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Like milk or wine: Does firm performance improve with age?☆

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ABSTRACT

Little is known about how firm performance changes with age, presumably because of the paucity of data on firm age. We analyze the performance of a panel of Spanish manufacturing firms between 1998 and 2006, relating it to firm age. We find evidence that firms improve with age, because ageing firms are observed to have steadily increasing levels of productivity, higher profits, larger size, lower debt ratios, and higher equity ratios. Furthermore, older firms are better able to convert sales growth into subsequent growth of profits and productivity. On the other hand, we also found evidence that firm performance deteriorates with age. Older firms have lower expected growth rates of sales, profits and productivity, they have lower profitability levels (when other variables such as size are controlled for), and also that they appear to be less capable to convert employment growth into growth of sales, profits and productivity.

1. Introduction

The literature often considers firm size and firm age as alternative measures of the same underlying phenomenon. Although they are closely related there are considerable differences among them. Based on an extensive Spanish dataset, this paper exploits these differences and analyses the relationship between firm performance and firm age for Spanish manufacturing firms with 3 or more employees between 1998 and 2006. This database is obtained from the Spanish business register and exhibits exhaustive information on firm age, performance and financial variables.

This article contributes on the empirical literature by exploiting the fact that we have detailed information on firm age and firm performance. The previous literature does not present the evolution of performance variables over time, while we provide a detailed description over years. This is because many previous datasets do not contain data on firm age. We begin by analyzing the evolution of the firm size distribution (FSD; measured in terms of log sales and log employees) as well as the growth rate distribution. We then explore the evolution of key variables such as financial variables, productivity, profitability, employees and sales, using both a semi-parametric graph-based approach as well as multivariate regressions. We also look at growth rate autocorrelation and estimate a reduced-form vector autoregression model of firm growth

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for different age groups, to get insights into how the growth process changes with age.

Our main results are the following. With reference to the firm size distribution, as in previous works, it becomes less skewed as firms get older. The descriptive analysis also shows that young firms are smaller, less productive and less profitable, but in their early years they experience higher growth rates in terms of sales, productivity and profits. Also as firms get older, the weight of external financial sources steadily decreases while the equity ratio steadily becomes a more important financial source. The autocorrelation coefficients remain negative for older firms, suggesting that firm growth remains an erratic process even for experienced firms. Our vector autoregression results for different age groups suggest that young firms display a higher positive impact of employment growth on profits, sales and productivity, while older firms benefit more from sales growth. Finally, there is a high sensitivity of financial variables to firm growth which diminishes over time. Short-term debt also displays a higher impact than long-term debt on growth.

Our results show that firm performance differs across the life course. Younger firms show a high level of heterogeneity, in terms of firm size, performance and financial sources, but this diversity decreases over time.

The structure of the paper is as follows. The second section reviews the theoretical and empirical literature about firm performance and firm age. The third section describes the dataset. The fourth section shows details on the evolution of some key variables by age. The fifth section contains vector autoregression analysis of firm growth processes for different age groups. Finally, concluding remarks are reported.

2. Literature review

2.1. Theoretical work

A number of theoretical models take firm size and firm age as representing the same fundamental concept. For example, Greiner (1972, p. 39) presents his ‘stages of growth’ model of organizational change in growing firms, in which size is linearly related to age. Other scholars have nonetheless made specific predictions about how firm performance changes with age. We summarize these theoretical predictions in terms of selection effects, learning-by-doing effects, and inertia effects. The way we have summarized these three effects is intended to bring clarity to the topic, at the expense of what might be an overly simplistic presentation of these effects.

2.1.1. Selection effects

Selection effects arise when selection pressures progressively eliminate the weakest firms, and result in an increase in the average productivity level of surviving firms, even if the productivity levels of individual firms do not change with age. This situation corresponds to the model in Jovanovic (1982), whereby firms are born with fixed productivity levels, and learn about their productivity levels as time passes. In Jovanovic’s influential model, low productivity firms are observed to exit, while high productivity firms remain in business. As a result, the average productivity of the cohort increases as the cohort ages, even if the productivity levels of individual firms remain constant over time. This can be written as follows:

$$\frac{d\overline{\pi}}{dage} = \frac{d\left(\sum_{i=1}^{N}\pi_i/N\right)}{dage} > 0, \quad \frac{d\pi_i}{dage_i} = 0 \qquad (1)$$

where π_i corresponds to the productivity level of firm i, and N is the number of surviving firms.

