DOCUMENT DE TREBALL

XREAP2009-7

The Black Box of Business Dynamics

María Callejón (PPRE-IREA)
Vicente Ortún

XARXA DE REFERÈNCIA EN ECONOMIA APLICADA

THE BLACK-BOX OF BUSINESS DYNAMICS[1]

María Callejón* (UB) and Vicente Ortún(UPF)**

September 2009

Contact:

Maria Callejón
Universitat de Barcelona (UB)
Facultat d'Economia i Empresa
Avda. Diagonal, 690
Despatx 6314
08034 Barcelona
maria.callejon@ub.edu

[1] This paper has benefited from the financial support of ECO2009-08735 (Spanish Ministry of Science and Innovation). It has benefited also from both authors' period (2009) as visiting scholars at Harvard University and MIT respectively.

[*] Professor of Economics, University of Barcelona. XREAP. [**]Professor of the Department of Business and Economics. University Pompeu Fabra (Barcelona).

Abstract

Research in business dynamics has been advancing rapidly in the last years but the translation of the new knowledge to industrial policy design is slow. One striking aspect in the policy area is that although research and analysis do not identify the existence of an specific optimal rate of business creation and business exit, governments everywhere have adopted business start-up support programs with the implicit principle that the more the better. The purpose of this article is to contribute to understand the implications of the available research for policy design.

Economic analysis has identified firm heterogeneity as being the most salient characteristic of industrial dynamics, and so a better knowledge of the different types of entrepreneur, their behavior and their specific contribution to innovation and growth would enable us to see into the 'black box' of business dynamics and improve the design of appropriate public policies. The empirical analysis performed here shows that not all new business have the same impact on relevant economic variables, and that self-employment is of quite a different economic nature to that of firms with employees. It is argued that public programs should not promote indiscriminate entry but rather give priority to able entrants with survival capacities. Survival of entrants is positively related to their size at birth. Innovation and investment improve the likelihood of survival of new manufacturing start-ups. Investment in R&D increases the risk of failure in new firms, although it improves the competitiveness of incumbents.

JEL Classification: D21, L16, L52, M13, O25.

Key words: Industrial dynamics, industrial policy, creative destruction, business demography.

Introduction

Many governments refer to new venture creation as one of the goals of their policy for creating jobs and improving competitiveness. International organizations issuing economic policy recommendations, including the European Commission, the OECD and the World Bank, report favorably on the strengthening of entrepreneurial initiatives in public programs. Yet the analytical bases for such programs are not always entirely clear. More often than not the programs fail to take into consideration, or are quite unaware of, the nature and contents of existing research that has been undertaken in business dynamics and its impact on efficiency. This article seeks to add to thinking on the contribution research in business dynamics can make to industrial policy.

This study comprises two parts. The first identifies the main lines of research in industrial dynamics developed to date and their contribution to knowledge in the field of economic policy design. It does not seek to undertake a review of the literature and its findings, rather its aim is to identify and differentiate analytical approaches and their implications.

It is argued that aggregate analyzes of the impact of business creation on growth fail to provide any substantive insights, since the heterogeneity of entrants means that the effects of each new firm on aggregate efficiency is very different. What is needed is for the “black box” of business dynamics to be opened up so as to know how and when the creation and destruction of businesses improves economic efficiency and well-being. The key seems to be that the more innovative a new firm is, the greater its contribution will be to society within a competitive environment.

The second part comprises an empirical study undertaken using databases available for Spain. The aim here is twofold. First, we seek to show the difference between self-employment (those who work for themselves without hiring any employees) and businesses (where the hiring of employees is indicative of the existence of a project with expectations of permanence and growth). It should be clear to governments that programs fostering self-employment are not the same as those that foster the creation and growth of firms.

The other aim of the empirical analysis considers survival as an observable characteristic that enables us to appraise the efficiency of a new firm. By applying Cox’s proportional-hazards regression we determine the effects that certain individual or sectoral variables might have on a firm's survival in the years following start up. Government programs would be more efficient if they strove to maximize the survival and growth rates of new start-ups, rather than indiscriminately seeking to maximize rates of entry.

1. Contributions from the field of business dynamics to the design of economic policy.

1.1 How much business turbulence?

A healthy economy is dynamic. One of the implications is that new innovative firms replace those that have become inefficient or obsolete. This dynamism entails a lot of turbulence when firms are simultaneously entering and exiting the market. If the number of new innovative firms is too small, medium and long-term growth will be too low and the country will lag behind. It may also happen that, if the economy experiences high entry of traditional non-innovative firms, the consequences may be no better if market competition is exacerbated, survival made too difficult, and a great number of firms are forced out of the market. Churning can be higher than optimal.

Given that the process of structural change involves benefits (new efficient firms) and costs (closures of firms), it is the experts' task to analyze and to seek to determine the limits and specific conditions under which business dynamics has a positive impact on economic growth and social prosperity.

Over the last decade, research into business dynamics has grown notably in quantity and quality. However, we are still some way from understanding the complex, noisy and confused phenomenon of business dynamics and so economists interested in these deep underlying forces face a stimulating challenge.

A number of firms equivalent to 20 per cent of all existing firms are created and destroyed, enter and exit the markets each year. Between 20 and 40 per cent of new firms close within two years. In terms of employment, the figures are also notable. Calculations made for the period 1977 to 2005 in the United States (Haltiwanger *et al.* 2008) report that the mean annual rate of new job creation stands at almost 18 per cent, while the equivalent rate for job destruction stands at around 16 per cent. This means there is a need for the reassignment of 34 per cent of total employment to achieve a net increase in employment of less than 2 per cent each year.

Of the new jobs created each year, 7 per cent approximately correspond to jobs generated by new start-ups and the rest is employment originated by firms that are growing. But the destruction of employment is equally high. Of the 16 per cent of jobs destroyed on average each year, around 6 per cent of these are lost following the closure of firms while the rest is attributable to the reduction in employment in existing firms.

The above data are drawn from the new database, *Business Demography Statistics* (BDS), which is prepared by the US Census Bureau and which gives us a very clear picture of business demography and its growth in the US. Other countries, including those in Europe (A1 Annex), present similar levels of turbulence but with the fundamental difference that in the US new firms grow more rapidly and that their survival rate is higher (Bartelsman *et al.* 2005).

Given the intensity of the turbulence in business units and employment it may seem odd to learn that, in the past, the dominant lines in economic research have paid relatively scant regard to it, with the obvious exception of Schumpeter and a part of the Austrian School. Fortunately, in recent years an abundant and sophisticated body of economic research has grown up in the field of business dynamics.

A phenomenon of such complexity might be tackled from various perspectives. In this article we adopt two broad points of view. First we look at the great regularities observed in business demography and at the individual patterns of firm behavior which result in the regularities observed. Second, we look at specific analyses of the effect of business dynamics and certain types of new start-ups on efficiency and growth.

1. 2. Stochastic dynamic models

Stochastic dynamic models analyze firm size and age distributions and seek to reveal individual behaviors and sectoral conditioning factors compatible with the regularities of observed distributions.

A persistent characteristic of business demography in practically all studies is the simultaneous occurrence of strong spatial and temporal stability in the distribution of firm sizes, and yet great turbulence among the individual firms. The first proposal that sought to account for this dual phenomenon of turbulence and stability was provided by Robert Gibrat (1931). Gibrat's Law, or the rule of proportionate growth, claims that the highly asymmetric distribution observed in firm sizes – a multitude of small firms and just a few large ones – can be explained if the growth of each firm in each time period is proportional to its size. The result would be identical if the growth of each firm followed a random pattern.

Gibrat's Law has conventionally been represented by a normal distribution, presenting an inverted-U shape relationship of the firms' growth rate. However, recent studies claim that a Laplace distribution, with an inverted-V shape, provides a better fit of the data observed (Teitelbaum & Axtell, 2005). The difference between the two distributions is significant. The Laplace distribution implies that the tails of the growth rate distribution are somewhat denser than those in a normal distribution, and that there is a greater number of firms growing at intermediate rates than is the case with a normal distribution, where the bulk of firms grow at rates close to the mean and a small number grow either very slowly or very quickly. The consequences of this dynamic, which undoubtedly are of great interest, have yet to be analyzed in depth. Segarra *et al.* (2008) provide an excellent presentation and discussion of alternative density functions representative of the distribution of firms by size and by age. Teruel (2009), moreover, analyzes the growth of Spanish firms in relation to Gibrat's Law.

The idea that firms follow random growth rates is disturbing and barely compatible with usual economic models. It is assumed that agents, and in particular business managers, far from operating in a random fashion, take rational and maximizing decisions. And, yet, the profession should be grateful to Gibrat for his provocative and stimulating ideas, even more so as it has not been possible to rule out random growth in those firms that have survived their first few years of activity (Loti, *et al*. 2009)

The most recent research has been based on two observable, and systematic phenomena. First, that the market structure varies from one industry to another and, second, that the differences in market structure between industries are similar from one country to another. The intersectoral variation suggests that the specific patterns of entry, exit and behavior (survival, growth, innovation) are also related to the characteristics of each industry such as their size, the degree of scale economies, the prevalence of product differentiation, and the level of investment in I+D. These non-random approaches suggest that agents behave so as to optimize their opportunities, albeit that the great regularities highlighted by Gibrat continue to be found. The convergence of both theoretical approaches has been resolved, according to Sutton (1997), by introducing stochastic elements in maximizing models.

