises. It has been subject to the application of the entrepreneurship definitions and methodology of the "Manual on Business Demography Statistics" (OECD/Eurostat, 2007), from where a specific entrepreneurship database was derived.

The *Quadros de Pessoal* is an annual survey conducted in Portugal by the Portuguese Ministry of Labour and Social Security (*Gabinete de Estratégia e Planeamento do Ministério do Trabalho e da Segurança Social)*, which provides a rich and comprehensive longitudinal matched employer-employee dataset. It covers virtually all establishments with wage earners (that is, all businesses with paid employees who contribute and benefit from Social Security benefits), with exception made for public administration and non-market services, which are excluded, and agriculture, silviculture, hunting and fishing activities (in case the workers are not included in the "common" social security regime[1] or in any other collective labour regulatory instrument). The target population excludes very small businesses with only one self employed person (sole proprietors[2]), unless they are formally registered in the Social Security system[3]. It focuses on the formal sector of the economy and covers virtually all private businesses with at least one paid employee in Portugal (Figure 1).

Figure 1 – Employer enterprises considered in *Quadros de Pessoal,* by legal form

---
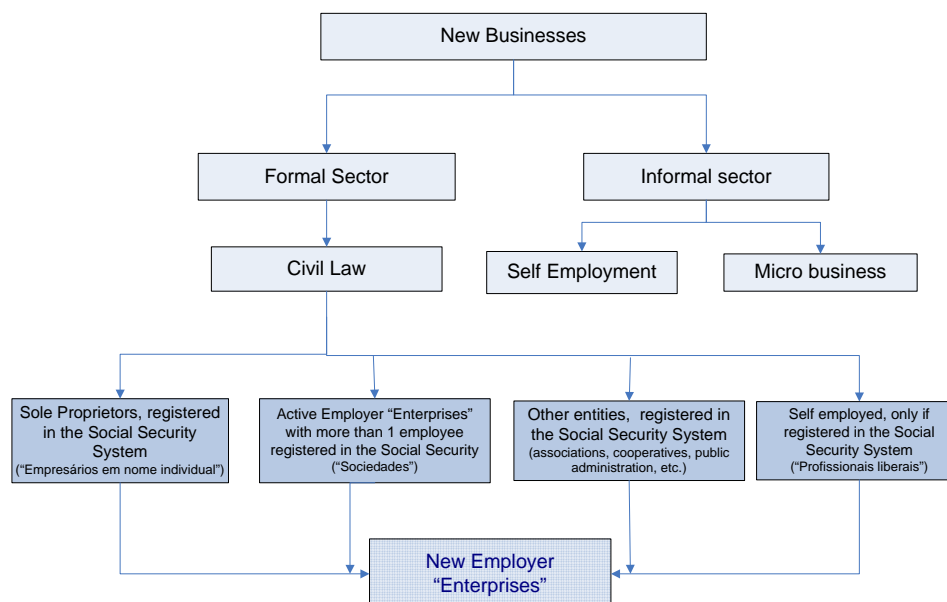
[1] *Regime geral de segurança social.*
[2] Sole proprietors are counted as an active employer enterprise, respecting the definitions of the Eurostat/OECD´s guidelines (2007), if the proprietor is considered as a paid employee, contributing to the Portuguese Social Security System.
[3] Since 2000, *Quadros de Pessoal* also includes businesses with a single owner and without paid employees. For those, filling out of the questionnaire is not compulsory by Law.

The importance of *Quadros de Pessoal* derives not only from its national coverage and comprehensiveness at the microeconomic level, but also from the fact that it is the only linked data source in Portugal, thus allowing the matching, throughout time, of firms with their correspondent employees and the establishments where they are located.

The empirical literature on entrepreneurship highlights the importance such a linked employee-employer database. Indeed, linked firm-level data is fundamental to answer questions about the relationships between entrepreneurial determinants and entrepreneurial performance, since it allows following individual firms for a particular period of time observing their overall characteristics and related changes. The availability of longitudinal datasets is also extremely relevant for a time-series analysis of entrepreneurship, in terms of the performance and survival of specific cohorts of newly created firms over time.

In the past, this dataset proved to be rich and flexible enough to be used in a great multiplicity of empirical applications. At the present, this dataset continues to respond well to the increasing needs in different areas of research, namely in regional entrepreneurship, not only in terms of performance but also of addressing its survival determinants.

The survival analysis provided in the following sections, will take place over this new entrepreneurship dataset, where only active employer enterprises and real births and deaths are accounted for. According to the Eurostat/OECD (2007) methodology, the core measure of births reflects the concept of employer enterprise birth[4]. The employer enterprise birth rate is based on a ratio where the numerator follows the above definition for employer enterprise births, while the denominator is the population of active enterprises with one or more employees during the reference period.

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 in order to remove them from the population, according to 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 Eurostat/OECD manual recommends waiting for two years after the reference period to allow for reactivations, before deaths are calculated. This is the reason why, despite the availability of the data until 2007, deaths were only recorded until 2005. The employer enterprise death rate is based on a ratio where the numerator follows the above definition for employer enterprise deaths, while the denominator is the population of active enterprises with one or more employees during the reference period.

The churn rate is an indicator which is 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).

The entrepreneurship database obtained from *Quadros de Pessoal*, after applying the Eurostat/OECD (2007) methodology, consists of 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.

---

[4] Births do not include entries into the population which result from break-ups, split-offs, mergers, restructuring of enterprises or reactivations of units which are dormant within a period of two years. 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.

3. Regional business characteristics and dynamics

As the creation of enterprises is considered a primary indicator of the level of entrepreneurship at the regional level, its closing can also be considered a primary indicator of local firms´ survival abilities. In Portugal, the regional distribution of deaths is relatively uneven across the seven NUT II regions (Figures 2 and 3). Norte is the region where more of enterprise deaths occur, where 39% of total enterprises died in 2005 (34% in 1985), a higher proportion than the region's share of total active enterprises.

Figure 2 - Deaths of active employer enterprises by NUT II regions
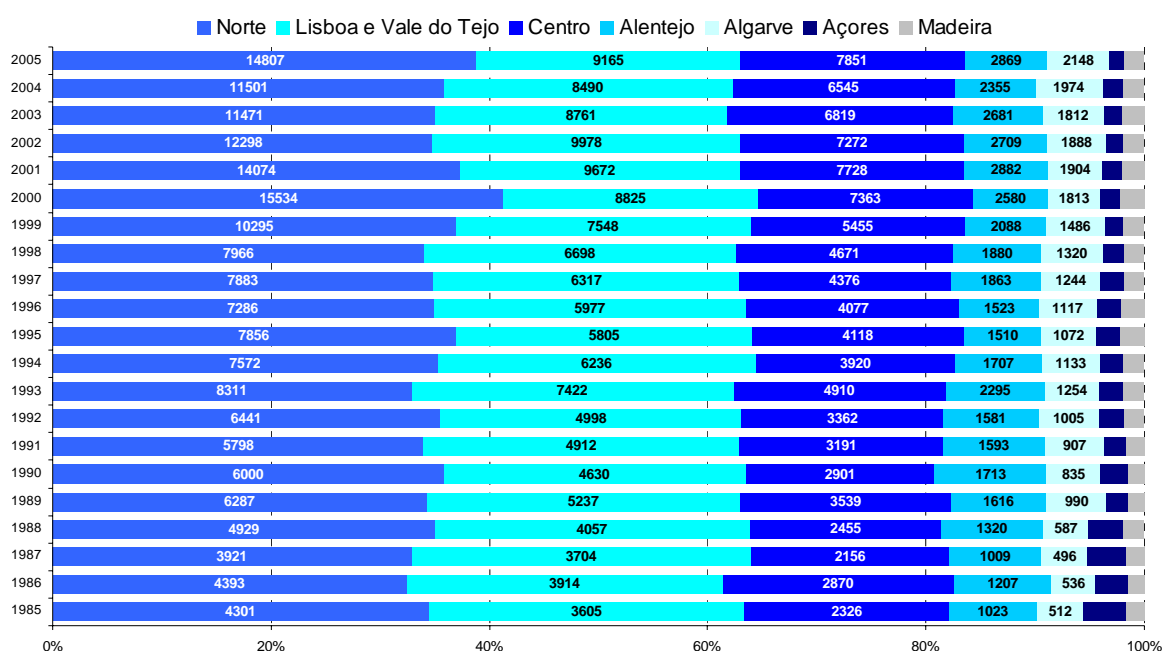
Source: Own calculations based on Quadros de Pessoal, GEP, MTSS.

Portugal has had in the past high birth[5] and death rates, when compared to other countries (Eurostat, 2009; INE 2009; OECD/Eurostat 2009; Sarmento and Nunes, 2010c and 2010b). Based on the cycles of enterprise birth and growth, Sarmento and Nunes (2010c) observe four main distinct periods of enterprise creation: before 1989, from 1990 to 1994, 1995 to 1999 and the period following the year 2000. Four main "peaks" in enterprise creation are clearly observable in Portugal, 1989, 1994 (with a total growth rate of 57% y.o.y., and the highest birth rate throughout the period), 2000 (birth rate of 19.5%) and 2005 (birth rate of 16.1%). Death rates were the highest in 1993 (15.2%), when Portugal faced a negative GDP growth, in a setting characterised by a widespread international economic crisis and speculative currency attacks within the European Monetary System, and in 2000 (14%). From 2000 (a "peak" year for enterprise births and deaths), the country shows an overall trend of decelerating growth rates of

---

[5] Among the European countries, Portugal has one of the highest records of new firms relatively to the stock of existing enterprises, even when different universes and methodologies are considered (OECD/Eurostat, 2009; Scarpetta et al., 2002; Cabral, 2007; Bartelsman et al., 2005a; Sarmento and Nunes, 2010b). The Structural Business Statistics data by Eurostat (2009) shows that in 2005, Portugal had the second highest business entry rate among 20 countries. In 2006, within a panel of 16 countries, Portugal ranks the third highest, after Estonia and Romania (INE, 2009).

the population of active employer enterprises, a phenomena extended to all NUT II regions (Table 1). The same occurs for enterprise births[6] and deaths (GEE, 2010).

The last 25 years of the 20th century may be seen as a period of creative destruction, where the development of information and communication technologies and globalisation shaped the behaviour of firms. Carree et al. (2002) argue that at least in modern economies, the secular trend of decreasing business ownership rate and its rise during this period is an indication of development changes in the level of entrepreneurship. After the 1970s, industries such as textiles, machinery and automobiles have lost comparative advantage and have been confronted by a rise of new ventures in service and knowledge-intensive sectors.

But globalisation is bringing an increasing level of risk, tougher competitive pressure and increasing barriers to entry the market for potential entrepreneurs (Colantone and Sleuwaegen, 2008). These phenomena might have had a considerable impact in Portugal, causing a smoothing of the rhythm of enterprise creation and bringing tougher survival for incumbent firms, felt particularly from the start of the new century. Death rates are highly correlated with birth rates and have thus accompanied this trend (Sarmento and Nunes, 2010c).