2.1.2. Learning-by-doing effects

Learning by doing effects occur when firms increase their productivity as they learn about more productive production techniques and incorporate these improvements in their production routines (for an early contribution, see Arrow (1962), see also Vassilakis (2008) for a survey of the learning-by-doing concept). Learning by doing effects can be expected to be particularly relevant for young firms. Garnsey (1998, p. 541) writes that:

> “New firms are hampered by their need to make search processes a prelude to every new problem they encounter. As learning occurs, benefits can be obtained from the introduction of a repertoire of problem-solving procedures. . . eliminating open search from the problem-solving response greatly reduces the labour and time required to address recurrent problems.”

Furthermore, older firms may benefit from their greater business experience, established contacts with customers, and easier access to resources.

This can be written as follows:

$$\frac{d\pi_i}{dage_i} > 0 \qquad (2)$$

For example, Sorensen and Stuart (2000) point out that entrepreneurs often lack detailed information about their jobs, firms and even the environments until they are active in the market. After a firm’s creation, an intense learning process starts and contributes to the firm’s growth and survival in the long-term. Chang et al. (2002) also provide evidence on the existence of microeconomic “learning-by-doing” effects with positive effects on the aggregate output.

2.1.3. Inertia effects

As firms get older, they might become less productive if they become increasingly inert and inflexible. Barron et al. (1994) argue that old firms are prone to suffer from a ‘liability of obsolescence’ (because they do not fit in well to the changing business environment) and also a ‘liability of senescence’ (according to which they become ossified by accumulated rules, routines and organizational structures). These negative effects, which may be especially important for very old firms, can be denoted as follows:

$$\frac{d\pi_i}{dage_i} < 0 \qquad (3)$$

At a theoretical level Hannan and Freeman (1984) justify inertia effects as “*an outcome of an ecological-evolutionary process*”. The idea is that firms are not able to change as fast as their environments. Firms with inertia effects can survive applying strategies such as the creation of new firms designed specifically to take advantage of new opportunities. However, if firms are not able to adapt applying strategies, new entrants will enter in the industry. Accordingly, it is environmental changes, which favour some (inert) bundles of firm resources over others, that lead to differences in firm performance.

Nevertheless, the three of these effects (i.e. selection, learning-by-doing and inertia) can be operating simultaneously on the industry. From a resource-based view, Helfat and Peteraf (2003) point out that in the market learning effects and inertia effects may coexist, suggesting that there exists a heterogeneity of capabilities and resources among firms. Those authors introduce the concept of the capability lifecycle in order to provide an explanation for the emergence and sustained heterogeneity of capabilities. Others such as Levinthal (1991) pointed out that firm learning contributes to organizational inertia and inertial forces, which are a prerequisite for intelligent adaptation.

2.2. Empirical work

Early empirical work on firm dynamics looked at firm size but not firm age. The seminal work by Gibrat (1931) led to interest in the firm size distribution (e.g. Hart and Prais, 1956; Simon and Bonini, 1958) and also in the relationship between firm size and growth rate (e.g. Hall, 1987; Hart and Oulton, 1996).[1] Later on, however, interest in firm age began to grow, as some studies included age as an explanatory variable in regressions that investigate differences in firm performance. A number of studies observed that age is usually negatively related to expected growth rate as well as growth rate variance.[2]

The relationship between firm age and survival has also been investigated by many researchers (see for example Evans, 1987a,b; Fariñas and Moreno, 2000; Mata and Portugal, 2004; Bartelsman et al., 2005), but the results have not been clear-cut. An early contribution coined the term 'liability of newness' to describe how young organizations face higher risks of failure (Stinchcombe, 1965). More recently, however, authors have referred to the 'liability of adolescence' (Bruderl and Schussler, 1990; Fichman and Levinthal, 1991) to explain why firms face an initial 'honeymoon' period in which they are buffered from sudden exit by their initial stock of resources. Still others have identified the above-mentioned liabilities of senescence and obsolescence according to which older firms are expected to face higher exit hazards once other influences (such as firm size) are controlled for.