The stochastic dynamic models that have had greatest repercussions in the subsequent literature are those proposed by Jovanovic (1982), Hopenhayn (1992), and Erikson & Pakes (1995). These models incorporate idiosyncratic firm characteristics that give rise to the individual variability observed. According to Jovanovic, firms might follow a pattern of *passive learning* in the sense that they learn to evaluate their own efficiency and so decide whether to grow, not to grow, to reduce their size or to close, but their levels of effectiveness do not change over time. A further, more complex vision is provided by the model of *active learning* proposed by Erikson & Pakes, where firms seek to improve their relative efficiency by investing in innovation. Here each firm can acquire either more, less or the same level of efficiency as its competitors, and the result is a Markov equilibrium. The theoretical development has continued with the proposals of the likes of Melitz (2003), and Asplund & Nocke (2006) who add specific differentiating elements to their stochastic models.

In Marc Melitz's model the progressive opening up to trade and international competition forces the exporting firms to improve their productivity, resulting in the exit of the most inefficient, non-international firms; while Asplund & Nocke find that, in a context of monopolistic competition, the bigger the market grows the greater the rate of entry and the level of competition and the lower the survival rate.

A common element in the above models is that the sum of agents' decisions with markedly heterogeneous degrees of efficiency gives rise to stable distributions of sizes and growth rates.

1. 3. Business dynamics and efficiency

Discovering the laws of behavior and the patterns underlying business demography constitutes an essential insight, but from the perspective of economic policy what is most urgent is understanding how the entry of new start-ups and the closure of incumbents can influence the economy, and what those responsible for economic policy can do to influence business dynamics and its effects.

Existing studies seek to analyze the relationship between business demography and dynamics (entry, exit, growth, survival) and other economic variables such as: business cycle, sectoral growth, innovation, employment, productivity, competitiveness and structural change.

Again two types of approach can be distinguished. The first approach is general, and includes studies that are concerned with the effect derived from new venture creation in general. The analysis of *entrepreneurship* belongs to this school. Other approaches are more selective in character, that is, they are concerned with the contribution that specific types of new start-ups, in particular innovative or high-growth firms, make to growth and innovation.

The economic models of new start-ups are in general in a phase of revision on finding that the enormous heterogeneity of entrants makes difficult the interpretation of the economic effects. Many existing empirical studies show that the relationship between the firms' rate of creation and economic efficiency is not direct.

The analysis of specific aspects of firm creation and entrepreneurship seems to have greater scientific potential. This shift can also be detected in the public policies of a number of countries where new programs are being oriented towards new firms that can grow (*high growth* firms), and towards new *technology based firms* from which it is expected an impact on the speed of innovation, on the improvement of the productive structure and on internationalization capacity.

1.3.1. The "black box" of business demography

It is reasonable to assume that the efficient rate of business creation belongs to a range with both an upper and lower limit. And it is also reasonable and important to consider that the efficient rate of entry should have some economic relationship with the efficient rate (range) of exit. This is because firm failures and closures imply social costs of more or less importance, so there must be a rate of exit beyond which social losses dominate social gains. Given that overall rates of entry and exit are closely correlated, efficient rates of entry and exit have to be related to each other. Now, given the heterogeneity of agents, it is necessary to determine what type of entrants contribute most to growth and what type of entrants contribute little, nothing or negatively. An entrant impacts negatively if it displaces a more efficient firm, and this can happen in very turbulent environments. In other words, if we borrow the terminology coined by Rosenberg (1982) to a different context, it is essential to "open the black box" of business entry and exit.

Several studies show that it makes little sense undertaking analyses that fail to take into account the type of entrants (Santarelli & Vivarelli, 2007; Headd & Saade, 2008). For example, using *Global Entrepreneurship Monitor* (GEM) data, a number of studies find that while self-employment out of necessity acts as a negative economic indicator, the creation of new ventures with an ambition to grow, prepared to invest their resources in physical and human capital is desirable (Stemberg & Wennekers, 2005). However, useful knowledge remains scarce, fragmented and of limited dissemination.

Economic prosperity has been related with entrepreneurship in many studies and even among public opinion. The existing literature mentions various reasons why the rate of new business creation is related positively with economic growth. It is often claimed that a dynamic society is less averse to risk and presents a greater proportion of individuals that prefer self-employment to dependent work (European Commission, 2003).

The formalization of entrepreneurial initiative as a growth motor was made by Audretsch & Keilbach (2004) who propose a model of economic growth in which entrepreneurship capital appears as a factor of production within the neoclassical model of the production function. In this model entrepreneurship is measured by the rate of new business start-ups.

A different perspective involves assuming that business churning, that is the combined process of the entry and exit of firms, strengthens growth by substituting the less efficient firms with more efficient business. Callejón & Segarra (1999) and Segarra & Callejón (2002) have estimated a production function with data for Spain where both the entry and exit rates appear positively related with productivity. The authors adopt the hypothesis that the entrants operate with latest capital equipment available which incorporates the newest technologies and, therefore, they are more efficient than the firms that have been displaced.

The most widely disseminated study on the relationship between the rate of entrepreneurship and the level of income is based on various GEM reports. The 2007 report is based on a survey of 42 rich and poor countries. From the transversal data a U-shaped curve of best fit is obtained between the rate of new entrepreneurs and the level of income. In other words, in countries with low income levels the rate of entrepreneurship (young firms and start-ups compared to the number of adult firms) is very high. The rate then falls as a country's income level increases until a minimum is reached, and rises again in richer countries (Bosma *et al*. 2008).

However, the interpretation of this pattern, were it to be confirmed, is not at all clear. The reason is that the positively sloped right part of the curve is associated in some studies with an increase in the proportion of self-employment – or persons that work for themselves without receiving any salary– and could indicate a reduction in adequately paid job opportunities, and a greater dependence on subcontracting on the part of businesses. According to the aforementioned GEM report, 40 per cent of new entrepreneurs in OECD countries do not choose self-employment for reasons of opportunity or personal preference, but rather out of necessity.

Carree *et al.* (2007) and Wennekers *et al.* (2008) undertake an alternative test of the connection between the rate of entrepreneurship and income levels over time in a group of developed countries. They use OECD databases and do not rely on a survey as was the case of the GEM report. The rate of entrepreneurship is captured by the number of business owners as a proportion of the active population between 1972 and 2004 in a set of eight rich OECD countries. What is interesting in this empirical study is that the fit of data to a U-shaped curve is somewhat inferior to that of an L-shaped curve (repositioned with the long horizontal line to the right).

The implications in both cases are very different: with a long-term tendency represented by a L shape, the proportion of business owners would not grow with rising income levels but rather would tend to become stable towards an asymptote at around 7 per cent; and, with a growing U-shaped trend, in 25 years the proportion of business owners would reach 12 per cent. The specific data for the US indicate a point of stabilization would be reached at around 10 per cent.

Further research carried out by Acs and Szerb (2009) finds that the relationship between entrepreneurship and economic growth might be neither U-shaped nor L-shaped but slightly S-shaped. Acs and Szerb sensibly advise about the convenience of moving away from simple measures of entrepreneurship across countries to more complex measures.

It should be borne in mind, however, that the series analyzed in studies carried out until now do not present such severe economic disruptions as those that have appeared since 2008, which means that the equilibrium values for entrepreneurship indexes could change drastically in the future due to the likely increase in self-employment if business employment opportunities decrease in many OCDE countries for the next years.

One clear fact is that the analyses undertaken to date are still largely inconclusive and the reason for this is the lack of longitudinal business data that can be compared between countries. The motivation and skills of entrepreneurs are certainly highly relevant and we know that they can differ notably between new start-ups. A study published by Stam *et al*. (2007) shows that new ambitious entrepreneurs contribute more to macroeconomic results than the creation of firms in general does.

The analysis of business skills is the aim of a study undertaken by Salas & Sánchez-Asín (2009) who draw on data for the sectors and regions of Spain. Salas & Sanchez-Asín build an interesting model in which the decision of an individual to become either an employee, a self-employed or an employer depends on what his business skills are with respect to the environment and how he or she perceives and evaluates them. Their model predicts that relatively high rates of employers to employees are associated with higher levels of productivity in a society, and that relatively high rates of self-employment are associated with lower levels of social productivity. These results provide evidence that what is important is not the number of entrepreneurs but rather their quality.

1.3.2. Firms and self-employment

Public programs should be clear as to whether they seek to foster self-employment or strengthen the creation of new firms with high-growth capacity or, also, whether they intend promoting the growth of existing firms.

Frequently public programs that try to stimulate the creation of new start ups, in fact foster self-employment. It is not unusual for many of these programs to be ambiguous or confused in their objectives. As discussed earlier, the GEM report points to the existence of a high proportion of new entrepreneurs that emerge out of necessity, owing to limitations in the number of adequately paid jobs. The empirical analysis in section 2.1 confirms that the net rate of entry of the self-employed grows as the net entry of firms with employed workers falls. The clear implication is that each group – employers and self-employed - react to the effects of the business cycle in a different and opposite way. This also demonstrates that employers and self-employed have different economic incentives. When demand grows and more new firms with employees enter the market, the rate of new self-employed decreases, and vice-versa.