Figure 3 - Death rates of active employer enterprises by NUT II regions (1987, 1997 e 2004)
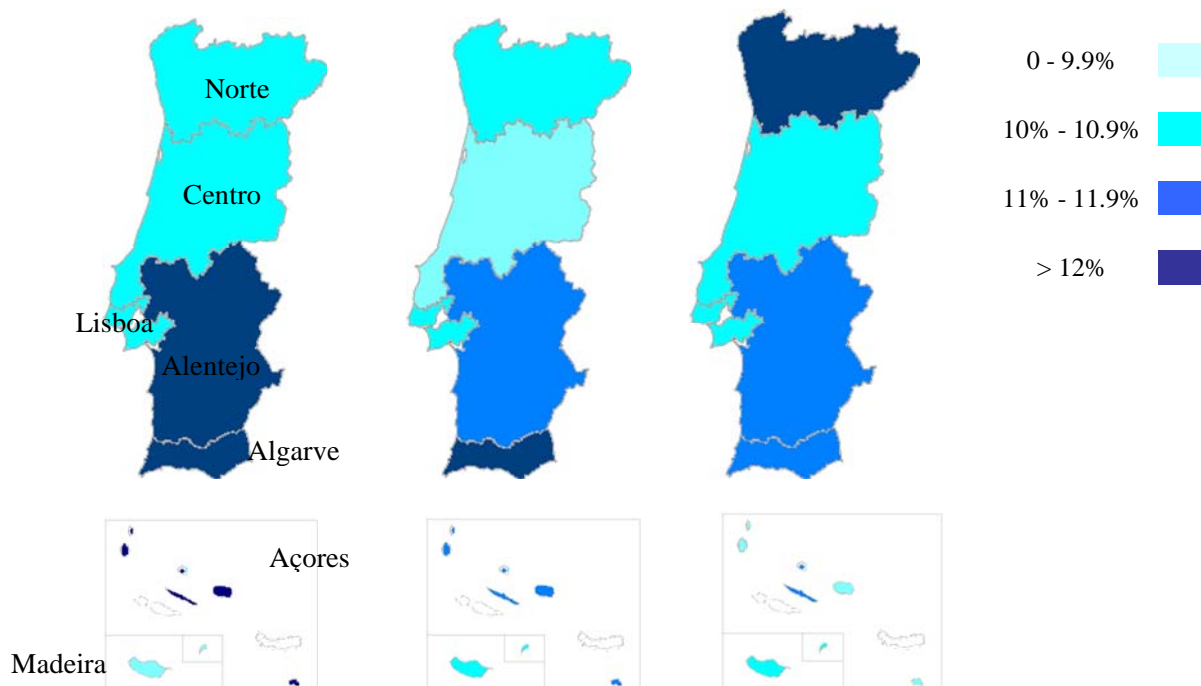
Source: Own calculations based on *Quadros de Pessoal* GEP, MTSS

---

[6] There is an exception for year 2005, which we think is related to the start of the electronic delivery of *Quadros de Pessoal*. The year 2005 shows an increase in enterprise creation, when 16 out of 100 were new Portuguese enterprises. In 2007, the birth rate was back to 2004´s level (12,6%).

Table 1 sheds additional light onto the rhythm of growth of enterprises, births and deaths, which has been clearly decreasing since the 2000 "peak". Most NUT II regions follow the country's general trend of decreasing birth and death rates (Sarmento and Nunes, 2010c). The Algarve is the only region that manages to dispute this tendency and maintain a positive annual growth rate of enterprise births after 2000 (1,0%), as it also has the highest growth in active enterprises throughout the whole period. On the other hand, it also shows the highest annual average growth in enterprise closures (3,4%)[7].

Norte has the greatest proportion of active firms in the country and the second greatest increase of active employer enterprises in the country between 2000 and 2007 (Table 1). It is also in the north of the country where the greatest share of business entries and closures occurred between 1985 and 2007, causing this region to exhibit a high level and turbulence (Table 2 and Figure 4) and volatility[8] (Sarmento and Nunes, 2010c). Despite having the greatest share of active enterprises and the greatest amount of small enterprises in the country, the weight of small and medium firms is the highest in Algarve (mainly due to services and construction from 2000) and Alentejo (mainly in services and agriculture and fishing sectors) (Sarmento and Nunes, 2010c).

Table 1 - Annual average growth rate of employer enterprises, births and deaths by NUT II

NUTII Regions	Active employer enterprises			Births		Deaths	
	1985-2007	1995-2000	2000-2007	1987-2007	2000-2007	1985-2005	2000-2005
Norte	6.2	7.1	4.4	4.3	-1.5	6.4	-1.0
Algarve	9.2	7.9	6.7	6.2	1.0	7.4	3.4
Centro	6.6	8.6	4.0	4.6	-5,3	6.3	1.3
Lisboa e Vale do Tejo	4.5	5.1	3.4	4.3	-1.1	4.8	0.8
Alentejo	5.8	8.3	3.1	3.1	-4.2	5.3	2.1
Açores	3.7	3.9	3.1	1.1	-1.0	0.4	-4.9
Madeira	6.4	7.1	4.4	4.9	-1.1	6.3	-3,3
Portugal	5.8	6.9	4.1	4.3	-2.3	5.7	0.2

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

From 1985 to 2005, Algarve (32,5%), Alentejo and Norte (29,9%) are the regions with the greatest amount of births and deaths in the country. In the second sub-period, from 2001, Norte and Algarve maintain high levels of business turbulence, though below the previous period turbulence rates (1987-2000).

---

[7] Algarve also has high volatility in active employer enterprises growth over time (e.g. from 27,7% of growth in 1989 to a low of 2,6% in 1990).
[8] Norte shows the highest volatility of all regions (particularly from 1993 to 1998), when measured through the standard deviation.

Table 2 – Average churn rates of Portuguese NUT II regions

|	1987-2005	1987-2000	2001-2005
Norte	29,9%	30,1%	29,4%
Algarve	32,5%	34,7%	29,4%
Centro	27,3%	28,8%	25,1%
Lisboa	26,8%	27,1%	26,2%
Alentejo	29,9%	31,8%	26,6%
Açores	27,1%	28,0%	25,5%
Madeira	28,6%	29,4%	27,3%
Portugal	28,5%	29,3%	27,3%

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

In Figure 4, birth, death and churn rates for each region are portrayed for three selected years, the first in our database for which we are able to calculate both death and birth rates (1987), a "peak" year in terms of turbulence (2000) and the most recent year for which we are able to also compute births and deaths (2005). In the years following 2000, Portuguese regions have been moving towards the first quadrant, to the bottom left side, closer to the dividing 45° degree line.

The first three quarters of the 20th century are often characterized as a period of declining small firm presence in most industries (Carree, et al., 2002). But in more recent decades, this has stabilized or has even been reversed, with the revival of small businesses in many industries of the industrialized world (Eurostat, 2009; OECD/Eurostat, 2009; Bartelsman et al., 2005a; Cabral, 2007; Núñez, 2004; Thurik, 1999; Storey, 1994; Acs, 1996; Acs and Audretsch, 1993; Loveman and Sengenberger 1991). After the 1970s, older and larger enterprises especially located in manufacturing sectors have lost ground for new smaller, more entrepreneurial and innovative counterparts. The increasing weight of services in most developed economies, which are characterized by smaller average sizes, contributed sharply to the decreasing average size of firms. In Portugal, the growing importance of services cannot be overlooked (Sarmento and Nunes, 2010c), which influences the already small entrepreneurial fabric and the creation of new enterprises. Over a period of more than 20 years, Sarmento and Nunes (2010c) find an overall decreasing average size for employer enterprises in Portugal, which is extended to all broad sectors, NUT II regions, entrants and exiters in the market.

By combining the geographical with the size class dimension, Sarmento and Nunes (2010c) observe the preponderance of small firms births in most regions, in particular in Algarve (above 98.1% of enterprises are born with fewer than 20 employees throughout the period), Alentejo (above 97.7%), Centro (97.2%) and the Açores. Over the period, Norte is the region where relatively fewer firms are born with fewer than 20 employees.

Figure 4 - Birth, death and churn rates in 1987, 2000 and 2005 respectively
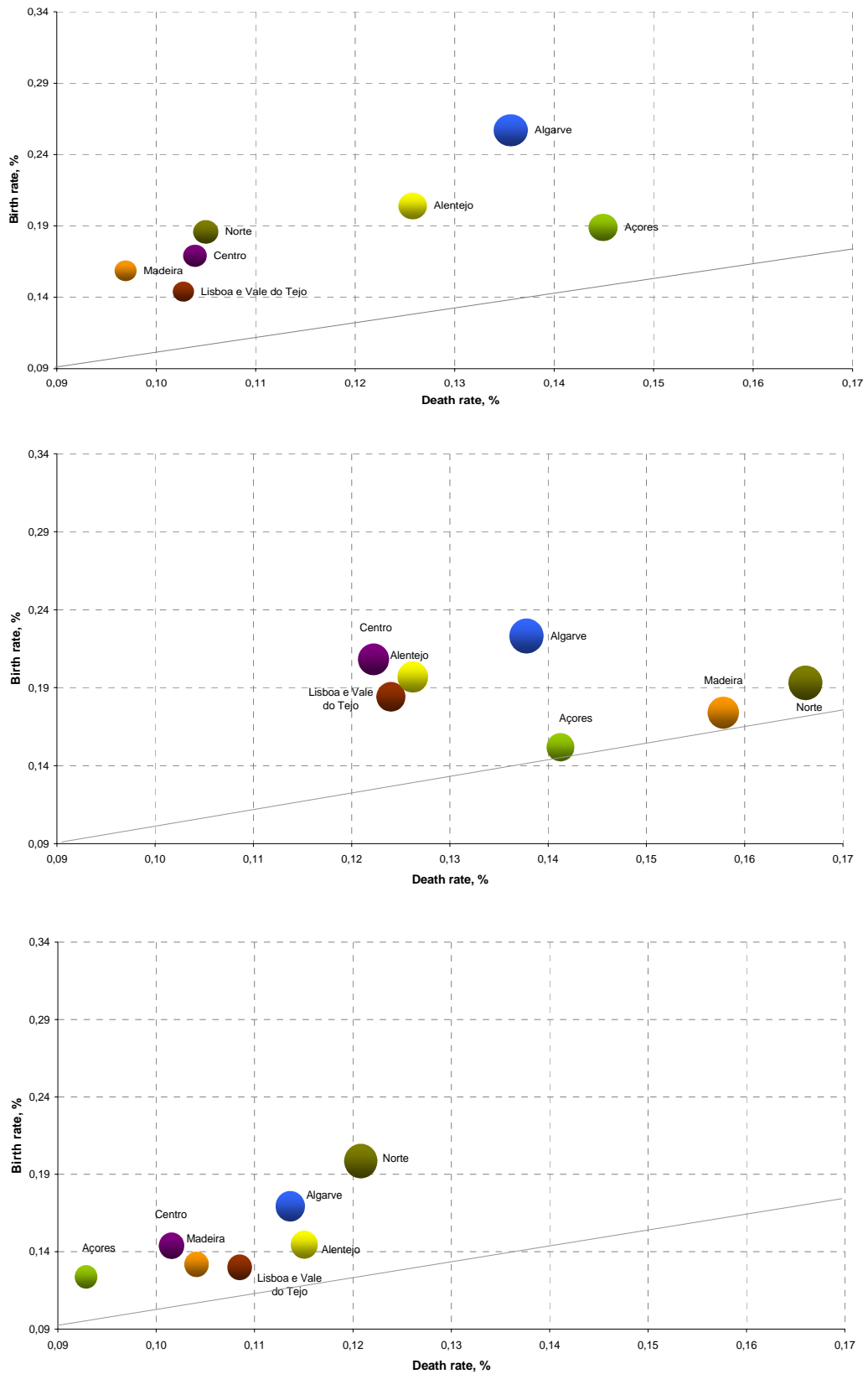
Source: Own calculations based on Quadros de Pessoal, GEP, MTSS.