More recently, researchers have begun to take more interest in the role age plays in the performance of surviving firms. Some authors have investigated age effects by focusing specifically on samples of young firms (Calvo, 2006; Garnsey et al., 2006; Stam and Wennberg, 2009). Some researchers have focused on the functional form of the aggregate age distribution, showing that the empirical density is well approximated by an exponential distribution (Coad, 2010a), while others have tracked the evolution of the FSD over time, for cohorts of ageing firms (Cabral and Mata, 2003; Angelini and Generale, 2008; Cirillo, 2010).

Other research has focused on differences in performance and behaviour across firms of different ages. For instance, it has been suggested that the age of a firm is positively related to its productivity levels (Haltiwanger et al., 1999), a finding that we verify in our data. Brown and Medoff (2003) investigate whether older firms pay higher wages. Bartelsman et al. (2005, p. 386) compare the post-entry growth rates of North American and European firms. Bellone et al. (2008) examine how pressures related to market selection (i.e. firm survival) change as firms age. Others have investigated how the probability of innovation and productivity growth change across the firm age distribution (Huergo and Jaumandreu, 2004a,b). Autio et al. (2000) observe that young international firms – 'born global' firms – experience faster growth in international sales than their older counterparts. They interpret this finding as evidence that younger firms are better able to develop export capabilities because they are better able to learn how to succeed in uncertain environments.

Attention has also been given to changes in financial structure in ageing firms. The link between financial structure and firm size has been analyzed exhaustively (Beck et al., 2005; Beck and Demirguc-Kunt, 2006; Oliveira and Fortunato, 2006), but the analysis between financial structure and firm age are more scarce. However, recently some papers show that the key variable in the analysis of financial constraints is firm age. For instance, Binks and Ennew (1996) report that young firms are more financially constrained. However, financial structure is not independent of firm age. For young firms, the ability to obtain external finance is a key factor in their development, growth and survival. Access to external finance has a particular impact on the entry of small firms, and that it improves market selection by allowing firms to be more competitive on a more equal footing (Aghion et al., 2007a). Additionally, financial accessibility significantly facilitates the post-entry growth of firms (Aghion et al., 2007b). Fluck et al. (1997) found that external finance decreases as a proportion of total finance over the first 7–8 years of a firm's life, while Berger and Udell (1998, p. 620) show that a firm's debt ratio decreases once small firms pass their adolescence period (3–4 years old). Similarly, Reid (2003) tracks small businesses in their first few years after inception and observes that the debt ratio decreases over time. We complement this body of research on the financial structure

[1] For a survey of the literature see Sutton (1997) and Coad (2009).

[2] Research that has found a negative effect of age on firm growth includes Fizaine (1968) Evans (1987a,b), Dunne et al. (1989), Dunne and Hughes (1994), Fariñas and Moreno (2000), Correa et al. (2003) and Geroski and Gugler (2004). While most studies find a negative effect of age on growth, a few have found a positive effect of age on growth (Das, 1995; Shanmugam and Bhaduri, 2002). Still others find an inverted U-shape relationship (Teruel-Carrizosa, 2010). Lotti et al. (2009) observe that while the growth of young firms displays a negative dependence on age, this becomes insignificant as time passes and the cohort of firms grows older. Moreno and Casillas (2007) observe that firm age does not help to discriminate between high-growth firms and moderate-growth firms in their sample of 7752 small Andalusian firms. A negative effect of age on growth rate variance has been found by Evans (1987a) and Dunne et al. (1989), among others.

of very young firms by describing how financial structure changes over a wider range of firm ages, for both young and also relatively old firms.

This brief literature review has shown that, although progress has been made in our understanding of how firm age affects firm performance, there are still many opportunities remaining for improving our understanding of how firm behaviour changes as firms grow older. One reason, it seems, is the paucity of data on firm age in administrative datasets (and also for data coming from questionnaires). Headd and Kirchhoff (2009, p. 548) write that there is a "dearth of information by business age. Simply stated, industrial organization and small business researchers are deprived of firm-age data." Some researchers have tackled these data limitations by using indirect measures of firm age.[3] In this dataset of Spanish firms, however, age is directly reported for all firms. Thus, we complement the literature by investigating changes in firm growth and performance in separate subsamples of firms of different ages.