The question, nevertheless, should still be raised as to whether the many firms that prosper, grow and eventually generate employment in fact started from self-employment opportunities. The answer though is no. A study published by Davis *et al*. (2007), made possible thanks to the new longitudinal database of the US Census Bureau, finds that in 2000 only 3.15 per cent of the existing self-employed migrated to the group of businesses with employees. The authors deduce from their study that it is not correct for business statistics and data bases to mix together both type of agents.

We have presently access to a set of recent studies (Davis *et al.* 2007, Wennekers *et al*. 2008 and Salas & Sánchez Asín, 2009) that present persuasive evidence regarding the need to separate analytically the self-employed from firms. Likewise, the new joint OECD-Eurostat database (2008) only includes establishments with at least one employee.

1.3.3. New firms and innovation

It is in their contribution to innovation and in their promotion of productive change that new start-ups acquire all their meaning.

Joseph Schumpeter contributed the seminal model that associates the creation of new firms with innovation and growth. However, Schumpeter proposed two different growth models each driven by innovation. His first model (1911), known as Schumpeter *Mark I,* introduces the notion of the innovative entrepreneur, the creator of his own firm, who uses existing knowledge to launch an innovation on to the market. The innovator brings about the obsolescence and decline of some incumbent firms producing the older good, and then enjoys a period of monopoly that is terminated by the entry of imitators, in what is known as a process of *creative destruction*. The innovative entrepreneurs are a minority since most of the entrants are imitators.

In Schumpeter's second technological model (1942), known as *Mark II*, innovation becomes a systematic activity of big companies, that have the capacity to invest in R+D. Schumpeter observes and describes the intense process of market concentration occurring between the First and Second World Wars as a consequence of the growing economies of scale of the new production technologies and organization. The new model was described as *creative accumulation*.

In the last years, however, it is Schumpeter's concept of creative destruction that has inspired many of the analyses and models related to business turbulence and its innovative effect. Some authors argue that the phase of market concentration in the first part of the 20th C has been followed by a period were innovation is dominated by small firms. According to Audretsch and Thurik (2001) the period of *managed economy* has been followed in present times by the *entrepreneurial economy* where the role of new firms is crucial in a context of systematic change. In Agarwal, Audretsch and Sarka (2008) it is argued that the industrial dynamics of the present time cannot be identified neither with creative destruction nor creative accumulation, but with the new entrepreneurial model of *creative creation*.

Although the emphasis of many studies typically falls on the positive effect of innovative entry, some important contributions take into consideration the social costs of the closures of firms that are forced out of the market and those incurred by firms that have to reduce their activities. Aghion & Howit (1992) have analyzed how a firm's incentives to invest in innovation can be affected negatively or positively according to the characteristics of the market in which they operate. Firms react differently to the threat of seeing themselves being pushed out by new competitors. While competition can act as a disincentive to innovative investment in traditional industries, it can stimulate it in cutting-edge industries. Traditional activities usually include many firms with just minor product differentiation. In advanced activities, a smaller number of firms compete with significant product differentiation and they have to be radically innovative so as not to be pushed out of the market.

From a different perspective, aligned with evolutionary economics, David Audretsch (1995) highlights the way in which new start-ups promote aggregate innovation. The notion of a technological trajectory is at the base of Audretsch's model in which it is the new firms that experiment with and take to the market innovations that the established incumbents consider too far removed from their nucleus of experience and know how. In this model, the big established firms find themselves subject to a technological dependence (Nelson & Winter, 1982) and, therefore, it is the new start-ups that introduce the innovations that are associated with greatest risk.

Also differing from the above focuses, the concept of "cost discovery", proposed by Hausmann, Hwang & Rodrik (2006), offers an excellent explanation as to how the market can fail because of a lack of innovative business projects. If, as it seems, countries are what they produce, we should concern ourselves with the mechanisms that determine their productive specialization and their position in the international division of labor. When an entrepreneur seeks to produce something for the first time, he or she experiences uncertainty as to the costs that will be incurred. Even when a standard technology is adopted, it needs to be adapted to the local conditions governing costs and access to specialist inputs. The entrepreneur explores the cost structure – in its broadest sense – of the economy in which he or she is operating this new activity, and the search presents considerable external economies for those that subsequently follow his or her lead. If the entrepreneur is successful, others will emulate him and thereby avoid part of the experimentation costs. If he fails, nobody will imitate him and the cost of failure will remain private.

The presence of external economies of knowledge means that the levels of private investment in "cost discovery" are sub-optimal at the aggregate scale, if the government does not manage to stimulate them. Therefore, the number of entrepreneurs that become involved in new activities which involve "cost discovery" becomes an important variable. Policies aimed at stimulating entrepreneurship, at creating innovative firms, at the undertaking of innovative projects by incumbent firms, therefore, take on special importance.

1.4. Productivity and survival

Measuring the impact of new firms and business rotation on aggregate productivity, the main determinant of sustained economic growth, faces considerable obstacles. Mairesse & Jaumandreu (2005) have highlighted the problems involved in measuring the productivity of individual firms on the basis of their sales income alone, without knowing their price variations.

One of the most frequently reported findings is the enormous heterogeneity in the productivity levels of new start-ups (Haltiwanger *et al.* 2000). Studies undertaken with data from Spain (Fariñas & Ruano, 2004, Segarra *et al*. 2008) find that new firms are less productive than incumbents, but that they achieve higher productivity growth rates in their first years (Huergo & Jaumandreu, 2004), which reduces the variance over time and supports the assumption of learning. However, these results can vary if the productivity of each firm is measured in terms of its income or the quantities it produces.

Foster *et al*. (2008) have been able to calculate both types of individual productivity and, as expected, they find that firms that close are less productive than incumbents whatever their size, but that the distance is greater in revenue based productivity. By contrast, new firms present greater physical productivity than incumbents but their advantage in revenue productivity is lower or non-existent. What is most interesting is that the authors believe the reason for this discrepancy lies in the fact that new firms charge lower prices than incumbents. Therefore, revenue productivity studies that do not include individual prices tend to understate the contribution of new start-ups to aggregate productivity growth.

The second interesting finding reported by Foster *et al.* (2008) is that although the firms that close are less productive when applying both measures, it is the differential in revenue productivity that contributes most to their failure. Firms that suffer falls in demand face greater risks of closure when adjusting for technical productivity. The study estimates that variations in demand between firms are the principal determinant of survival.

2 Empirical analysis applied to Spain

With data drawn from the *Directorio Central de Empresas* (DIRCE), a directory including data for all Spanish establishments, we undertake three types of empirical analysis. First, we compare the behavior of the net entry rate (entries minus exits) for self-employment (no employees) with respect to that for firms (establishments) that are created with employees, and we find that these rates are diametrically opposed. This can be interpreted as evidence of the distinct nature – incentives and behavior – of self-employment compared to that of firms that employ workers.

Second we build life tables – of duration and hazards– for all start-ups and instances of self-employment created in 1994. The resulting data show that self-employed entrants face a considerably greater risk of failure than entrants with employees.

Third, we estimate Cox's proportional-hazards regression to determine whether a business establishment's endowment of physical and immaterial resources and the particular environment provided by their business sector contribute to its chances of survival. In this case we only include entrants to the manufacturing sectors from the 1994 cohort.

2.1. Differential behavior of self-employed and firms

Self-employment accounts for the majority of the business units in the DIRCE data base. The DIRCE includes business establishments with and without employees. What we call firms and self-employed. Around 50 per cent of all establishments and around 70 per cent of the new establishments correspond to self-employed.

The correlation tests performed for a panel of 40 industries (manufacturers and services) for the series of years 1994 to 2001 confirm that the decision to enter the market is made for different reasons among the self-employed and businesses with employees. The technique used is a panel regression with fixed effects that controls for the specific effects of each industry in the rate of net entry. The net rate of entry is defined as the difference between the gross rate of entry (number of establishments that are created each year divided by the stock of establishments) and the gross rate of exit (number of establishments that close divided by the stock of establishments). The aim is to compare the signs and the significance (not the value) of the regression coefficients. Table 1 shows that:

- The variation in net rates of entry between self-employed (entrants with 0 employees) and entrants with 1-2 employees presents opposite signs. That is, if in a given year the net entry rate of firms grow, the net entry rate of self-employed shrinks.
- The same opposite variation is observed for self-employment and entrants with 3 or more employees
- By contrast, the net rates of entry vary in the same direction between firms with 1-2 employees and entrants with 3 or more employees. So, entrants with employees react in the same way to the business cycle. When demand grows the rate of gross entry (exit) is higher (lower) and when demand falls the rate of gross entry (exit) shrinks (grows).

A plausible interpretation for these three correlations is that the decision to pay employees implies a great difference in business type. It is reasonable to treat the group of business without employees as a distinct group, which reacts differently to the economic stimuli that govern the entry and exit of businesses with employees.