The average firm size of entrants has been decreasing throughout the country's regions (Table 3), except for size class of 20-49 employees which, despite the natural fluctuations over the period, has been able to show systematic recoveries and maintain its average range between 25 and 31 employees throughout the period. Until 2003, the Açores had the smallest sized enterprises, in the size class one to four employees (1.8 employees on average). From 2005, it was overthrown by Norte (1.6 employees on average). On the other hand, Lisbon has the biggest sized enterprises in the country in the size class of over 250 employees, although average firm size has been decreasing considerably in recent years (1 645 employees on average in 1989, 2 628 in 2000 and 624 in 2007), followed by Centro and Norte, which recovers in 2007, the second place in this size class.

In higher birth rate years in Portugal, we observe an overall increase in firm dimension, with some heterogeneity throughout the Portuguese regions, in particular during the "peak" years of enterprise creation of 2000 to 2002. The year of 1994, also characterised by a sharp increase in birth rates, shows a more homogenous regional impact on the average enterprises´ size (except for Centro and the Açores), compared to the "peak" of 2000 to 2002, which had a more localised impact in respect to firm size increase in Lisbon, Açores and Madeira.

Table 3 - Entrants and exiters average firm size, by NUTII

	Average firm size of entrants								Average firm size of exiters							
	Norte	Algarve	Centro	Lisboa	Alentejo	Açores	Madeira	Portugal	Norte	Algarve	Centro	Lisboa	Alentejo	Açores	Madeira	Portugal
1985									7.9	6.3	6.0	6.8	5.7	3.1	7.0	6.8
1986									7.5	5.7	6.0	6.1	6.3	3.7	9.1	6.5
1987	6.2	4.7	5.2	5.1	4.5	3.6	6.9	5.4	8.4	5.1	5.9	6.3	5.2	3.3	8.1	6.7
1990	6.1	4.1	5.3	6.3	4.3	3.0	4.8	5.7	7.7	4.9	5.7	6.1	4.6	3.4	7.1	6.4
1991	6.2	4.4	5.3	6.8	4.0	2.8	6.2	5.8	8.0	4.1	6.3	6.7	4.4	2.7	4.5	6.6
1992	5.6	4.0	4.6	5.5	4.2	3.4	4.4	5.1	7.6	4.5	5.9	6.3	4.9	3.2	5.9	6.4
1993	4.9	3.8	5.1	6.5	4.1	4.4	5.0	5.2	7.6	4.6	6.1	12.4	5.4	3.6	5.4	8.2
1994	5.9	4.1	4.5	8.6	4.3	3.8	5.4	6.1	6.5	3.8	4.6	5.5	3.9	4.0	4.3	5.4
1995	4.6	3.4	3.6	4.3	3.3	2.8	5.2	4.1	6.4	3.6	4.6	4.9	4.3	3.1	3.2	5.2
1996	4.3	3.3	3.8	4.5	3.9	2.4	4.7	4.1	5.5	3.4	4.6	5.0	3.9	2.4	4.5	4.9
1997	4.5	3.4	3.5	4.4	3.6	2.5	3.8	4.1	5.9	3.5	4.3	5.6	3.9	2.1	3.7	5.1
1998	4.6	3.3	3.4	5.1	3.3	3.2	4.4	4.3	6.0	3.0	4.1	4.8	3.2	2.5	3.4	4.8
1999	4.2	3.4	3.6	4.8	3.6	2.6	4.0	4.1	6.4	3.2	4.0	6.1	3.5	2.9	5.6	5.4
2000	4.0	2.9	3.1	6.6	3.1	3.9	4.3	4.3	5.2	3.1	4.3	5.7	3.0	3.0	4.3	4.8
2001	4.6	3.4	3.7	4.6	3.3	4.1	4.8	4.2	5.0	4.1	4.2	5.7	3.6	3.3	4.9	4.8
2002	4.1	3.2	3.3	4.4	3.3	3.9	4.4	3.9	5.0	3.0	3.8	4.8	3.4	3.2	3.9	4.4
2003	4.2	3.3	3.3	4.6	3.1	3.5	3.6	4.0	4.2	2.9	3.3	5.0	2.8	3.3	3.2	4.0
2004	3.8	3.3	3.3	4.5	3.2	3.9	4.2	3.8	3.9	2.9	3.0	4.5	3.0	3.7	3.2	3.7
2005	3.9	3.5	3.8	4.9	3.5	3.3	3.3	4.0	3.5	2.9	3.3	4.4	2.6	3.0	4.0	3.6
2006	3.4	3.2	2.9	3.8	2.9	3.3	4.1	3.4								
2007	3.4	3.0	2.7	3.9	3.1	3.5	3.7	3.4								

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

4. Non Parametric Survival Analysis

This section provides an analysis of new firm survival using non parametric estimation methods, which draws extensively on the survival analysis literature in industrial economics.

4.1 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. T is a non-negative variable, denoting the time to a failure event ("death"). The survivor function is thus represented by:

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

<div align="right">(1)</div>

With $F(t) = \Pr(T \le t)$ 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") occurs in a given interval, conditional upon the subject having survived to the beginning of that interval, divided by the width of the interval:

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

<div align="right">(2)</div>

Where $f(t) = \dfrac{dF(t)}{dt} = \dfrac{d\{1 - S(t)\}}{dt} = -S'(t)$ 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.

The non-parametric Kaplan-Meier estimator was applied for the estimation of the survivor function $S(t)$. 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:

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

<div align="right">(3)</div>

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 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:

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

<div align="right">(4)</div>

4.2. Empirical Results for the Non Parametric Survival Analysis

Table 4 provides the estimations for the hazard duration and survival functions for the Portuguese economy. The survival function shows the probability of survival, considering that the firm has been active during a certain period. The hazard function shows the probability of "death" throughout a given period of time.

According to this table, during the period from 1987 to 2005, approximately 86% of all the employer enterprise births remain active after one year of activity, 75% after two years and 46% after seven years. These results are in line with the OECD´s estimates, where around 60% to 80% of newly born enterprises survive beyond the first two years of activity, and only around 40% to 50% of total enterprises survive beyond the seventh year of activity. Eurostat (2009) reported for the whole business economy in the European Union (EU), that roughly half of the enterprises born in 2001 was still active in 2006. In *Quadros de Pessoal,* the data reveals that after six years of activity, almost 50% of the enterprise population was still active. After 18 years of activity, only 22% of employer enterprise start-ups were still alive or equivalently, almost 78% had already exited the market.

Table 4 - Life Table for Employer Enterprise Births, 1987-2005

Time	Observations	Deaths	Censured Observations	Kaplan-Meier		Nelson Aalen	
				Survivor Function	Failure Function	Hazard Rate	Cumulative Hazard Rate
Years	n°	n°	n°	%	%	%	%
				P(S)	100-P(S)	P(D)	$\sum P(D)$
1	451041	63088	24000*	86.0%	14.0%	14.0%	14.0%
2	364233	46351	22000*	75.1%	24.9%	10.9%	26.7%
3	295786	32973	28000*	66.7%	33.3%	8.4%	37.9%
4	235002	23655	24000*	60.0%	40.0%	6.7%	47.9%
5	187102	17353	19000*	54.4%	45.6%	5.6%	57.2%
6	150840	12966	12000*	49.7%	50.3%	4.7%	65.8%
7	125525	10059	11000*	45.8%	54.2%	4.0%	73.8%
8	104121	7735	9613	42.4%	57.6%	3.4%	81.2%
9	86773	6089	7943	39.4%	60.6%	3.0%	88.3%
10	72741	5068	7491	36.6%	63.4%	2.8%	95.2%
11	60182	4172	11000*	34.1%	65.9%	2.5%	102.2%
12	45130	3037	6150	31.8%	68.2%	2.3%	108.9%
13	35943	2422	5626	29.7%	70.3%	2.2%	115.6%
14	27895	1681	5546	27.9%	72.1%	1.8%	121.7%
15	20668	1133	4733	26.4%	73.7%	1.5%	127.1%
16	14802	805	5361	24.9%	75.1%	1.4%	132.6%
17	8636	490	4418	23.5%	76.5%	1.4%	138.2%
18	3728	228	3500	22.1%	77.9%	1.4%	144.4%

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

Notes: * Approximate values.

The curvature of the Nelson Aalen estimator[9] provides an idea of the shape of the hazard rate. But this is better depicted by the smoothed hazard estimate or unconditional hazard function for the total economy (Figure 5). The smoothed hazard function exhibits an inverted U-shape, with a maximum around the sixth year of activity. Thus, the estimated median duration of a new born enterprise in Portugal lies between the fifth and the sixth year. This means that after a firm enters the market, the conditional probability of failure increases continuously until the sixth year and declines steeply thereafter. This pattern is similar to those 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 countries, 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
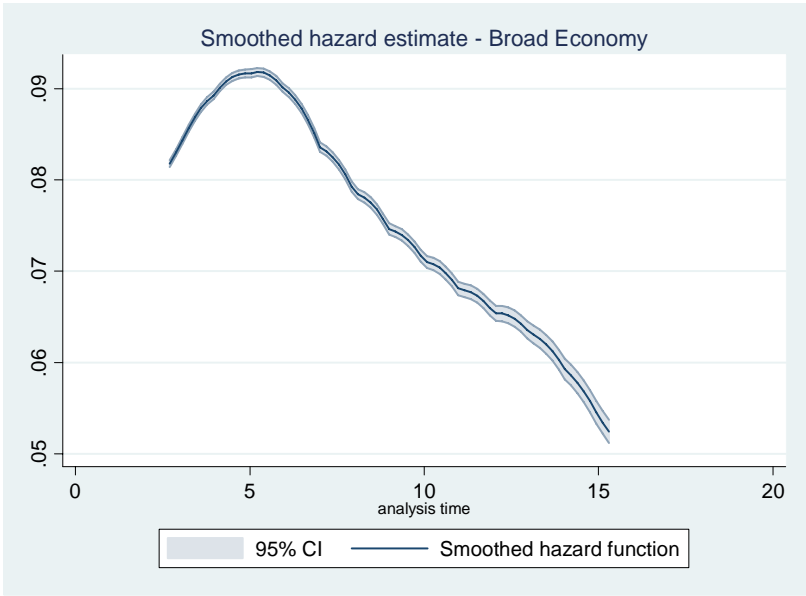
Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.