3. Data

This study uses the Spanish Mercantile Register through the System of Analysis of Iberian Balance Sheets (SABI database) compiled by Bureau van Dijk. This database offers exhaustive information over balance sheets and financial sources for an important number of firms. This sample contains 73,891 manufacturing firms in 2006 year that represents 51.29% from the total population firms in manufacturing sectors. Thus, a database like this is suitable for studying how firm performance varies with age.

Our dataset is composed of manufacturing sectors belonging to the NACE classification with codes between 15 and 36[4] during the period 1998–2006.[5] We restrict our analyses to firms with 3 or more employees, so the sample is limited to 62,259 firms, and covers 61.72% of total Spanish manufacturing firms with 3 or more employees.[6]

This sample conforms to an unbalanced panel-data format. During the intermediate years of the period – between 2002 and 2004 – the number of firms that enter in the Spanish Business Register increased. One possible explanation for this is that the Mercantile Register has improved its monitoring of active firms' balance sheets over the time period.[7]

The variables that we use for the empirical analysis are the following. Firm age is the difference between the current year and the year of firm creation according to registration of the firm in the Mercantile Register. All firm performance variables (sales, value added, profits, equity, short-term and long-term debt) are deflated using the sectoral Industrial Price Index of the Spanish National Institute of Statistics. Productivity is defined as value added divided by employees (i.e., labour productivity). Profitability is the ratio between accounting profits and sales, corresponding to the 'Return on Sales' ratio (following e.g. Bottazzi et al., 2008), where our profits variable is defined as operating income less expenditures (including those related to financial operations). Short-term debt ratio, Long-term debt ratio and Equity ratio are calculated as the ratios between those financial variables and total assets (following e.g. Sogorb-Mira, 2005).

Table 1 shows the median and standard deviation in 2006 of the main descriptive variables from our database (further descriptive statistics can be found in Table A1 in the Appendix). We classify firms into three roughly homogenous age groups.[8] First, all the absolute variables increase with firm age group. In other words, when firms get older they are in general larger, their sales increase and their efficiency and profitability are also higher. Second, financial variables such as total amounts of short-term and long-term debt increase over time. Third, when we consider financial ratios defined in terms of debt/assets we find a negative relationship between firm age group and the ratio of external finance to assets. One possible explanation is that older firms are able to accumulate more internal financial resources and, thus, they are less dependent of external finance (which would be consistent with the 'Pecking Order Theory' of financial structure (Myers and Majluf, 1984)).

Long-term debt is related to the ability of firms to provide assurances about their assets. The related literature on corporate finance shows that young, small firms usually are less able to obtain internal funds. As a consequence, firms with greater difficulties have restricted access to credit, and often finance their investment projects with short-term finance, which is more expensive. Less informed investors may undervalue firms and, as a consequence, may ask for

[3] For example, Winker (1999) argues that firm size (measured as number of employees) can be used as a proxy for firm age. Bellone et al. (2008) do not have any direct data on firm age (their INSEE/EAE database does not contain any direct information on firm age), but age is calculated indirectly by considering the first time a firm is included in the national statistical office records – which essentially corresponds to the first time a firm passes the 20 employee threshold above which firms are required to send data to the national statistical office. Although there is only an imperfect correspondence between a firm's birth and the first time its employment exceeds 20 employees, this methodology can be justified because most manufacturing firms enter at a relatively large size (compared to service firms), and because their analysis centers on changes within ageing firms over time, rather than the performance of firms at specific ages. Another, related, approach used for calculating age is by measuring age relative to whether firms are present during the first year of the time period covered by the database (this approach is taken by e.g. Kandilov (2009), who takes firm age as a control variable). Yet another method for obtaining data on firms is by painstakingly collecting information on each individual firm one at a time (see e.g. Mishina et al., 2004, p. 1188) – a methodology which is hardly feasible for large samples of small firms.

[4] Here sectors 16 (tobacco) and 23 (petroleum) are not included given their sectoral specificities.

[5] Although there is information available for year 2007, it remains still incomplete and so we restrict our analysis until 2006.