When the net entry is greater in businesses with employees because there are better opportunities for the survival of firms, self-employment presents lower net rates of entry. This finding is compatible with the theory that the majority of self-employed are not in fact entrepreneurs, but rather they seek a means of living.

Table 1

Correlation test (fixed effects regression)

	Net entry of self-employed	Net entry of firms with 1-2 employees
Net entry of firms with 1-2 employees	-0.2767***	
Net entry of firms with 3 or more employees	-0.8720***	1.3707***

Number of observations: 320
F test (p-value)< 0.0002 or less for the three coefficients
Data source: DIRCE (INE)

This result might be interpreted as an indicator that public policies which seek to strengthen business capacity should include specific programs that go above and beyond facilitating self-employment.

In the academic field this result supports the recommendation that analyses of the dynamics of self-employment should be conducted separately from the dynamics of firms. Headd & Saade (2008) reach the same conclusion, and most convincingly, following their analysis of business dynamics data in the US.

2.2. Survival analysis

Survival analyses using individual, censored panel data enjoy a long tradition in economic analyses, both in labor economics and industrial economics. Below we present the most usual concepts included in tables of business survival.

The survival rate of a cohort of establishments in financial year “t” shows the number of firms that remain active in “t” in relation to the initial number of establishments. In other words,

$$S(t)=\frac{Establishments\ active\ at\ "t"}{Establishments\ born\ at\ t=0}$$

The probability of a business ceasing to trade in “t” is the hazard rate to which the business is exposed. If time adopts a discrete dimension we can express the hazard rate using the following expression,

$$h(t) = 1 - \left[\frac{S(t)}{S(t-1)} \right]$$

The hazard rate *h(t)* indicates the probability of an establishment that has survived financial year “t” exiting the market in time period “t+Δt”. When time adopts a discrete dimension we have,

$$h(t) = \lim_{\Delta t \to 0} \frac{P(t \leq T \leq t + \Delta t | T \geq t)}{\Delta t} = \frac{f(t)}{S(t)}$$

where *t = 1,2,...T*, is the discrete time; *f(t)=dF(t)/dt* is the density function corresponding to the distribution of exits as regards the initial number of establishments in the group; *F(t)=Pr(T<t)* is the probability that the establishments in the group reach a vital period “T” inferior to “t”; and, finally, *S(t)=1-F(t)* is the survival function.

2.2.1. Life tables of new start-ups

The life tables have been built with the cohort of firms for all sectors created in 1994, and contain the survival rates and hazard rates in each period and for each size class (tables 2 and 3).

Table 2

Life table

	Size class at birth: number of employees							
	(0)	(1-2)	(3-5)	(6-9)	(10-19)	(20-49)	(50+)	All
after 1 year	0.7688	0.8238	0.8829	0.9040	0.9020	0.8731	0.9331	0.7896
after 2 years	0.6635	0.7141	0.7730	0.7952	0.7926	0.7836	0.8425	0.6833
after 3 years	0.5845	0.6186	0.6780	0.7011	0.6941	0.7023	0.7677	0.6001
after 4 years	0.5142	0.5535	0.6126	0.6379	0.6355	0.6370	0.6988	0.5313
after 5 years	0.4717	0.5120	0.5711	0.5941	0.5886	0.5972	0.6437	0.4889
after 6 years	0.4307	0.4753	0.5359	0.5587	0.5547	0.5545	0.6280	0.4492
after 7 years	0.4031	0.4466	0.5053	0.5280	0.5240	0.5205	0.5827	0.4211

Source: DIRCE (INE) and Stata

Table 3

Hazards rate table

	Size class at birth: number of employees							
	(0)	(1-2)	(3-5)	(6-9)	(10-19)	(20-49)	(50+)	All
ter 1 year	0.2312	0.1762	0.1171	0.096	0.098	0.1269	0.0669	0.2104
after 2 years	0.1369	0.1332	0.1244	0.1203	0.1213	0.1024	0.097	0.1346
after 3 years	0.1191	0.1336	0.1229	0.1183	0.1242	0.1038	0.0888	0.1218
after 4 years	0.1203	0.1053	0.0966	0.0902	0.0844	0.0929	0.0897	0.1147
after 5 years	0.0828	0.0751	0.0677	0.0686	0.0738	0.0625	0.0789	0.0798
after 6 years	0.0868	0.0716	0.0617	0.0596	0.0576	0.0715	0.0245	0.0812
after 7 years	0.0641	0.0604	0.0571	0.055	0.0553	0.0614	0.0721	0.0626

Source: DIRCE (INE) and Stata

It can be seen that the hazard rate for this specific cohort differs according to establishment size and tends to decrease with the initial size of the entrant. The possible bias of including just a single cohort does not appear, on the other hand, to be very relevant. Other studies undertaken, in particular Audretsch & Keilbach (2002), fail to find significant differences in the behavior of different cohorts (at least if they are consecutive in time).

2.2.2. Proportional risk analysis in new industrial start-ups

The most representative observable variable of the success of a firm might be its survival capacity. It is to be expected that the most efficient firms, those that compete with most success, are the ones with the longest lives.

Due to information availability hazard analysis has been limited to manufacturing establishments. The number of establishments is not significantly different from the number of firms in the group of small and medium firms. So it is possible to use the term establishment and firm indistinctively. The data used in the empirical analysis for Spain cover the manufacturing sectors (codes 15 to 36 of the national classification - CNAE), and draw on four databases from the National Institute of Statistics: (a) the *Directorio Central de Empresas (DIRCE)*; (b) the *Encuesta Industrial de Empresas* (EIE); (c) the *Estadística de I+D*; and (d) the *Encuesta de Innovación*. In this study we use information relating to the cohort of manufacturing establishments that entered the market in 1994, and we tracked the evolution of this cohort through to 2002. The information is disaggregated by size classes on entry and by 21 productive sectors.

In order to complete the characterization of the establishments, as we only know their size class on entry and the sector to which they belong, we have no alternative but to link each of the establishments with the characteristics of the sector to which they belong. In other words, we assume that each firm during its years of existence presents an investment, innovation and R+D behavior, and pays salaries equivalent to the mean of its sector. Despite the bias of this assumption the important factor remains the differential mean values across sectors. The best source for manufacturing business data in Spain is the EIE, an official compulsory survey that includes annual data regarding a large number of sectoral variables (number of establishments, employment, production, purchases, investment, and others.). The *Estadística de I+D* compiled by INE gathers data regarding investments in R+D by sector, and the *Encuesta de Innovación* provides additional data regarding investment in licenses, equipment and training.

Cox's proportional-hazards regression model is the method used in this part of the study for obtaining more information about the relationship between size and the risk of being pushed out of the market. Cox's regression (Cox, 1972; Kiefer, 1988; Cléber *et al.* 2004) captures the effects of the explanatory variables on the firms' hazard rates, and in addition corrects the problem of censored data, when the duration of the firms that survive into the last year of observation is unknown.

The model takes the hazard rate, *h(t)*, as the dependent variable and estimates the function:

$$h(t) = h_0(t)\exp(\beta_1 x_1 + ... + \beta_k x_k)$$

where x_k is the vector of covariates. Cox's regression provides estimations of $\beta_1,..., \beta_k$, but does not provide a direct estimate of $h_0(t)$, which is the function of the baseline hazard assuming that all the β coefficients are zero.

The estimation includes the individual variables of each establishment and variables that affect the sector to which the establishment belongs. In some cases the variable is calculated as the average of several years to minimize the effect of short term shocks on that variable.

- ✓ *Initial size*. Represented by the size class to which the establishment belonged on being set up, measured by the number of workers. The size classes considered are: 0, 1-2, 3-5, 6-9, 10-19 and 20-49. Entrants with 50 employees or more are very few in number and are not included here.
- ✓ *Investment.* Indicates investment in capital assets (in 000s of euros) per worker and year in each sector; we have used the mean value for the period 1994 to 2000.
- ✓ *Innovation*. The covariate innovation effort is approached by the mean yearly expenditure on innovation by the firms in the sector for the period 1994 to 2000 divided by sales figures.
- ✓ *R+D*. It is measured by the annual mean investment in R+D by the establishments in the sector for the period 1994 to 2000 in terms of expenditure on R+D divided by total sales.
- ✓ *Wage*. Measured by the mean wage for the sector obtained by dividing total expenditure on personnel (in 000s of euros) by the number of employees.

- ✓ *Mean size.* Mean size of establishments obtained by dividing total sectoral employment by the number of establishments.
- ✓ *Employees*. Total number of employees in the sector as a mean of the period.
- ✓ *Gross entry rate*. Number of entrants in the sector divided by the number of active incumbents.
- ✓ *Production growth.* Mean annual increase in sectoral production for the period 1994 to 2000.

2.2.3 Results

Table 4 shows the results of the regressions using Cox's proportional-hazards model with censored data, using as reference the group of entrants without employees in specifications III and IV, in which the *dummy* variables corresponding to the size classes have been introduced. In Cox's regression the interpretation of the coefficient depends on how the values of the covariates are specified and in many cases this is not straightforward. The relevant information for the regressions is the sign of the effect of the covariates on the establishment's risk of closure.