Table 5 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.

---

[9] The idea behind the former estimator is simple. If the estimator cumulates all the "hazards" at all possible moments between t_0 and t_j, a reasonable estimate can be obtained of the total estimated hazard that exists between those two points in time. Thus, by definition the estimator starts at moment 0 and rises over time (never decreasing). In practice, the estimator cannot be interpreted directly and should not be considered as a probability. Still, the cumulative hazard function provides an important link between the hazard function (estimated for a discrete time which, in our case corresponds to annual periods) and the survivor function, whose double bounded nature, makes it insensitive to changes in the hazard. Given that these random variations occur within discrete survival periods of time, estimates of the hazard must be smoothed in order to distinguish the trends from the noise. Although the cumulative hazard function is instructive when concerning the estimation made with continuous time hazard functions, it is nevertheless important to consider 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. In practice, the kernel smoothed estimator of the hazard function is based on the Nelson-Aalen estimator $\overline{H}(t)$ and its variance,

that is, it uses the changing rates of change in cumulative hazard to compute pseudo-hazard estimates and averages them so as to stabilize the hazard rate.

13

Table 5 - Survival Table for Employer Enterprise Births by NUTII region, 1987-2005

Years	Norte	Centro	Lisboa e Vale do Tejo	Alentejo	Algarve	Açores	Madeira
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.

In line with the results shown previously for the total economy, over 85% 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% in the Açores, to a high of 87.5% in the Centro region, meaning that the new born enterprises died relatively more prematurely in Açores archipelago than in other Portuguese regions.

After three years, Norte presents the lowest survival rate, which is maintained throughout the period, while Centro has the best survival performance. In fact, Centro has a higher survival rate than the economy's average, it is where firms manage to survive longer during the period considered. After 6 years of firm activity, Norte is the only region with less than 50% of survival probability, lagging behind all other regions in terms of enterprise survival. Table 2 also reveals that the survival gap between these two regions grows systematically with time. At the end of the analysis period, Norte is the region that presents the lowest survival rate, with only 20.7% of the firms' population managing to survive after eighteen years of activity. Centro, in turn, has 27.4% of its active start-ups still active after 18 years.

Next, the survival probabilities of different cohorts, born in each of the eighteen years of the analysis is depicted for three different regions, Centro with the highest survival rates (Table 6), and Norte and Algarve (Tables 7 and 8), with some of the lowest survival rates. After 5 years of activity, 58.1% of firms born in 2000 had survived in Centro, but only 57.5% in Centro and 51.4% in Norte. The structural characteristics of these regions is diverse, but Norte and Centro would seem to have more in common in terms of industrial structure than Algarve, as the former are regions where the manufacturing sector is more representative, whilst the Algarve is dominated by very small firms, concentrated in the service sector.

Table 6 – Firm survival rates of different enterprise cohorts in Centro

Survival years	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	88,4%	85,7%	88,3%	87,2%	88,4%	83,3%	89,0%	88,6%	88,4%	88,3%	88,3%	88,1%	85,5%	85,9%	87,2%	88,4%	88,0%	86,9%
2	76,1%	76,2%	80,1%	78,6%	75,6%	74,1%	79,8%	80,2%	78,2%	78,8%	79,1%	76,3%	74,1%	76,6%	77,9%	79,7%	77,4%	
3	69,2%	69,7%	73,7%	67,7%	69,0%	67,3%	73,5%	73,3%	70,8%	70,5%	69,7%	67,6%	66,7%	69,2%	70,8%	72,3%		
4	63,0%	63,8%	64,9%	62,2%	63,8%	62,6%	68,6%	67,9%	64,0%	63,0%	62,4%	61,3%	60,8%	63,4%	64,5%			
5	58,7%	56,8%	60,7%	57,7%	59,4%	59,0%	63,9%	62,7%	58,8%	56,8%	56,9%	56,8%	55,8%	58,1%				
6	53,1%	52,7%	56,8%	53,8%	55,5%	55,1%	59,7%	57,6%	53,3%	52,1%	52,7%	52,9%	51,2%					
7	50,0%	49,0%	52,8%	50,8%	52,4%	51,2%	55,0%	52,8%	49,6%	48,7%	49,1%	48,9%						
8	47,1%	46,7%	49,8%	48,4%	49,2%	47,3%	50,9%	49,6%	46,8%	45,6%	45,0%							
9	44,2%	44,1%	47,1%	45,6%	45,5%	43,8%	48,3%	46,4%	44,1%	42,8%								
10	41,8%	41,2%	44,3%	43,3%	42,3%	41,4%	45,5%	43,8%	41,3%									
11	39,7%	38,9%	41,2%	40,9%	40,1%	39,3%	43,2%	40,9%										
12	37,8%	36,7%	38,7%	38,2%	37,9%	37,6%	41,3%											
13	35,1%	34,2%	36,6%	36,4%	36,1%	35,7%												
14	32,2%	32,5%	34,8%	34,7%	34,3%													
15	30,2%	30,9%	33,4%	33,4%														
16	28,7%	29,7%	31,9%															
17	27,4%	28,1%																
18	26,0%																	

Source: Own calculations based on Quadros de Pessoal, GEP, MTSS.
Note: This was estimated using the non parametric Kaplan-Meier estimator. The probabilities relate to the enterprises ("cohorts") born in the above years mentioned.

Table 7 – Firm survival rates of different enterprise cohorts in Algarve

Survival years	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	88,6%	81,2%	85,6%	86,8%	84,8%	80,7%	85,3%	85,2%	83,7%	85,2%	86,4%	83,7%	82,8%	86,8%	89,3%	86,9%	85,5%	85,8%
2	75,8%	71,2%	76,5%	74,7%	70,9%	73,2%	78,8%	76,3%	73,1%	73,3%	75,0%	72,7%	72,4%	77,7%	80,2%	76,1%	76,2%	
3	66,2%	64,8%	67,4%	64,5%	63,9%	65,4%	72,6%	69,7%	64,3%	64,5%	65,8%	65,7%	64,2%	70,4%	73,1%	68,9%		
4	60,3%	57,8%	58,7%	59,6%	58,7%	58,8%	66,5%	63,4%	57,5%	57,2%	60,1%	58,5%	57,7%	63,7%	67,1%			
5	54,0%	50,8%	54,7%	55,6%	54,6%	54,3%	61,5%	57,4%	51,0%	50,3%	55,4%	54,5%	52,9%	57,5%				
6	49,3%	47,0%	51,4%	51,7%	49,5%	49,3%	57,3%	51,3%	46,3%	46,0%	50,8%	49,8%	48,4%					
7	45,3%	44,3%	47,4%	47,9%	46,5%	44,5%	52,7%	46,5%	42,6%	44,1%	46,8%	45,5%						
8	43,2%	41,4%	45,5%	44,0%	43,4%	40,9%	49,4%	43,6%	39,6%	41,2%	44,2%							
9	39,5%	38,7%	43,0%	41,3%	40,2%	37,6%	46,9%	40,6%	36,5%	37,6%								
10	37,7%	36,4%	40,8%	38,5%	37,7%	34,7%	43,8%	38,1%	33,8%									
11	35,9%	34,2%	37,8%	34,5%	36,4%	33,3%	42,1%	35,4%										
12	33,8%	31,7%	35,6%	32,3%	34,4%	31,9%	39,2%											
13	31,5%	29,5%	34,0%	30,0%	32,8%	29,6%												
14	30,0%	28,0%	32,2%	28,2%	30,8%													
15	29,7%	27,0%	30,8%	26,6%														
16	28,7%	25,8%	29,3%															
17	25,8%	23,8%																
18	24,3%																	

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

## Table 8 – Firm survival rates of different enterprise cohorts in Norte

Survival years	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	87,3%	84,7%	86,8%	87,0%	85,7%	81,5%	87,3%	85,6%	85,9%	87,1%	88,3%	85,9%	79,6%	82,2%	87,1%	87,3%	86,7%	85,7%
2	75,9%	75,0%	77,4%	77,2%	72,7%	72,8%	77,9%	76,8%	76,2%	77,6%	77,1%	70,0%	66,6%	71,3%	77,5%	77,9%	76,9%	
3	67,6%	67,7%	69,3%	67,1%	65,6%	64,8%	70,7%	69,2%	68,7%	68,3%	64,1%	59,6%	58,4%	62,7%	69,7%	69,9%		
4	62,0%	61,4%	61,3%	61,2%	59,7%	59,4%	64,9%	63,9%	61,7%	57,5%	55,1%	53,0%	52,6%	56,6%	63,2%			
5	56,8%	54,6%	56,1%	56,4%	55,6%	55,0%	59,7%	57,9%	52,9%	50,2%	49,7%	48,0%	47,6%	51,4%				
6	51,7%	50,8%	52,1%	52,7%	51,9%	51,4%	54,9%	50,5%	46,6%	45,2%	45,6%	43,9%	43,4%					
7	48,0%	46,8%	48,8%	49,4%	48,5%	47,0%	48,5%	45,2%	43,0%	41,6%	41,7%	39,9%						
8	44,2%	43,9%	45,8%	46,1%	44,8%	41,1%	43,4%	41,6%	40,0%	38,4%	38,8%							
9	41,7%	41,3%	43,2%	42,5%	39,8%	37,2%	40,3%	38,9%	37,1%	35,5%								
10	39,3%	39,3%	39,5%	37,7%	36,0%	34,7%	38,0%	36,0%	34,4%									
11	36,9%	36,6%	35,1%	34,1%	33,5%	32,4%	35,4%	33,5%										
12	34,3%	32,7%	31,8%	31,8%	31,6%	30,3%	33,5%											
13	30,8%	29,6%	29,5%	29,8%	29,7%	28,0%												
14	28,5%	27,6%	27,8%	27,9%	28,0%													
15	26,7%	26,4%	26,1%	26,1%														
16	25,2%	24,6%	24,4%															
17	23,7%	23,3%																
18	22,4%																	

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

There are also clear disparities between regions, in particular between Norte and Centro, in terms of median duration survival (Figure 6). The median duration of firms at the regional level is below seven years for most regions, except for Centro (around the eight year).

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[10].