[6] We have data on smaller firms, but we choose the cut-off point at 3 employees because the data on smaller firms is particularly noisy.

[7] Our database has difficulty detecting when a firm exits the market, given that firms must report their exit to the Mercantile Register. In some cases exiting firms forget to give information about their exits, while continuing firms might ignore their obligation to send the information. Although this may only affect a small share of firms, tracking them is a difficult task.

[8] Here, we homogenize the groups according to the number of observations. However, previous empirical works distinguish different firm age classification. For instance, Berger and Udell (1998) classify firms in four periods: 'Infant' (0–2 years), 'Adolescent' (3–4 years), 'Middle-aged' (5–25 years) and 'Old' (25 or more years).

Table 1
Descriptive statistics.

	All	Less than 10 years	Between 10 and 19	20 or more years
Median and standard deviation in 2006				
Employees	10	7	10	19
	(99.07)	(57.73)	(78.15)	(158.70)
Sales	768.96	508.13	723.59	1879.32
	(44,500.19)	(19,782.46)	(50,359.21)	(58,684.61)
Added value	270.07	179.31	260.18	631.05
	(6772)	(4396.40)	(5872.75)	(10,152.02)
Productivity	26.71	23.71	26.22	32.58
	(90.04)	(138.05)	(39.43)	(46.89)
Profitability	1.53	1.26	1.66	1.74
	(67,993.88)	(112,724.9)	(723.37)	(209.27)
Financial structure				
Short-term debt	297.87	217.09	272.28	638.86
	(19,370.84)	(8726.03)	(14,785.15)	(32,838.44)
Long-term debt	62.34	53.54	57.59	96.88
	(7775.45)	(8231.64)	(5394.27)	(10,022.65)
% over total assets				
Short-term debt	51.39	60.28	50.05	42.71
	(221.95)	(351.76)	(58.09)	(105.82)
Long-term debt	10.45	14.69	10.45	6.17
	(95.69)	(151.39)	(32.66)	(39.74)
Growth variables				
Employees	0	0	0	0
	(120.97)	(154.59)	(100.34)	(96.21)
Sales	6.93	11.84	5.78	4.32
	(24,230.72)	(41,670.9)	(134.14)	(324.17)
Added value	5.96	10.54	4.90	2.98
	(575,010.1)	(985,298.70)	(8055.37)	(777.11)
Productivity	3.83	4.65	3.53	3.34
	(10,093.04)	(17,350.76)	(342.42)	(783.38)

Source: Own elaboration.

higher interest rates. In addition, the risk of failure is higher for small and young firms, and so banks may prefer lending on a short-term contract in order to gain control over the firm and its investment decisions, while long-term debt is more suited for firms that invest in projects that do not provide an immediate pay-off (Myers, 2001). Our results are partially consistent with this line of reasoning, because the short-term debt ratio decreases with age. However, we also observe that the long-term debt ratio decreases with age, which suggests that even the youngest firms in our sample can obtain access to long-term debt.

Finally, regarding the growth variables, median growth rates decrease over the age groups regardless the variable. The only exception is employee growth which remains constant with a value equal to 0. Consequently, our data show that the median young firm improves more in terms of efficiency and market share in comparison with the median old firm.

Fig. 1 presents the age distribution for firms in our sample. We observe that young firms are the most numerous, and that, above the mode, the number of firms steadily decreases with age in a way that might resemble exponential decay (more on this in Coad, 2010a). The modal age for the year 2006 is 11 years, which suggests that young firms are under-represented in our database (Presumably, under-representation of very young firms can also help explain the peculiar age distributions found in Huergo and Jaumandreu (2004a, p. 198; 2004b, p. 558) and also Fagiolo and Luzzi (2006, p. 31).).[9] We therefore draw the reader's attention to the likely under-representation of very young firms in our data, which can be expected to

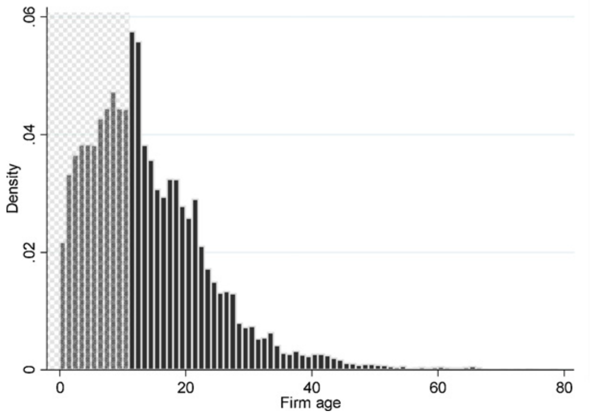

Fig. 1. the age distribution for the year 2006. The shaded area highlights the area below the mode, where we suspect that young firms are particularly under-represented.