The *investment* variable captures the effect of the establishment's capital investment on its chances of survival (or, inversely, hazard). It also captures in part the prevailing size of scale economies in the industry where the establishment belongs. Here, a negative sign is expected (reduction of hazard) in general and, especially, in the case of the micro-establishments. It is expected that establishments operating in those activities that require the greatest capital utilization, and present high barriers to entry, will enjoy a competitive advantage. The negative coefficient obtained confirms the expected effect, and coincides with findings reported by Honjo (2000) for Japan.

It is expected that the most *innovative* firms, those that enter the most innovative sectors, with the greatest product differentiation, and which invest the greatest amount of resources in intangible assets, will also present better prospects for staying in the market and growing. The expected sign is negative for all firm sizes and so the result of the regressions confirms expectations.

The positive impact of innovation on firm survival has been corroborated in a number of studies including that of Cefis & Marsili (2005) using the *Community Innovation Survey* (CIS).

Table 4. Determinants of New Firms Survival

Cox proportional hazards regression model

Covariates	I	II	III	IV
Investment	-0.3463	-0.2789	-0.3564	-0.2594
	(0.000)	(0.000)	(0.000)	(0.000)
Innovation	-0.2673	-0.2382	-0.2922	-0.2560
	(0.000)	(0.000)	(0.000)	(0.000)
R+D	0.1439	0.1648	0.1284	0.1643
	(0.006)	(0.001)	(0.014)	(0.001)
Wage	0.0163	0.0125	0.0182	0.0112
	(0.003)	(0.001)	(0.001)	(0.004)
Mean size	0.0069	0.0073	0.0079	0.0083
	(0.000)	(0.001)	(0.000)	(0.000)
Employed	-0.1373	-0.1065	-0.1536	-0.1108
	(0.000)	(0.000)	(0.000)	(0.000)
Gross entry rate	-1.0920	-	-1.5148	-
	(0.102)	-	(0.024)	-
Sector growth	-	-0.6742	-	-0.4933
	-	(0.021)	-	(0.089)
Size 1-2	-	-	-0.1429	-0.1393
	-	-	(0.000)	(0.000)
Size 3-5	-	-	-0.3332	-0.3301
	-	-	(0.000)	(0.000)
Size 6-9	-	-	-0.4047	-0.4015
	-	-	(0.000)	(0.000)
Size 10-19	-	-	-0.2862	-0.2847
	-	-	(0.000)	(0.000)
Size 20-49	-	-	-0.2769	-0.2742
		-	(0.000)	(0.000)
Nº observations	24891	24891	24891	24891
Log-likelihood	138648.5	138686.1	138556.9	138558.0
LR Chi2	386.01	388.72	647.16	644.97

Source: Data from INE and Stata

The innovation effort indicator has also been used by Audretsch & Mahmood (1994) although in their study the coefficient was positive (an increase in the rate of hazard), though not significant.

The covariate measuring investment effort in *R+D* conveys different implications than the covariate that captures innovative effort. The direct undertaking of research projects requires much more capacity in terms of human capital and presents greater risks of failure than innovation activities. The innovation information comes from the *Encuesta de Innovación* conducted by the Instituto Nacional de Estadística, which follows the *Oslo Manual*, and includes not only R+D expenditures but also the acquisition of licenses and equipment and other low risk firm activities.

The results of the survival analyses conducted in several studies for the R+D covariate are not as unanimous as those conducted for innovation, but overall they tend to corroborate the result shown in Table 4 in which R+D effort impacts positively on the hazard of the firm and, so, negatively on survival. Some other empirical tests (Segarra & Callejón, 2002; Audretsch & Mahmood, 1994) find a positive relation between investment in R+D and the hazard rate. Segarra & Teruel (2007), with very similar data, find that investment in R+D does not improve survival in service firms nor, albeit with more ambiguous results, in industrial firms. By contrast, Esteve *et al.* (2004), using data from the *Encuesta sobre Estrategias Empresariales*, report that investment in R+D improves chances of survival. Given that the test reported in Esteve *et al*. is not applied solely to new start-ups but to all firms, its results are compatible with our own results. It is reasonable to expect that once an incumbent firm has consolidated its market position and is advancing in a specific technological pipeline, the risk of its R+D projects will be lower.

Included in the regression is the sector's *salary* level interpreted as an indicator of the relative qualification of the productive sectors. The salary is, however, a cost component and as such has a negative impact on a firm's profits. Although the sign expected for this variable is negative, our results do not confirm this hypothesis. This might suggest that the effect on costs is more important than the effect of human capital.

Since the entrants have an *average size* that is much smaller than the average size of the sector, we would expect them to have to face greater cost disadvantages as the relative average size of the firms in the sector increases. This is clearly true in all cases. This result coincides with that reported in other studies.

The effect of absolute market size, measured by the covariate that captures the total number of *employees* in the sector, lends itself to different hypotheses. On the one hand, a large market size presents in principle greater room for entrants, but competition is also high. Some authors (Asplund & Nocke, 2006) expect the hazard rate to rise with market size. The alternative hypothesis is that a large market also incorporates a greater number of business niches in which very small firms can prosper. In our test the second hypothesis wins.

The *gross entry rate* covariate is introduced in the model to capture the effect of competition among entrants in a sector. Although a positive sign was expected for the hazard rate, the result of the regression indicates the opposite, but the coefficient is less significant than the other covariates.

Many studies use the *growth rate of sectoral production* as a control variable. Indeed, the greater the growth in demand, the greater is the reduction in the hazard rate.

The *dummy* variables that represent the size of the firms at birth in the last two regressions confirm that the relative hazard of businesses with employees is lower than that of the self-employed (*dummy* omitted).

3.- Conclusions

Business dynamics is a far-reaching, vigorous process that constantly alters the productive structure. The entry, exit and growth of firms are determinants of this productive development, affecting economic growth, innovation and structural change. However, just what occurs within this turbulence is in large measure intuitively imagined while remaining basically unknown. It is a "black box", in the sense of the term coined by Nathan Rosenberg (1982) in reference to the role of technology in the economy. We know that a powerful unobservable process is influencing the economic outcome, but we do not know exactly how it affects the behavior of each different agent. The economic analysis of business dynamics has only recently been initiated but relevant studies have grown considerably in both quality and quantity. Segarra *et al*. (2003), for example, have contributed notably to our understanding of the situation in Spain. The availability of very complete longitudinal data bases (US Census Bureau) and others that can be compared at the international scale (OECD-Eurostat) should allow a better understanding of the complex, noisy phenomenon of business dynamics.

The structure of industrial sectors is the combined result of the decisions of many, extremely heterogeneous, firms. New start-ups differ in the skills they possess and in their efficiency. The incentives for creating a new firm also vary greatly - from exploiting varying degrees of business opportunities to escaping unemployment. The extremely high percentage of "infant firm mortality" indicates that many entrepreneurs fail to appraise correctly the environment in which their project is to compete, or that they overestimate their own skills. Different types of sector and activity condition initial investments and the skills that new firms should have if they are to survive.

Many studies have examined the aggregate effect of new venture creation, and entrepreneurship, but it is more important to identify *specific* business characteristics and behavior that allow firms to grow, generate qualified employment, open up new market niches or win a larger share of the international market. Only a small part of entrants will contribute significantly to aggregate productivity and the generation of employment.

Industrial policy should not concern itself solely with established, pre-existing sectors, but rather it should aim to contribute to productive growth by ensuring that new economic activities are set up and that production processes become increasingly more knowledge intensive, more technologically advanced and more efficiently organized. Business dynamics, and new start-ups in particular, should be promoted using a range of different programs.

In recent years many governments have adopted, or have proposed introducing, specific programs to foster the creation of new business. In most cases the programs fail to identify their objectives clearly and self-employment is grouped together along with businesses with employees. In this article we have insisted that the two represent different categories that ought to be treated differently through their own specifically designed programs.

In periods of rising unemployment and anemic markets, the growth in self-employment can help the economy. Governments, in particular at the local scale, can offer valuable support with training and advisory programs, by providing well-equipped business spaces and micro-credit facilities, and by generating and disseminating relevant economic information.

On the other hand, businesses wishing to grow need a suitable environment of service provision for firms and of suppliers. We have shown that firms that invest, and in addition invest in innovation, are more likely to survive. Regional and national governments should promote technology transfer by providing incentives for the opening of laboratories that work for the firms. However, the main determinant of a firm's development is the demand for its products (Foster *et al.* 2008). A firm's innovative and marketing capacity is as, if not more, important than its technological capacity. Public programs need to bear in mind these needs of firms and to promote the development of complementary specialist activities and services that the business system requires.

Governments often seem to make little use of economic studies in the design of their programs, while at the same time economists working in academia are often unconcerned about the application of their studies. In industrial policy, and especially in business dynamics, it would make sense to correct this tendency.

References

Acs, Z. and L Szerb (2009) "The global entrepreneurship index (GEINDEX), Jena Economic Research Papers, Max Planck Institute, 2009-028.

Agarwal, R., DB Audretsch and MB Sarkar (2008) "The process of creative construction" Jena Economic Research Papers, Max Planck Institute, 2008-008.