Figure 6 – Smoothed hazard estimate by NUTII, 1987-2005
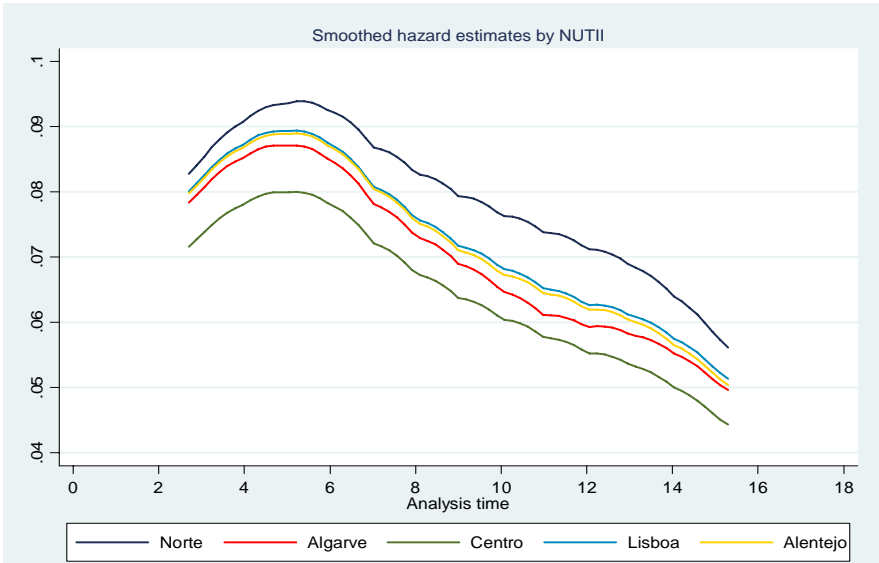
Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.

5. A Semi-Parametric Survival Analysis

Both seminal and the most recent literature agrees that size affects the survival rates of new firms (Mata et al., 1995; Mata and Portugal, 1994; López-Garcia and Puente, 2006; Fariñas and Moreno, 2000). This generated one of the most striking stylized facts in the literature of industry dynamics (Audretsch and Mahmood, 1994; Bartelsman et al., 2005a and 2005b; Robinson et al. 2006; Sharpe and Currie, 2008). The fact that small firms are less likely to survive and that tend to grow faster than their large counterparts (once survival bias has been controlled for) has already been confirmed by empirical evidence in different countries.

Several studies have reported that the probability of firms exiting the market decreases with initial size. According to the literature, there are several reasons behind the importance of initial size for survival. The most prevalent relate to the efficient scale needed to operate efficiently in a market, to the capital intensity production technology, to the firms' capacity to access financial markets and to the "inferior" management ability of small entrepreneurs. Regarding the first reason, Audretsch and Mahmood (1994) have considered that larger firms are more likely to be

---

[10] 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. This piece of evidence is not included in the present work, but is available at request.

closer to the necessary minimum efficient scale to operate efficiently in a market. Even if larger firms find themselves to be less efficient than they had expected, they may become smaller before they exit the market (Mata and Portugal, 2004). Additionally, larger firms diversify more than smaller ones, enabling them to better adjust to fluctuations in the demand for individual products (Ungern-Sternberg, 1990), which also contributes to reduced market risks. Thus, diversification as well as flexibility can both be expected to raise the probability of survival.

Moreover, the stock of capital accumulated by firms should also be considered. Small firms are less capital intensive, so variable costs represent a larger share of capital costs. Thirdly, internal financial constraints and internal capital markets imperfections are also commonly pointed out as reasons for the smaller size of entrants. Firms enter small, not because they choose to, but because new firms under invest as they are financially constrained, which leads to a negative impact on firms' survival probabilities (López-Garcia and Puente, 2006). Lastly, the entrepreneur's management ability. Being an entrepreneur has higher opportunity costs when the economy's wages grow, and lower quality managers are more likely to miscalculate their true value label (Mata and Portugal, 2004).

Mata, Portugal and Guimarães (1995) and Geroski, Mata and Portugal (2003) stress the previous observations concerning to the importance of initial firm size in explaining the survivor probability of firms. However, they argue that current size is a better predictor of failure than initial size. After controlling for initial size, measuring current size amounts to measuring firm performance. According to them, the fact that a firm has grown is the past, signals that it has been performing well and therefore its probability of exit is low. Moreover, Mata, Portugal and Guimarães´s (1995) findings indicate that after controlling for size differences, past growth does matter for survival, suggesting a partial adjustment process of firm size in the post-entry period. Although accepting their arguments López-Garcia and Puente (2006) highlight the fact that current size could be endogenous to the firm dynamics, since firms that are about to abandon the market, grow smaller before exiting and vice-versa. Considering Spanish manufacturing firms, Fariñas and Moreno (2000) conclude that there is a downward trend in the failure rate as firm size increases and that there are significant differences in failure rates across size, age and interactions of size on age.

5.1. Modeling with the Cox Proportional Hazard Model

In this section, we provide an overview the theoretical foundations of the Cox Proportional Hazard Model.

The statistical representation of the relation between the survival time of a firm and specific variables is known as the hazard rate model of the duration of the life of a firm. According to the model a given firm j faces a hazard rate (h_j) that is a function of a baseline hazard rate (h_0), which all firms face, transformed by a set of explanatory variables (X) through a vector of parameters (β). The hazard rate model can be written in the form:

$$h_j(t) = f\left(h_0(t), \phi(X, \beta)\right)$$

(5)

In this model, two firms with the same birth date will face a different hazard function if, and only if, their other characteristics are different. By definition, the model seems a natural solution to understand the temporal pattern of survival and to identify the covariates that could be related

significantly to survival. Additionally, it is also a good solution for working with longitudinal datasets, characterized by right censored data and other types of selection issues.

An empirical application of the model implies the specification of a functional form for the hazard function. One of the most common options is the proportional hazard model, given by:

$$h_j(t) = h_0(t)\phi(X,\beta) \tag{6}$$

The name derives from the fact that the hazard that a firm faces is proportional to the baseline hazard. In other words, the shape of the hazard function is the same for all individuals, and variations in the explanatory variables will translate into parallel displacements of this function, thereby affecting only the scale of the hazard function and not its shape. Given the fact that the hazard is a conditional probability and, therefore, must be positive, a convenient functional form for $\phi(X,Y)$ is exponential. Hence the hazard a subject j faces is written in the following form:

$$h_j(t) = h_0(t)e^{(X,\beta)} \tag{7}$$

Note that this particular functional form offers the advantage of a very convenient interpretation of the estimated coefficients, since $\beta = \dfrac{\partial \ln \phi(X,\beta)}{\partial X}$. This means that the coefficient of one explanatory variable is the constant proportional effect of a unit increase of this variable on the conditional probability of exiting.

The assumption made for the functional form of $\phi(X,Y)$ is widely accepted, while it is not so for the functional form of the baseline hazard, since different parametric specifications of the hazard function display different duration dependence behaviors. Positive (negative) duration dependence implies that the likelihood of failure at time t, conditional on the duration up to t, is increasing (decreasing) in t. *A priori* it is not obvious which distribution is most appropriate even when economic theory provides some clues concerning the way the baseline hazard varies over time. In case of doubt, one line of action to consider is to make no assumption about the functional form of the baseline hazard. Such a method was first suggested by Cox (1972) and the resulting models are called semi-parametric. Cox (1972) also suggested that the proportional hazard model could be easily extended to account for time varying covariates. This is what we will approach next.

The model incorporates the main features of discrete duration models, as described by Lancaster (1990), where the logarithm of the probability that a firm exits at time t given that it survived in $t-1$ is explained by a series of explanatory covariates X_{t-1} plus a set of parameters identifying the baseline hazard function, according to the following specification:

$$\log h(t \mid x_t, x_0) = \lambda_t + \beta x_t + \gamma x_0, \text{ for } t = 1,...,k \tag{8}$$

The use of the partial likelihood function does not require that $h_o(t)$ must be specified, which allows the estimation of β and γ and avoids the risk of misspecifying the baseline hazard function. The model described previously, considers two types of heterogeneities that may cause exit, and that need to be considered: current heterogeneities between firms, that is heterogeneities based on differences that exist in period t, and heterogeneities that occur from differences that existed in the moment when firms were created (t=0). Heterogeneities due to differences in founding conditions include those conditions that are cohort specific, i.e., which take a common

value for all firms in the same cohort, such as macroeconomic or industry-wide factors and those which are firm-specific (Baptista and Mendonça, 2007).

In our case (e.g. as in López-Garcia and Puente, 2006) the survival is a continuous phenomenon, but the available information is reported annually in the month of October, transforming time in a discrete variable. To circumvent this, we have grouped the data, by creating 11 interval specific dummy variables (one for each spell year at risk) and will be using a discrete hazard model. The most common discrete time representation of an underlying continuous time Cox proportional hazard model is the complementary log-log (cloglog model), which is what will be used in the following estimations. The major advantage of using the hazard model is that each firm contributes several times to the likelihood function, each time it is at risk.

5.2. Explanatory Variables

We have considered seven explanatory variables for the semi-parametric approach, beyond sector and year dummies (Table 9), which will be briefly described next.

Table 9 – Explanatory Variables Considered in the Model

Variable	Definition	Measurement
Start-up Size	Number of employees at the birth year of the firm.	Logarithm of the number of employees.
Current Size	Number of employees at the current year.	Logarithm of the number of employees.
Industry Entry Rate	Industry entry rate calculated for sectors defined at a 2-digit CAE level.	Logarithm of the industry entry rate, defined as the number of entrants divided by the total number of firms in industry.
Concentration (HHI)	Herfindhal-Hirschman Index (HHI) calculated for industries at a 2-digit CAE level.	Logarithm of the HHI.
Growth	Logarithmic difference of industry employment in two consecutive periods.	Logarithm of the number of employees at year t minus the logarithm of the number of employees at year $t-1$.
Entry Rate x Growth	Interaction variable, defined as the product of entry and growth.	Product of logarithms.
Turbulence	Sum of entry and exit rates calculated for sectors defined at a 2-digit CAE level.	Sum of logarithms of the industry entry rate with the industry exit rate.
Sector Dummies	Dummies for 4 broad sectors: Agriculture, Construction, Manufacturing and Services.	
Regional Dummies	Dummies for 7 NUTII regions: Norte, Centro, Lisboa e Vale do tejo, Alentejo, Algarve, Açores and Madeira	
Year Dummies	Dummies for each current year.	

Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.
Note: * The literature has shown that there is a non linear effect of the start-up size on survival, which is normally accounted for via a log transformation. The specification is reasonable given that the value of the likelihood increases.

The first explanatory variable is the firm start-up size. It is measured by the logarithm of the number of employees at the firm's year of birth. A negative influence on the hazard rate is expected, i.e., larger start-ups should face a reduced risk of survival.

The second variable relates to the number of employees reported at the year of measurement.

Besides these two firm characteristics, the specific conditions of the industry are likely to affect firm survival (López-Garcia and Puente, 2006). Among the measures of firm dynamics is important to control for industry entry and growth rate and its degree of competition. Thus, the third variable has to do with the firm's entry rate. New firms are more likely to live longer if they enter expanding industries or industries with low entry activity (Mata et al., 1995).

Another important industry characteristic is the degree of competition, which is measured through the Herfindhal-Hirschman Index (HHI). Highly concentrated industries may allow suboptimal scale of new firms and therefore give some room for survival after entry. On the other hand, according to the industrial organization literature, highly concentrated industries might as well represent a higher potential for incumbent's collusion and therefore a more aggressive behaviour towards new entries (Mata and Portugal, 1994; López-Garcia and Puente, 2006).