[9] The database analyzed in Huergo and Jaumandreu (2004a,b) has a modal age category from 5 to 8 years (if we ignore the residual 37+ age category), and the data in Fagiolo and Luzzi (2006) is apparently well approximated by a lognormal distribution, indicating that the mode is not the minimum observation.

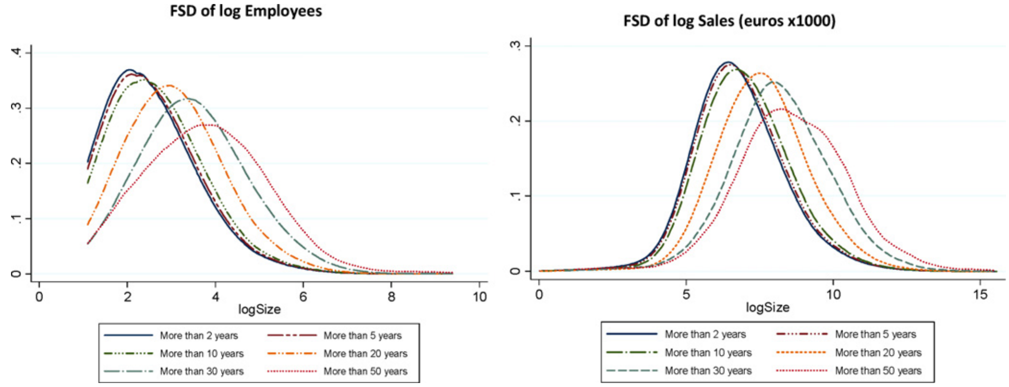

Fig. 2. Kernel density estimates for the firm size distribution (FSD) of Spanish manufacturing firms by age in 2006. The kernel density is estimated with an Epanenchnikov kernel bandwidth equal to 0.5.

have some implications on how our results should be interpreted. In particular, our data on very young firms may well be over-representative of larger firms with above-average performance.

4. Analysis

4.1. Evolution of the firm size distribution

We analyze first the evolution of the FSD according to employees and sales (Fig. 2). In line with Cabral and Mata (2003), the FSD of employees for the whole sample (solid line) appears skewed towards the right. Furthermore, Fig. 2 sheds light on how the firm size distribution evolves with age. Specifically, the skewness of the FSD of employees diminishes when considering older firms (this is confirmed by an inspection of the skewness statistics for the relevant age classes). Fig. 2 (right) shows the corresponding plot for the sales FSD. Our results appear to be in line with Cabral and Mata (2003), Angelini and Generale (2008) and Cirillo (2010).[10]

4.2. Evolution of the growth rates distribution

Figs. 3 and 4 present the growth rate distributions for employment growth rates and sales growth rates, for three age categories. In line with previous work (e.g. Bottazzi and Secchi, 2006), we observe that the growth rate distributions are 'tent-shaped', indicating that most firms have growth rates close to zero while a non-negligible proportion of firms experience rapid growth or decline. An interesting finding that is clearly visible in both of these plots is that while the left tail of the growth rate distribution seems roughly invariant to age, the right tail displays some dependence on age. These plots suggest that older firms are less likely to experience very fast growth rates (in terms of both employment and sales), although they have roughly the same chances as younger firms of facing accelerated decline. These growth rate distribution plots provide an interesting twist to the previous finding of a negative dependence of growth on age, by suggesting that age lowers the probability of firms experiencing fast growth while having little effect on the probability of firm decline. Our results are consistent with the quantile