Aghion, P. and P. Howitt (1992) "A Model of Growth Through Creative Destruction", *Econometrica*, 60 (2): 323-351.

Aghion, P, R Blundell, R Griffith, P Howitt andS Prantl (2006) "The effects of entry on incumbent innovation and productivity", NBER Working Paper 12027.

Asplund, M and V Nocke (2006) "Firm Turnover in Imperfectly Competitive Markets", *Review of Economic Studies*, 73: 295-237.

Audretsch, DB and M Keilbach (2004) "Entrepreneurship capital and economic performance", *Regional Studies*, 38: 949–959.

Audretsch, DB (1995) *Innovation and Industry Evolution*, MIT Press, Cambridge, Massachusetts.

Audretsch DB andR Thurik (2001) "What's New about the New Economy? Sources of Growth in the Managed and Entrepreneurial Economies", *Industrial and Corporate Change*, 10(1): 276-315.

Audretsch, DB. and MC. Keilbach (2004) "Entrepreneurship and Regional Growth: an Evolutionary Interpretation", *Journal of Evolutionary Economics*, 14: 605-16.

Audretsch, DB. and T. Mahmood (1995) "New Firm Survival: New Results Using a Hazard Function", *Review of Economics and Statistics,* 77: 97-103.

Bosma N, K Jones, E Autio and J Levie (2008) *Global Entrepreneurship Monitor 2007 Executive Report*, Babson College/ London Business School. http://www.gemconsortium.org/download/1236292097826/GEM_2007_Executive_Report.pdf

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

Callejón, M andA Segarra (1999) "Business Dynamics and Efficiency in Industries and Regions. The case of Spain", *Small Business Economics*, 13(4): 253-271.

Carre, M., A Van Stelz, R Thurik andS Wennekwes (2007) "The relationship between economic development and business ownership revisited", *Entrepreneurship and Regional Development*, 19: 281–291.

Cefis, E. and O Marsili (2005) "A matter of life and death: innovation and firm survival", *Industrial and Corporate Change*, 14 (6): 1167-1192.

Cleves, M., W. Gould andR Gutiérrez (2004) "*An introduction to survival analysis using Stata*", Stata Press Publications, Texas, EE.UU.

Cox, DR. (1972) "Regression Models and Life-Tables", *Journal of the Royal Statistical Society. Series B*, 34(2): 187-220.

Davis, S., J Haltiwanger, R Jarmin, C Krizan, J Miranda, A Nucci, K Sandusky (2007): “Measuring the dynamics of young and small businesses: integrating the employer and nonemployer universes”, NBER Working Paper 13226.

Ericson, R and A Pakes (1995) “Markov-Perfect Industry Dynamics: a Framework for Empirical Work”, *Review of Economic Studies*, 62: 53-82.

Esteve, S., A. Sanchis and JA Sanchis (2004) “The determinants of survival of Spanish manufacturing firms, *Review of Industrial Organization*, 25: 251-278.

European Commission (2003) *Entrepreneurship in Europe. Green Paper*, COM(2003) 27 final, Bruselas.

Fariñas, JC and S Ruano (2004) “The Dynamics of Productivity: A Decomposition Approach Using Distribution Functions”, *Small Business Economics*, 22: 237-251.

Foster, L, J Haltiwanger and C Syverson (2008) “Reallocation, Firm Turnover, and Efficiency:Selection on Productivity or Profitability?”, *American Economic Review*, 98 (1): 394-425.

Gibrat, R. (1931) *Les inégalités économiques; applications: aux inégalités des richesses, à la concentration des entreprises, aux populations des villes, aux statistiques des familles, etc., d'une loi nouvelle, la loi de l'effet proportionnel.* Librairie du Recueil Sirey, París.

Haltiwanger, J., J. Lane and J. Spletzer (2000) “Wages, Productivity and the Dynamic Interaction of Businesses and Workers”, NBER Working Paper 7994.

Haltiwanger, J. R. Jarmin and J. Miranda (2008) “Business Formation and Dynamics by Business Age:Results from the New Business Demography Statistics”, Mimeo citado con autorización. http://econ-server.umd.edu/~haltiwan/papers.htm

Hausmann, R., J Hwang, and D Rodrik, (2006) “What You Export Matters”, CEPR DP5444.

Headd, B and R Saade (2008) “Do Business Definition Decisions Distort Small Business Research Results?” An Office of Advocacy Working Paper. http://www.sba.gov/advo/research/rs330tot.pdf

Honjo, A (2000) “Business Failure of New Firms: an Empirical Analysis Using a Multiplicative Hazards Model”, *International Journal of Industrial Organization*, 18: 557-574.

Hopenhayn, H. (1992) “Entry, Exit and Firm Dynamics in Long Run Equilibrium”, *Econometrica*, 60 (3): 1127-1150.

Huergo, E. and J Jaumandreu (2004) “Firms' age, process innovation and productivity growth”, *International Journal of Industrial Organization*, 22 (4): 541-559

Jovanovic, B. (1982) “Selection and Evolution of Industry”, *Econometrica*, 50 (3): 649-670.

Kiefer, NM. (1988) “Economic Duration Data and Hazard Functions”, *Journal of Economic Literature*, 26 : 646-679.

Lotti, F., E Santarelli, and M Vivarelli (2009) “Defending Gibrat's Law as a long-run regularity”, *Small Business Economics*, 32 (1): 31-44.

Mairesse, J. and J Jaumandreu (2005) “Panel-data Estimates of the Production Function and the Revenue Function: What Difference Does It Make?”, *Scandinavian Journal of Economics*, 107(4): 651-672.

Mata, J. and P Portugal (1994) “Life Duration of New Firms”, *Journal of Industrial Economics*, 42 (3): 227-245.

Melitz, MJ. (2003): “The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity”, *Econometrica*, 71(6): 1695–1725.

Nelson, R. and S Winter (1982) *An Evolutionary Theory of Economic Change*, Harvard University Press, Cambridge, EE.UU.

OECD-Eurostat-EIP (2008) *Measuring Entrepreneurship. A Digest of Indicators*, http://www.oecd.org/dataoecd/53/23/41664409.pdf

Rosenberg, N. (1982) *The Black Box: Technology and Economics*, Cambridge University Press, Cambridge, Reino Unido.

Salas, V. and J Sánchez-Asín (2009) “Entrepreneurs and Welfare in Economies with Employers and Own Account Self-Employed” http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1338855

Santarelli, E. and M Vivarelli (2007) “Entrepreneurship and the process of firms’ entry, survival and growth”, *Industrial and Corporate Change*, 16 (3):1-34.

Schumpeter, JA. (1911) *The Theory of Economic Development*, publicado en inglés en 1934 por Harvard University Press y reimpreso en 1997 por Transaction Publishers.

Schumpeter, JA. (1942) *Capitalism, Socialism and Democracy*, reimpreso en 1994 por Routledge.

Segarra, A. M Teruel, JM Arauzo, S Iranzo and V Gombau (2008) *Dinámica empresarial, creación de empleo y productividad en las manufacturas españolas*. Publicado por la Dirección General de Política de Pequeña y Mediana Empresa del Ministerio de Industria, Turismo y Comercio. http://www.ipyme.org/NR/rdonlyres/48D61376-F69E-4E6D-8185-DF118BC8CF69/0/DinamicaEmpresarial.pdf

Segarra, A. and M Teruel (2007) “Creación y supervivencia de las nuevas empresas en las manufacturas y los servicios”, *Economía Industrial*, 363: 45-58.

Segarra, A. and M Callejón (2002) “New firms’ survival and market turbulence: new evidence from Spain”, *Review of Industrial Organization*, 20 (1): 1-14.

Segarra, A, Arauzo JM, Gras N, Manjón M, Mañe, F, Teruel, M and Theilen B (2003) *La creación y la supervivencia de las empresas industriales*, Civitas, Madrid.

Stam, E., K Suddle, A Hessels, and A van Stel (2007) “High Growth Entrepreneurs and Economic Growth”, Jena Economic Research Paper 2007-019.

Sternberg, R. and S Wennekers (2005) “Determinants and Effects of New Business Creation Using Global Entrepreneurship Monitor Data”, *Small Business Economics*, 24(3): 193–203.

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

Teitelbaum, D. and R Axell (2005) “Firm Size Dynamics of Industries: Stochastic Growth Processes, Large Fluctuations, And The Population Of Firms As A Complex System”, SBA Office of Advocacy, report SBAHQ-03-Q-0015.

Teruel, M. (2009) “Gibrat’s Law and the Learning Process”, *Small Business Economics*, en prensa.

Van Stel, A. and M Carree (2002) “Business Ownership and Sectoral Growth”, mimeo, Workshop on the Post-Entry Performance of Firms, Bologna, noviembre 2002.

Wennekers, S., A. van Stel, M Carree, and R Thurik (2008) “The relation between entrepreneurship and economic development: is it U-shaped?”, EIM Research Reports H200824.

A1. ANNEX. European Union Countries with Norway and Switzerland . Average Annual Rates of Business Entry and Exit. Period 1998-2004.