By definition, at start-up there is no post-entry growth. The effect of growth can only be perceived as firms' age and current size shifts from initial size. At any time after start-up, current size can be viewed as initial size plus the change in size which occurred. As size is measured in logs, this change is the cumulative growth rate since start-up. Therefore after controlling for the effect of start-up size, the coefficients associated with the current provides an estimate of the effect of the post-entry growth (Mata et al., 1995).

A positive correlation between firm size and survival is expected, as predicted by the learning literature (Jovanovic, 1982; Ericson and Pakes, 1995) and shown by empirical evidence (Callejón and Ortun, 2009).

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. The sum of birth and death rates (Eurostat/OECD, 2007) is the chosen indicator for the measurement of turbulence.

There may well be differences in survival rates between industries over and above those captured by the industry-specific variables mentioned above. For this reason industry dummy variables are also included in the analysis. Finally, since the overall state of the economy has long been indicated as an important force driving firms out of business, we include year dummies, to proxy the moment of the cycle and, therefore, control for the macroeconomic environment (López-Garcia and Puente, 2006; Mata et al., 1995).

5.3. Estimation Results for the Portuguese Regions

The same cloglog regression estimation process was conducted for Portugal and for its seven NUT II regions, for the period 1995 to 2005[11]. The determinants considered for explaining regional survival behavior are the variables described in the previous section. All the models control for structural effects, through industry dummies and for macroeconomic effects, through year dummies[12].

The values presented in Table 10 correspond to the hazard ratios, that is, the ratio of hazard rate when the variable increases by the one unit. A hazard ratio over one implies that an increase in the given explanatory variable increases the probability of exit and, correspondingly, a hazard ratio below one means that an increase in the variable decreases the hazard.

Since the number of firms in each region is quite diverse, ranging from 164 599 firms in the Norte to 7 523 firms in Açores, the conclusions are not straightforward when we take into consideration the absolute values of the coefficients. Therefore, the analysis must rely more on the overall results than on the absolute values of the hazard coefficients.

As argued in the literature and mentioned previously, the start-up size of a firm improves the chances of survival. However, this is not apparent from Table 10. These results show hazard ratios which are greater than one, not only for the total economy but also for each region, as the model does not isolate the effects of initial firm size from the effects of current firm size. When the hazard ratios for the variable that proxies current size are considered, the effect of a firms' current size seems to be predominant. This effect can not be observed in the table, since it does not detail the common cloglog estimators, but only the hazard ratios. However, when introducing the sum of the start-up and the current size (by denoting S_0 and S_t the initial and current size, respectively, and α and β the correspondent coefficients, the effect of size is expressed by $\alpha S_0 + \beta S_t$), it becomes evident that the current size improves the chances of survival and that the initial size does not. This effect is observed for all Portuguese regions and is consistent with the results of Mata, Portugal and Guimarães (1995). According to the previous authors, firms that have started smaller and have experienced faster post-entry growth, do face a higher probability of survival.

International studies also indicate that in industries characterized by high entry rates at the moment of birth, post-entry survival becomes harder. Firms that experience more competition from entrants, have a higher probability of failure. This is also observed for Portugal and for the country's NUT II regions. However, this is particularly enhanced in regions where the entrepreneurial background is not as developed as those of other regions[13] (Açores) and in those dominated by sectors which do not pose high entry barriers to new firms, such as services (Madeira, Algarve and Lisboa). From 2000 to 2007, Algarve (6,7%) and Madeira (4,4%) displayed the greatest annual average growth rates in active employer enterprises (Table 1).

---

[11] The regional disaggregation is only provided after 1995 due to the introduction of the System of European Accounts in 1995 and up to 2006 due to the problems of compatibility with the Portuguese Classification of Economic Activities (CAE Rev. 3) after 2007. We only estimate until 2005 given that the Eurostat/OECD methodology requires checking for reactivations in the two following years before an enterprise is actually considered to be "dead".

[12] The year dummies values have been introduced but the values are not shown, as no clear pattern is discernible from the estimated coefficients, as is usually the case (Mata et al., 1995).

[13] It is a widely held belief that urban settings and metropolitan areas offer more favourable incubator conditions for the emergence of creative entrepreneurs, as there are more favourable conditions for human resource training and management and better labour recruitment (Davelaar, 1991).

Algarve is also systematically the region with the highest birth rates in Portugal[14] and Madeira is within the three regions with the highest birth rates throughout the period. Moreover, Madeira, Algarve and Lisboa are regions where service firms are relatively more predominant.

Table 10 - Estimation Results for the Total Economy and for each one of the seven Portuguese NUT II Regions

Variables	Portugal	Regions						
		Norte	Centro	Lisboa	Alentejo	Algarve	Açores	Madeira
Log of start-up size	1.334***	1.310***	1.342***	1.414***	1.250***	1.286***	1.139***	1.267***
	(0.007)	(0.011)	(0.016)	(0.014)	(0.023)	(0.028)	(0.041)	(0.044)
Log of current size	0.459***	0.479***	0.418***	0.463***	0.451***	0.444***	0.501***	0.440***
	(0.002)	(0.004)	(0.005)	(0.004)	(0.008)	(0.009)	(0.018)	(0.014)
Industry (2 digit) start-up entry rate	1.24***	1.233***	1.181***	1.160***	1.515***	1.290***	1.429***	1.613***
	(0.018)	(0.028)	(0.038)	(0.032)	(0.077)	(0.08)	(0.152)	(0.164)
Start-up industry HHI (2 digit)	0.988***	0.986***	0.986***	0.992***	0.988**	0.997	1004,0	0.975***
	(0.001)	(0.002)	(0.003)	(0.003)	(0.005)	(0.006)	(0.011)	(0.009)
Turbulence rate	5.29***	11.444***	3.664***	3.406***	1.698***	3.574***	1.285	14.441***
	(0.222)	(0.791)	(0.344)	(0.336)	(0.22)	(0.699)	(0.341)	(4.792)
Industry Growth (log)	1.122***	1.087***	1.140***	1.159***	1.144**	1.113*	1.326**	1.036
	(0.018)	(0.029)	(0.044)	(0.036)	(0.065)	(0.07)	(0.146)	(0.104)
Growth x Entry rate	1.082***	1.069**	1.116***	1.091***	1.083	1.015	1.272**	1.033
	(0.017)	(0.028)	(0.042)	(0.033)	(0.061)	(0.065)	(0.141)	(0.109)
Sector dummies								
Agriculture	0.612***	0.443***	0.706***	0.643***	0.795***	0.823*	1.178*	0.841
	(0.01)	(0.016)	(0.024)	(0.033)	(0.034)	(0.069)	(0.11)	(0.156)
Construction	0.895***	0.858***	0.931***	0.919***	1.155***	1.013	1.742***	1.343***
	(0.009)	(0.012)	(0.021)	(0.023)	(0.049)	(0.616)	(0.18)	(0.116)
Manufacturing	(a)	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Services	0.705***	0.631***	0.770***	0.799***	0.884***	0.869**	0.905	0.792***
	(0.006)	(0.007)	(0.015)	(0.017)	(0.032)	(0.048)	(0.077)	(0.062)
Regional dummies								
Norte	(a)	-----	-----	-----	-----	-----	-----	-----
Centro	0.847***	-----	-----	-----	-----	-----	-----	-----
	(0.006)							
Lisboa	1.027***	-----	-----	-----	-----	-----	-----	-----
	(0.007)							
Alentejo	0.926***	-----	-----	-----	-----	-----	-----	-----
	(0.01)							
Algarve	0.939***	-----	-----	-----	-----	-----	-----	-----
	(0.011)							
Açores	0.942***	-----	-----	-----	-----	-----	-----	-----
	(0.02)							
Madeira	1.014	-----	-----	-----	-----	-----	-----	-----
	(0.019)							
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of firms	447772	164599	97606	109405	33692	25802	7523	9140
LR X2 (34) / LRX2 (28) for regions	47329.9***	17871.03***	10705.95***	11192.01***	3695.93***	2698.05***	860.98***	1421.47***
Log likelihood	-422915.7	-152494.34	-91424.886	-106768.52	-33112.584	-23204.949	-6.744.716	-8283.6

Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS. Notes: (a) refers to the reference sector; The year dummies "yes" means that they have been included in the estimation; Standard deviation is shown in brackets and *. **, *** means, respectively, 10, 5 and 1% level of significance.

---

[14] The Algarve is systematically the region with the highest birth rates in Portugal. In 2007, this region had a birth rate of 15,3%, compared to a national birth rate of 12,6% (in 2001 there was a 4,3 p.p. difference relatively to the national average).On the other hand, the Açores archipelago has had smaller birth rates than the country's average over this period (Sarmento and Nunes, 2010c).

A high entry rate combined with fast growth rates for any given industry generates, in general, a shorter duration of firms (Mata, et al., 1995; Gort and Klepper, 1982). This somehow expected piece of evidence can also be drawn from these results, even if statistical significant estimators are not obtained for some of regions (Algarve, Alentejo and Madeira). It might seem easier to enter the market in earlier stages of the product life-cycle, when markets are expanding, but it becomes particularly difficult to survive. It is particularly so in the Açores archipelago, in Centro, Lisboa and Norte.

HHI estimation results for concentration influence on survival probabilities do not provide very disparate conclusions at the regional level, except for the Açores, where the small entrepreneurial fabric in terms of number and firm average size, might be relatively more susceptible to firm concentration.

These results have stressed the literature's conclusions so far. However, the effect of industry growth is at odds with the mainstream results in the literature. One would expect that firms operating in industries with faster growth would suffer from a smaller probability of failure, since they can penetrate the market without harming the competitors, but the estimation results show otherwise. In order to help shedding light over this result, it should be pointed out that industries in the early stages of their life-cycles usually register high rates of entry and exit (Agarwal and Gort, 1996; Baptista and Karaoz, 2007). In general, industries with higher than average entry rates also exhibit higher than average exit rates (Cabral, 2007), due to birth and death rates being highly correlated across industries, corroborating the idea that "entry barriers are exit barriers" (Mata et al., 1995). The combined effect of entry and growth can explain this unexpected effect of industry growth on survival probabilities. Industries experiencing higher growth rates are also more turbulent, registering high rates of entry and also of exit (the "revolving door" at work), thus decreasing the likelihood of survival.

Next, Table 11 shows the pair wise correlation for the explanatory variables for the all Portuguese economy. The correlation between turbulence (sum of the entry and exit rates) and growth rate is positive (58%) and statistically significant at 5% confidence level, corroborating the previous argument. These results can be extended to the Portuguese regions, underlining that turbulence is indeed a major driver of Portuguese firms´ survival chances.

Table 11 – Correlation Matrix

	Log of Start-up Size	Log of Current Size	Industry (2digit) start–up entry rate	Start-up Industry HHI (2 digit)	Log of Industry Growth	Growth X Entry rate	Turbulence
Log of Start-up Size	1						
Log of Current Size	0.8253*	1					
Industry (2digit) start–up entry rate	0.0570*	0.1036*	1				
Start-up Industry HHI (2 digit)	0.1122*	0.1417*	0.6323*	1			
Industry Growth (log)	0.0523*	-0.0409*	0.3552*	0.2619*	1		
Growth x Entry rate	---	---	0.0044*	---	-0.0383*	1	
Turbulence	0.0268*	-0.0571*	0.5349*	0.3057*	0.5797*	---	1

Source: Own calculations based on *Quadros de Pessoal*, GEP, MTSS.
Note: * refers to the correlations coefficients with 5% statistical significance.