	Gross Entry Rates							Gross Exit Rates						
	Employment at birth													
	All	**0**	1 - 4	5 - 9	10-19	20 or +	**1 or +**	**All**	**0**	1-4	5-9	10-19	20 or +	**1 or +**
EU	**8,4**	**10,6**	5,2	3,4	2,6	0,8	**4,5**	**7,2**	**9,4**	4,5	2,3	1,9	0,8	**3,8**
Belgium	**7,8**	**9,5**	4,9			0,8	**4,0**	**7,7**	**9,8**					**4,0**
Czech R.	**10,7**	**12,4**	6,4	3,6	2,7	1,3	**4,9**	**9,9**	**11,7**	5,5	2,0	1,3	0,7	**4,1**
Denmark	**10,0**	**14,0**	5,6	2,1	1,6	0,5	**4,2**	**8,7**	**12,3**	4,5	1,6	1,2	0,5	**3,4**
Estonia	**13,5**	**31,7**	12,1	4,0	2,8	1,0	**9,1**	**11,2**	**27,3**	10,3	5,4	3,6	2,2	**7,7**
Spain	**9,5**	**12,3**	**7,0**	**5,7**	**4,4**	**1,3**	**6,4**	**6,8**	**8,7**	**5,4**	**3,3**	**2,4**	**0,7**	**4,6**
Italy	**8,1**	**10,1**	3,5	1,7	1,2	0,5	**2,8**	**6,9**	**8,6**	3,0	1,4	0,9	0,4	**2,6**
Latvia	**13,8**	**20,0**	14,9	8,1	5,4	1,8	**10,9**	**11,6**	**37,1**	12,9	3,9	2,6	1,0	**7,8**
Lithuania	**10,6**	**16,5**	11,4	7,5	5,8	2,8	**8,8**	**9,8**	**17,3**	11,6	3,0	1,6	0,9	**7,8**
Luxemburg	**12,3**	**18,1**	11,9	4,7	2,4	0,9	**8,3**	**9,5**	**14,2**	8,8	3,4	2,1	0,6	**6,0**
Hungary	**12,2**	**15,2**	10,6	4,7	4,1	2,7	**9,1**	**10,5**	**14,1**	7,4	4,3	4,0	2,8	**6,6**
Netherlands	**9,3**	**14,7**	6,6	3,3	2,9	0,8	**5,3**	**8,5**	**11,2**	8,1	4,6	3,9	1,8	**6,7**
Portugal	**7,4**	**11,1**	7,5	5,1	3,7	1,5	**6,3**	**4,6**	**5,3**	4,6	2,9	3,2	2,3	**4,0**
Romania	**14,5**	**22,2**	13,9	6,2	4,7	3,2	**10,9**	**10,5**	**22,3**	7,7	3,1	2,7	1,5	**6,2**
Slovenia	**6,7**	**9,8**	5,2	2,2	1,6	0,5	**4,2**	**6,8**	**9,9**	5,7	1,6	1,0	0,4	**4,6**
Slovakia	**11,9**	**18,2**	4,6	3,3	2,8	2,7	**3,5**	**11,9**	**16,1**	7,1	4,9	4,5	5,8	**8,6**
Finland	**7,6**	**11,4**	3,0	0,7	0,3	0,0	**2,2**	**7,0**	**10,6**	2,5	0,9	0,7	0,1	**2,0**
Sweden	**6,4**	**8,4**	4,1	1,7	0,9	0,2	**3,1**	**5,4**	**7,3**	2,6	1,9	1,3	0,8	**2,3**
United Kingdom	**12,8**	**12,9**	15,3	7,1	5,3	1,6	**12,6**	**10,8**	**13,0**	11,5	7,3	6,7	3,5	**10,0**
Norway	**11,0**	**15,7**	9,8	1,9	1,3	0,9	**7,2**	**8,0**	**12,4**	5,5	1,5	1,1	0,6	**4,0**
Switzerland	**3,6**	**4,9**	4,4	1,3	0,7	0,2	**3,0**	**3,6**	**3,9**	4,1	2,7	2,3	1,7	**3,5**

A1. ANNEX (Continuation)

	Net Entry Rates							Rotation Rates						
	Employment at birth													
	All	0	1 - 4	5 - 9	10-19	20 or +	1 or +	All	0	1-4	5-9	10-19	20 or +	1 or +
EU	1,2	1,2	0,6	1,1	0,7	-0,1	0,7	15,6	20,0	9,7	5,8	4,5	1,6	8,3
Belgium	0,1	-0,2				0,8	0,0	15,5	19,3				0,8	8,0
Czech R.	0,7	0,6	0,9	1,6	1,4	0,6	0,8	20,6	24,1	11,9	5,7	4,0	2,0	8,9
Denmark	1,3	1,6	1,1	0,5	0,4	0,0	0,8	18,8	26,3	10,1	3,8	2,7	0,9	7,6
Estonia	2,3	4,4	1,9	-1,4	-0,8	-1,1	1,4	24,7	59,1	22,4	9,4	6,4	3,2	16,8
Spain	2,7	3,6	1,6	2,4	2,0	0,6	1,8	16,4	21,0	12,4	9,0	6,8	2,1	11,0
Italy	1,2	1,6	0,5	0,4	0,3	0,1	0,3	15,0	18,7	6,4	3,1	2,2	0,8	5,4
Latvia	2,2	-17,1	2,0	4,2	2,8	0,7	3,1	25,4	57,1	27,9	12,0	8,0	2,8	18,6
Lithuania	0,7	-0,8	-0,2	4,5	4,1	1,9	1,0	20,4	33,8	23,0	10,5	7,4	3,7	16,5
Luxemburg	2,9	3,9	3,2	1,3	0,3	0,3	2,2	21,8	32,4	20,7	8,0	4,5	1,5	14,3
Hungary	1,8	1,1	3,2	0,4	0,1	-0,1	2,5	22,7	29,2	17,9	8,9	8,0	5,5	15,7
Netherlands	0,8	3,5	-1,5	-1,3	-0,9	-1,0	-1,4	17,7	25,9	14,7	7,9	6,8	2,6	12,0
Portugal	2,8	5,8	2,9	2,2	0,5	-0,8	2,3	12,0	16,4	12,1	8,0	7,0	3,8	10,3
Romania	4,1	-0,1	6,3	3,2	2,0	1,7	4,7	25,0	44,4	21,6	9,3	7,4	4,7	17,1
Slovenia	-0,1	0,0	-0,5	0,6	0,6	0,1	-0,4	13,4	19,7	10,8	3,9	2,6	0,9	8,8
Slovakia	-0,1	2,1	-2,5	-1,7	-1,7	-3,1	-5,0	23,8	34,3	11,7	8,2	7,3	8,5	12,1
Finland	0,6	0,8	0,5	-0,3	-0,3	-0,1	0,2	14,7	22,0	5,4	1,6	1,0	0,1	4,1
Sweden	1,1	1,2	1,5	-0,2	-0,4	-0,5	0,8	11,8	15,7	6,7	3,5	2,2	1,0	5,3
United Kingdom	2,0	-0,1	3,8	-0,2	-1,3	-1,9	2,6	23,6	25,9	26,8	14,5	12,0	5,2	22,6
Norway	3,1	3,3	4,3	0,4	0,3	0,3	3,2	19,0	28,1	15,3	3,4	2,4	1,4	11,2
Switzerland	0,0	1,0	0,2	-1,4	-1,7	-1,5	-0,5	7,2	8,8	8,5	4,0	3,0	1,8	6,5

Source: Eurostat, manufacturing and services, construction excluded.
Net entry rates: gross entry minus gross exit rates. Rotation rates: gross entry plus gross exit rates.
1 or + : business with at least one employee.

2006

CREAP2006-01
Matas, A. (GEAP)**; Raymond, J.Ll.** (GEAP)
"Economic development and changes in car ownership patterns"
(Juny 2006)

CREAP2006-02
Trillas, F. (IEB)**; Montolio, D.** (IEB)**; Duch, N.** (IEB)
"Productive efficiency and regulatory reform: The case of Vehicle Inspection Services"
(Setembre 2006)

CREAP2006-03
Bel, G. (PPRE-IREA)**; Fageda, X.** (PPRE-IREA)
"Factors explaining local privatization: A meta-regression analysis"
(Octubre 2006)

CREAP2006-04
Fernàndez-Villadangos, L. (PPRE-IREA)
"Are two-part tariffs efficient when consumers plan ahead?: An empirical study"
(Octubre 2006)

CREAP2006-05
Artís, M. (AQR-IREA)**; Ramos, R.** (AQR-IREA)**; Suriñach, J.** (AQR-IREA)
"Job losses, outsourcing and relocation: Empirical evidence using microdata"
(Octubre 2006)

CREAP2006-06
Alcañiz, M. (RISC-IREA)**; Costa, A.; Guillén, M.** (RISC-IREA)**; Luna, C.; Rovira, C.**
"Calculation of the variance in surveys of the economic climate"
(Novembre 2006)

CREAP2006-07
Albalate, D. (PPRE-IREA)
"Lowering blood alcohol content levels to save lives: The European Experience"
(Desembre 2006)