From Table 10, it is also possible to conclude that the turbulence rate exhibits the most significant effect when considering other determinants in the model, such as firm and market characteristics. For all the regions, with the exception the Açores[15], where there is no statistical significance, those that have the highest record of firm turbulence, also display the lowest business survival probabilities. Turbulence decreases severely the survival probabilities of firms located in Madeira and Norte and to a lesser extent in the Algarve. The hazard ratios obtained range from around 14.5 % in Madeira to 1.2% in Açores. The Açores display a lower entrepreneurial turbulence than the country's average for most of the years up to 2005 (GEE, 2010b) and the lowest regional churn rates, factors accruing to explaining the lowest regional hazard ratio. From 1987 to 2005, the Algarve shows the greatest churn rate (32.5%) in the country, followed by Norte (29.9%). Norte has the highest hazard rate within the continental regions (11,5%) and possesses clear regional specificities (INE, 2009; Nunes and Sarmento, 2010c), showing one of the highest regional rates of turbulence (Table 2). Madeira in turn, has 28.6% for firm churn in the 1987-2005 period, but has the second greatest from 2001 (Table X). Turbulence is in fact the most significant determinant in the survival probabilities of Portuguese firms in all regions, notably in the Norte.

A known stylized fact is that turbulence is usually higher in services than in the manufacturing sector (Bartelsman et al., 2005). For the period 2005 and 2006, the Eurostat/OECD (2009) observes that birth (and death) rates are significantly higher in the service sector for the vast majority of countries. This is also the case in Portugal[16] (Sarmento and Nunes, 2010c). Despite this fact, manufacturing is the sector whose firms have the biggest probability of exiting from the market. Concerning the model's sector dummies, all regions, with the exception of the archipelagoes of Madeira and Açores, show similar results. Norte shows a lower hazard probability rate relatively to manufacturing, when compared to the remaining regions, indicating lower survival chances for industrial firms, already diagnosed by the non-parametric analysis and by the firm demography analysis (GEE, 2010c; Sarmento e Nunes, 2010c). Manufacturing is in fact, the sector where firms are more likely to abandon the market in general, but in particular in the north of the country.

In the estimation of the regional components for the total economy, we can observe disparities among regions. When compared to firms in the Norte, only firms located in Lisbon show a higher probability of exiting the market.

6. Final Remarks

Entrepreneurship has acquired a greater level of importance among the critical success factors that shape regional economic change. Regional growth is very much a product of its human capital, R&D, knowledge-spillovers, networks, industrial culture and last but not least, smart public policy. But it is no less a product of entrepreneurial activity and firm ability, in which the entry of newly created firms results in increased innovation, competition and job creation and the growth of surviving of firms assures a stable pool of employment and value added generation.

Regions face two main imperatives in a globalised and market-driven society, the increase of social welfare through job creation and economic development, brought about by structural change and productivity improvements. As there are usually large sectoral and geographical

---

[15] As regiões autónomas apresentam resultados sensivelmente distintos das regiões de Portugal continental, pois apresentam características na demografia empresarial distintas das restantes regiões do país (GEE, 2010; Sarmento e Nunes, 2010).
[16] Manufacturing churn was 28.4% in 2000 and 18.5% in 2006 and Services churn was 32.4 % in 2000 and 25.7% in 2006.

variations among the success and survival rates of new firms, entrepreneurial adjustment as a consequence of the cycles of enterprise birth, growth and survival is of decisive importance to structural change and for the triggering of converging or diverging patterns in regional systems.

The last decades of the 20th century were characterized by a period of creative destruction in Portugal. In particular, regions such as Norte, Algarve and Madeira show the highest growth rates in enterprise births and deaths but also of firm churn. After 2000, a new tendency seems to emerge, where both births and deaths of employer enterprises are relatively less turbulent. This is verified for all regions, sectors and size classes.

The decreasing average size of entrants and exiters in the market occurring during this almost 20 year period, visible in all sectors and regions can also be considered as major factor hindering firm survival in Portugal, especially in sectors more exposed to international competition.

In the non-parametric analysis for Portugal, we find that around 25% of enterprises entering the market fail within the first 2 years of activity and that more than 50% fail within a period of six years. Breaking down the analysis, we identify statistically significant disparities among regions. Norte has the lowest survival rate and Centro is where firms manage to survive longer. The survival gap between these two regions gets amplified over time.

In line with the literature, we also find that firms that start small and experience faster post-entry growth, face a higher probability of survival. Firm's current size dimension is extremely important in determining the probability of survival, particularly in the Norte and Açores. In industries characterized by high entry rates at the moment of a firm's birth, post-entry survival becomes harder. This happens mostly in the south and in the Portuguese archipelagoes, the regions with the lowest number of active employer enterprises. A higher entry rate combined with fast growth rates for any given industry also generates a shorter duration of firms. It might seem easier to enter the market in earlier stages of the product life-cycle, when markets are expanding, but it becomes particularly hard to survive. Firms that experience more competition from entrants, also face higher probabilities of failure.

However, there is a different result from the literature, for the effect of industry growth in survival rates. Firms operating in industries which are growing faster seem to suffer from a higher probability of failure. The combined effect of entry and growth helps clarifying this unexpected effect of industry growth on survival probabilities. It is related to turbulence and the high rates of entry and exit verified in most the Portuguese regions throughout this period. Turbulence is in fact the most significant determinant of survival probabilities of Portuguese employer enterprises, particularly in the north of the country. Manufacturing is the sector where more firms are more likely to abandon the market, particularly in Madeira and Norte.

References

Acs, Z. J. (1996), "Small Firms and Economic Growth", in P. H. Admiraal (ed.), Small Business in the Modern Economy, De Vries Lectures in Economics, Oxford, U.K.: Blackwell Publishers.

Acs, Z., Desai, S. and Klapper, L. (2008), "What does "Entrepreneurship" Data Really Show?, a Comparison of the Global Entrepreneurship Monitor and the World Bank Group Datasets", World Bank, Policy Research Working Paper Series 4467.

Acs, Z. J. and Audretsch, D. B. (1993), "Conclusion", in Z. J. Acs and D. B. Audretsch (eds.), Small Firms and Entrepreneurship: an East-West Perspective, Cambridge, U.K.: Cambridge University Press.

Audretsch, D. (1995), "Innovation, Growth and Survival", International Journal of Industrial Organization, n. 13, 441-457.

Audretsch, D. B. and Mahmood, T. (1994), "The Rate of Hazard Confronting New Firms and Plants in U.S. Manufacturing", Review of Industrial Organisation, vol. 9, 41-56.

Audretsch, D., Santarelli, E. and. Vivarelli, M. (1999), "Start-up size and industrial dynamics: some evidence from Italian manufacturing," International Journal of Industrial Organization, Elsevier, vol. 17(7), 965-983, October.

Baptista, R., Escária, V. and Madruga, P. (2008), "Entrepreneurship, Regional Development and Job Creation: the Case of Portugal." Small Business Economics, n. 30, 49-58.

Baptista, R. and Carias, C. (2007), "Job Creation and Destruction by Small Businesses in the Portuguese Regions", IN+, presented at the European Regional Science Association, ERSA 2007.

Baptista, R. and Mendonça, J. (2007), "Short and Long Term Survival of New Businesses: the Role of Human Capital", IN+, Draft version of 2007.

Bartelsman, E.J., Scarpetta, S. and Schivardi, F. (2005a), "Comparative Analysis of Firm Demographics and Survival: Evidence from Micro-level Sources in OECD Countries", Industrial and Corporate Change, vol. 14, n. 3, 365–391.

Bartelsman, E. J., Haltiwanger, J. and Scarpetta, S. (2005b), "Measuring and Analyzing Cross Country Differences in Firm Dynamics," (co-authored with Eric Bartelsman and Stefano Scarpetta), in Producer Dynamics: New Evidence from Micro Data, (Dunne, Jensen and Roberts, eds.) NBER/University of Chicago Press.

Bhattacharjee, A. (2005), "Models of Firm Dynamics and the Hazard Rate of Exits: Reconciling Theory and Evidence using Hazard Regression Models," Econometrics 0503021, EconWPA.

Brito, P. and Mello, A. (1995), "Financial Constrains and Firm Post-Entry Performance", International Journal of Industrial organization, n.13, 543-566.

Boschma, R. and Frenken, K. (2006), "Applications of Evolutionary Economic Geography", Nº 06-26, DRUID Working Papers, DRUID, Copenhagen Business School.

Boschma, R. and Frenken, K. (2002), "Why is economic geography an evolutionary science?", ERSA conference papers, European Regional Science Association.

Cabral, L. (2007), "Small firms in Portugal: A selective Survey of Stylized Facts, Economic Analysis and Policy Implementation", Portuguese Economic Journal, vol. 6, n. 1, 65-88.

Cabral, L. and Mata, J. (2003), "On the Evolution of the Firm Size Distribution: Facts and Theory", The American Economic Review, vol. 93, n. 4, 1075 - 1090.

Callejon, M. and Ortún, V. (2009), "The black box of business dynamics" Document de treball XREAP 2009-7, Xarxa de referència en economia aplicada.

Carree, M., A. van Stel, R. Thurik and S. Wennekers (2002), "Economic development and business ownership: an analysis using data of 23 OECD countries in the period 1976-1996", Small Business Economics 19, 271-290.

Caves, R.E. (1998), "Industrial Organization and New Findings on the Turnover and Mobility of Firms", Journal of Economic Literature 36: 1947-1982.

Colantone, Italo and L. Sleuwaegen (2008), "Entry and exit of firms in a global economy: a cross-country and industry analysis," Vlerick Leuven Gent Management School Working Paper Series 2007-36, Vlerick Leuven Gent Management School.

Cox, D. R. (1972), "Regression Models and Life Tables", Journal of the Royal Statistical Society, Series B, vol 34, n. 2, 187-202.

Davelaar, E. J. (1991), "Incubation and innovation: a spatial perspective", Ashgate, Aldershot.

Dunne, T., Roberts, M. J. and Samuelson, L. (1989), "The Growth and Failure of U.S. Manufacturing Plants," The Quarterly Journal of Economics, MIT Press, vol. 104, n. 4, 671-98, November.

Ericson, R. and Pakes, A. (1995), "Markov-Perfect industry dynamics: a framework for empirical work", Review of Economic Studies 62, 53-82.

Eurostat/OECD (2007), "Eurostat/OECD Manual on Business Demography Statistics".

Eurostat (2009), "Business Demography: employment and survival", Statistics in focus, nº 70/2009.

Fariñas, J. C. and Moreno, L. (2000), "Firms´ growth, size and age: a nonparametric approach", Review of Industrial Organization, 17, 249-265.

Fischer, M. M. and Nijkamp, P. (2009), "Entrepreneurship and regional development", Serie Research Memoranda 0035, VU University Amsterdam, Faculty of Economics, Business Administration and Econometrics.

GEE (2010a), "Síntese Estatística da Dinâmica Empresarial", Gabinete de Estratégia e Estudos do Ministério da Economia, da Inovação e do Desenvolvimento.

GEE (2010b), "Síntese Estatística da Dinâmica Empresarial: Região Açores", Gabinete de Estratégia e Estudos do Ministério da Economia, da Inovação e do Desenvolvimento.

GEE (2010c), "Síntese Estatística da Dinâmica Empresarial: Região Norte", Gabinete de Estratégia e Estudos do Ministério da Economia, da Inovação e do Desenvolvimento.

Geroski, P. (1995), "What do we know about entry?", International Journal of Industrial Organization, vol. 13, 421-440.

Geroski, P.A., Mata, J. and Portugal, P. (2003), "Founding Conditions and the Survival of New Firms", DRUID Working Paper n. 07-11.

Gort, M. and Klepper, S. (1982), "Time Paths in the Diffusion of Product Innovations", Economic Journal, n. 92, 630-653.

Hannan, M. T. and Freeman, J. (1989), Organizational Ecology, Cambridge, MA: Harvard University Press.

Instituto Nacional de Estatística (2009), "Demografia de Empresas 2004-2007, O Empreendedorismo em Portugal - Indicadores sobre a Demografia das Empresas", Destaque.

INE (2009), "Anuários Estatísticos Regionais-Informação estatística à escala regional e municipal, 2008", Destaque, Instituto Nacional de Estatística, 26 de Novembro de 2009.

Jovanovic, B. (1982), "Selection and evolution of industry", Econometrica, vol. 50, n. 3, 649-670.

Klapper, L., Amit, R. and Guillén, M. (2008), "Entrepreneurship and firm formation across countries" The World Bank Policy Research Working Paper Series 4313.

Klapper, L., Lewin, A. and. Delgado, J. M.Q. (2009), "The impact of business environment on the business creation process", The World Bank Policy Research Working Paper Series 4937.

Lancaster, T. (1992), The Econometric Analysis of Transition Data, Cambridge University Press.

López-Garcia, P. and Puente, S. (2006), "Business demography in Spain: determinants of firm survival", Documentos de Trabajo n. 608, Banco de España.

Loveman, G. and Sengenberger, W. (1991), "The Re-emergence of Small-Scale Production: an International Comparison", Small Business Economics, 3, 1–37.

Masso, J., R. Eamets and K. Philips (2004) ,"Creative Destruction and Transition: The Effects of Firm Entry and Exit on Productivity Growth in Estonia", Discussion Paper Series, Institute for the Study of Labor (IZA).

Mata, J. (1993), "Entry and type of entrant: evidence from Portugal", International Journal of Industrial Organization, vol 11, n. 1, 101-122.

Mata, J. and Machado, J. (1996), "Firm start-up size: a conditional quantile approach", European Economic Review, vol 40, 1305-1323.

Mata, J. and Portugal, P. (1994), "Life Duration of New Firms", The Journal of Industrial Economics vol 42, n. 3, 227-245.

Mata, J., Portugal, P. and Guimarães, P. (1995), "The survival of new plants: Start-up conditions and post-entry evolution", International Journal of Industrial Organization, n.13, 459-481.

Nelson, R. R., and Winter, S. G. (1982), An Evolutionary Theory of Economic Changes, Cambridge MA: Harvard University Press.

Nunes, A. and Sarmento, E. de Morais (2010a), "Business demography dynamics in Portugal: a semi-parametric survival analysis", GEMF Working Papers, n. 9/2010, Universidade de Coimbra.

Nunes, A. and Sarmento, E. de Morais (2010b), "Business demography dynamics in Portugal: a non-parametric survival analysis", GEMF Working Papers, n. 10/2010, Universidade de Coimbra.

Nunes, A. e Sarmento, E. de Morais (2010c), "Análise comparativa de sobrevivência - o caso da região Norte de Portugal", Actas do 16º Congresso da Associação Portuguesa de Desenvolvimento Regional, Funchal, 661-679.

Núñez, S. R. (2004), "Salida, entrada y tamaño de las empresas españolas", Boletín económico, Banco de España, n. 3, 53.

OECD/Eurostat (2009), "Measuring Entrepreneurship A Collection of Indicators 2009 Edition", OECD-Eurostat Entrepreneurship Indicators Programme.

Pellenbarg, P. H. and van Steen, P. J.M. (2003), "Spatial Perspectives on Firm Dynamics in The Netherlands," Tijdschrift voor Economische en Sociale Geografie, Royal Dutch Geographical Society KNAG, vol. 94(5), 620-630, December.

Robinson, C., O´Leary, B., Rincon, A. (2006), "Business start-ups, closures and economic churn, a review of the literature", National Institute of Economic and Social Research, Final Report prepared for the Small Business Service, 23rd August of 2006.

Sarmento, E. Morais and Nunes, A. (2010a), "Getting smaller: size dynamics of employer enterprises in Portugal", presented in the II International Workshop Entrepreneurship Culture and Finance, Spain.

Sarmento, E. de Morais and Nunes, A. (2010b), "Criação de Empresas em Portugal e Espanha: Análise Comparativa com Base nos Dados do Banco Mundial", Boletim Mensal de Economia Portuguesa, Ministério da Economia, da Inovação e do Desenvolvimento e Ministério das Finanças e da Administração Pública, July 2010.

Sarmento, E. de Morais and Nunes, A. (2010c), "Entrepreneurship Performance Indicators for Active Employer Enterprises in Portugal", Temas Económicos nº 9, Ministério da Economia, da Inovação e do Desenvolvimento.

Scarpetta, S., Hemmings, P., Tressel, T. and Woo, J. (2002), "The role of policy and institutions for productivity and firm dynamics", OECD Economics Department Working Papers, n. 329.

Siegfried J. and Evans L. (1994), "Empirical studies of entry and exit: a survey of the evidence", Review of Industrial Organization, 9, 121–156.

Sharpe, A. e Currie, I. (2008), "Competitive Intensity as Driver of Innovation and Productivity Growth: A Synthesis of the Literature", CSLS Research Reports 2008-3, Centre for the Study of Living Standards.

Storey, D. ed. (1994), Understanding the small business sector, Thomson Learning.

Thurik, A. R. (1999), "Entrepreneurship, Industrial Transformation and Growth", in G. D. Libecap (ed.), The Sources of Entrepreneurial Activity: Vol. 11, Advances in the Study of Entrepreneurship, Innovation, and Economic Growth, JAI Press, pp. 29–65.

Ungern-Sternberg, T. von (1990), "The flexibility to switch between different products", Economica 57, 355-69.

Van Dijk, J. and Pellenbarg, P. H. (1999), "Firm relocation decisions in The Netherlands: an ordered logit approach", Proceedings of the European Regional Science Association, ERSA.

Wagner, J. (1994), "The Post-Entry Performance of new Small Firms in German Manufacturing Industries", The Journal of Industrial Economics XLII., 125-131.

ESTUDOS DO G.E.M.F.

(Available on-line at http://gemf.fe.uc.pt)

2009-16 *The performance of the European Stock Markets: a time-varying Sharpe ratio approach*
- José A. Soares da Fonseca

2009-15 *Exchange Rate Mean Reversion within a Target Zone: Evidence from a Country on the Periphery of the ERM*
- António Portugal Duarte, João Sousa Andrade & Adelaide Duarte

2009-14 *The Extent of Collective Bargaining and Workplace Representation: Transitions between States and their Determinants. A Comparative Analysis of Germany and Great Britain*
- John T. Addison, Alex Bryson, Paulino Teixeira, André Pahnke & Lutz Bellmann

2009-13 *How well the balance-of- payments constraint approach explains the Portuguese growth performance. Empirical evidence for the 1965-2008 period*
- Micaela Antunes & Elias Soukiazis

2009-12 *Atypical Work: Who Gets It, and Where Does It Lead? Some U.S. Evidence Using the NLSY79*
- John T. Addison, Chad Cotti & Christopher J. Surfield

2009-11 *The PIGS, does the Group Exist? An empirical macroeconomic analysis based on the Okun Law*
- João Sousa Andrade

2009-10 *A Política Monetária do BCE. Uma estratégia original para a estabilidade nominal*
- João Sousa Andrade

2009-09 *Wage Dispersion in a Partially Unionized Labor Force*
- John T. Addison, Ralph W. Bailey & W. Stanley Siebert

2009-08 *Employment and exchange rates: the role of openness and technology*
- Fernando Alexandre, Pedro Bação, João Cerejeira & Miguel Portela

2009-07 *Channels of transmission of inequality to growth: A survey of the theory and evidence from a Portuguese perspective*
- Adelaide Duarte & Marta Simões

2009-06 *No Deep Pockets: Some stylized results on firms' financial constraints*
- Filipe Silva & Carlos Carreira

2009-05 *Aggregate and sector-specific exchange rate indexes for the Portuguese economy*
- Fernando Alexandre, Pedro Bação, João Cerejeira & Miguel Portela

2009-04 *Rent Seeking at Plant Level: An Application of the Card-De La Rica Tenure Model to Workers in German Works Councils*
- John T. Addison, Paulino Teixeira & Thomas Zwick

2009-03 *Unobserved Worker Ability, Firm Heterogeneity, and the Returns to Schooling and Training*
- Ana Sofia Lopes & Paulino Teixeira

2009-02 *Worker Directors: A German Product that Didn't Export?*
- John T. Addison & Claus Schnabel

2009-01 *Fiscal and Monetary Policies in a Keynesian Stock-flow Consistent Model*
- Edwin Le Heron

2008-08 *Uniform Price Market and Behaviour Pattern: What does the Iberian Electricity Market Point Out*
- Vítor Marques, Isabel Soares & Adelino Fortunato

2008-07 *The partial adjustment factors of FTSE 100 stock index and stock index futures: The informational impact of electronic trading systems*
- Helder M. C. V. Sebastião

2008-06 *Water Losses and Hydrographical Regions Influence on the Cost Structure of the Portuguese Water Industry*
- Rita Martins, Fernando Coelho& Adelino Fortunato

2008-05 *The Shadow of Death: Analysing the Pre-Exit Productivity of Portuguese Manufacturing Firms*
- Carlos Carreira & Paulino Teixeira

2008-04 *A Note on the Determinants and Consequences of Outsourcing Using German Data*
- John T. Addison, Lutz Bellmann, André Pahnke & Paulino Teixeira

2008-03   *Exchange Rate and Interest Rate Volatility in a Target Zone: The Portuguese Case*
      - António Portugal Duarte, João Sousa Andrade & Adelaide Duarte
2008-02   *Taylor-type rules versus optimal policy in a Markov-switching economy*
      - Fernando Alexandre, Pedro Bação & Vasco Gabriel
2008-01   *Entry and exit as a source of aggregate productivity growth in two alternative technological regimes*
      - Carlos Carreira & Paulino Teixeira

A série Estudos do GEMF foi iniciada em 1996.