CREAP2006-08
Garrido, A. (IEB)**; Arqué, P.** (IEB)
"The choice of banking firm: Are the interest rate a significant criteria?"
(Desembre 2006)

CREAP2006-09
Segarra, A. (GRIT)**; Teruel-Carrizosa, M.** (GRIT)
"Productivity growth and competition in spanish manufacturing firms:
What has happened in recent years?"
(Desembre 2006)

CREAP2006-10
Andonova, V.; Díaz-Serrano, Luis. (CREB)
"Political institutions and the development of telecommunications"
(Desembre 2006)

CREAP2006-11
Raymond, J.L.(GEAP)**; Roig, J.L..** (GEAP)
"Capital humano: un análisis comparativo Catalunya-España"
(Desembre 2006)

CREAP2006-12
Rodríguez, M.(CREB)**; Stoyanova, A.** (CREB)
"Changes in the demand for private medical insurance following a shift in tax incentives"
(Desembre 2006)

CREAP2006-13
Royuela, V. (AQR-IREA)**; Lambiri, D.**; **Biagi**, **B.**
"Economía urbana y calidad de vida. Una revisión del estado del conocimiento en España"
(Desembre 2006)

CREAP2006-14
Camarero, M.; Carrion-i-Silvestre, J.LL. (AQR-IREA)**.**;**Tamarit**, **C.**
"New evidence of the real interest rate parity for OECD countries using panel unit root tests with breaks"
(Desembre 2006)

CREAP2006-15
Karanassou, M.; Sala, H. (GEAP)**.**;**Snower** , **D. J.**
"The macroeconomics of the labor market: Three fundamental views"
(Desembre 2006)

2007

XREAP2007-01
Castany, L (AQR-IREA)**; López-Bazo, E.** (AQR-IREA)**.**;**Moreno** , **R.** (AQR-IREA)
"Decomposing differences in total factor productivity across firm size"
(Març 2007)

XREAP2007-02
Raymond, J. Ll. (GEAP)**; Roig, J. Ll.** (GEAP)
"Una propuesta de evaluación de las externalidades de capital humano en la empresa"
(Abril 2007)

XREAP2007-03
Durán, J. M. (IEB)**; Esteller, A.** (IEB)
"An empirical analysis of wealth taxation: Equity vs. Tax compliance"
(Juny 2007)

XREAP2007-04
Matas, A. (GEAP)**; Raymond, J.Ll.** (GEAP)
"Cross-section data, disequilibrium situations and estimated coefficients: evidence from car ownership demand"
(Juny 2007)

XREAP2007-05
Jofre-Montseny, J. (IEB)**; Solé-Ollé, A.** (IEB)
"Tax differentials and agglomeration economies in intraregional firm location"
(Juny 2007)

XREAP2007-06
Álvarez-Albelo, C. (CREB)**; Hernández-Martín, R.**
"Explaining high economic growth in small tourism countries with a dynamic general equilibrium model"
(Juliol 2007)

XREAP2007-07
Duch, N. (IEB)**; Montolio, D.** (IEB); **Mediavilla, M.**
"Evaluating the impact of public subsidies on a firm's performance: a quasi-experimental approach"
(Juliol 2007)

XREAP2007-08
Segarra-Blasco, A. (GRIT)
"Innovation sources and productivity: a quantile regression analysis"
(Octubre 2007)

XREAP2007-09
Albalate, D. (PPRE-IREA)
"Shifting death to their Alternatives: The case of Toll Motorways"
(Octubre 2007)

XREAP2007-10
Segarra-Blasco, A. (GRIT); **Garcia-Quevedo, J.** (IEB); **Teruel-Carrizosa, M.** (GRIT)
"Barriers to innovation and public policy in catalonia"
(Novembre 2007)

XREAP2007-11
Bel, G. (PPRE-IREA); **Foote, J.**
"Comparison of recent toll road concession transactions in the United States and France"
(Novembre 2007)

XREAP2007-12
Segarra-Blasco, A. (GRIT);
"Innovation, R&D spillovers and productivity: the role of knowledge-intensive services"
(Novembre 2007)

XREAP2007-13
Bermúdez Morata, Ll. (RFA-IREA); **Guillén Estany, M.** (RFA-IREA), **Solé Auró, A**. (RFA-IREA)
"Impacto de la inmigración sobre la esperanza de vida en salud y en discapacidad de la población española"
(Novembre 2007)

XREAP2007-14
Calaeys, P. (AQR-IREA); **Ramos, R.** (AQR-IREA), **Suriñach, J**. (AQR-IREA)
"Fiscal sustainability across government tiers"
(Desembre 2007)

XREAP2007-15
Sánchez Hugalbe, A. (IEB)
"Influencia de la inmigración en la elección escolar"
(Desembre 2007)

2008

XREAP2008-01
Durán Weitkamp, C. (GRIT)**; Martín Bofarull, M.** (GRIT) ; **Pablo Martí, F.**
"Economic effects of road accessibility in the Pyrenees: User perspective"
(Gener 2008)

XREAP2008-02
Díaz-Serrano, L.; Stoyanova, A. P. (CREB)
"The Causal Relationship between Individual's Choice Behavior and Self-Reported Satisfaction: the Case of Residential Mobility in the EU"
(Març 2008)

XREAP2008-03
Matas, A. (GEAP)**; Raymond, J. L.** (GEAP)**; Roig, J. L.** (GEAP)
"Car ownership and access to jobs in Spain"
(Abril 2008)

XREAP2008-04
Bel, G. (PPRE-IREA) **; Fageda, X.** (PPRE-IREA)
"Privatization and competition in the delivery of local services: An empirical examination of the dual market hypothesis"
(Abril 2008)

XREAP2008-05
Matas, A. (GEAP); **Raymond, J. L.** (GEAP); **Roig, J. L.** (GEAP)
"**Job accessibility and employment probability**"
(Maig 2008)

XREAP2008-06
Basher, S. A.; Carrión, J. Ll. (AQR-IREA)
Deconstructing Shocks and Persistence in OECD Real Exchange Rates
(Juny 2008)

XREAP2008-07
Sanromá, E. (IEB)**; Ramos, R.** (AQR-IREA); Simón, H.
Portabilidad del capital humano y asimilación de los inmigrantes. Evidencia para España
(Juliol 2008)

XREAP2008-08
Basher, S. A.; Carrión, J. Ll. (AQR-IREA)
Price level convergence, purchasing power parity and multiple structural breaks: An application to US cities
(Juliol 2008)

XREAP2008-09
Bermúdez, Ll. (RFA-IREA)
A priori ratemaking using bivariate poisson regression models
(Juliol 2008)

XREAP2008-10
Solé-Ollé, A. (IEB), **Hortas Rico, M.** (IEB)
Does urban sprawl increase the costs of providing local public services? Evidence from Spanish municipalities
(Novembre 2008)

XREAP2008-11
Teruel-Carrizosa, M. (GRIT), **Segarra-Blasco, A.** (GRIT)
Immigration and Firm Growth: Evidence from Spanish cities
(Novembre 2008)

XREAP2008-12
Duch-Brown, N. (IEB), **García-Quevedo, J.** (IEB), **Montolio, D.** (IEB)
Assessing the assignation of public subsidies: Do the experts choose the most efficient R&D projects?
(Novembre 2008)

XREAP2008-13
Bilotkach, V., **Fageda, X.** (PPRE-IREA), **Flores-Fillol, R.**
Scheduled service versus personal transportation: the role of distance
(Desembre 2008)

XREAP2008-14
Albalate, D. (PPRE-IREA), **Gel, G.** (PPRE-IREA)
Tourism and urban transport: Holding demand pressure under supply constraints
(Desembre 2008)

2009

XREAP2009-01
Calonge, S. (CREB)**; Tejada, O.**
"A theoretical and practical study on linear reforms of dual taxes"
(Febrer 2009)

XREAP2009-02
Albalate, D. (PPRE-IREA)**; Fernández-Villadangos, L.** (PPRE-IREA)
"Exploring Determinants of Urban Motorcycle Accident Severity: The Case of Barcelona"
(Març 2009)

XREAP2009-03
Borrell, J. R. (PPRE-IREA)**; Fernández-Villadangos, L.** (PPRE-IREA)
"Assessing excess profits from different entry regulations"
(Abril 2009)

XREAP2009-04
Sanromá, E. (IEB)**; Ramos, R.** (AQR-IREA), **Simon, H.**
"Los salarios de los inmigrantes en el mercado de trabajo español. ¿Importa el origen del capital humano?"
(Abril 2009)

XREAP2009-05
Jiménez, J. L.; Perdiguero, J. (PPRE-IREA)
"(No)competition in the Spanish retailing gasoline market: a variance filter approach"
(Maig 2009)

XREAP2009-06
Álvarez-Albelo,C. D. (CREB)**, Manresa, A.** (CREB)**, Pigem-Vigo, M.** (CREB)
"International trade as the sole engine of growth for an economy"
(Juny 2009)

XREAP2009-07
Callejón, M. (PPRE-IREA)**, Ortún V, M.**
"The Black Box of Business Dynamics"
(Setembre 2009)

XARXA DE REFERÈNCIA EN ECONOMIA APLICADA

xreap@pcb.ub.es