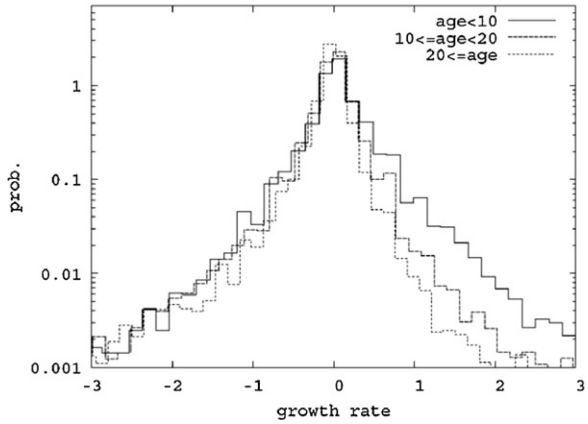

Fig. 3. Growth rate distributions for employment growth rates, for different age categories. Note the log scale on the y-axis. Kernel density fitted using an Epanenchnikov kernel (using gbutils 5.2).

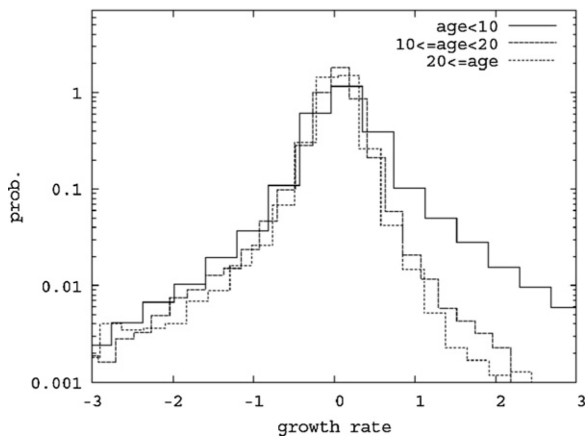

Fig. 4. Growth rate distributions for sales growth rates, for different age categories. Note the log scale on the y-axis. Kernel density fitted using an Epanenchnikov kernel (using gbutils 5.2).

[10] However, Fagiolo and Luzzi (2006) report that they find no evidence for an evolution from a right-skewed to a log-normal size distribution.

regression analysis in Reichstein et al. (2010) and Serrasqueiro et al. (2010), who observe that firm age has a significantly negative impact on growth for the positive-growth quantiles but a less significant effect on growth for the negative-growth quantiles of the growth rate distribution.

4.3. Evolution of key variables

In order to go deeper into the analysis of the market selection mechanism along the firm life cycle, this section investigates the evolution of a number of key variables as firms age: (log) sales, profitability, productivity, (log) profit levels, growth rates (of sales, productivity and profits); and also financial variables (short-term debt, long-term debt and equity measured as a ratio over total assets). Our methodology of plotting the evolution of key variables by age builds on work by Fariñas and Moreno (2000, p. 259) and Huergo and Jaumandreu (2004a,b).

Given that our database compiles information on all firm sizes, it is highly affected by the presence of extreme values. Although we restrict our analysis to firms with at least three employees, we still have many extreme observations that we would prefer not to drop because they are nonetheless meaningful observations. Thus, we show the median values for all variables because means are heavily influenced by extreme values (especially for the financial ratio variables). We should comment also that we do not plot the median employment growth rate, because this is 0.00 in most cases corresponding to small firms that do not change their numbers of employees from 1 year to the next.

With respect to the evolution of log sales and profitability (measured as the ratio of profits over sales) we can see a positive evolution of the variables over time. Thus, young firms have less log sales and profitability in comparison to older firms that were active in the market in 2006. This positive evolution of the median values reflects two trends.

First, the market pressures firms to increase their profitability and also their sales in order to survive. In fact, these results are also confirmed by the evidence on the evolution of the log productivity and the log profits (Fig. 6) given that those variables increase for each age.

Second, Figs. 5 and 6 show evidence on the firms' capacity to grow over time. There appears to be an increase in productivity and profits when they are young, while their values stabilize in later years. Fig. 7 shows the evolution of the growth rate of sales, productivity and profits according to firm age. Results confirm that young firms initially grow faster than older firms, although we caution that this may well be an artefact of selection bias, whereby unsuccessful young firms are under-represented. We are already aware that young firms are under-represented in our data by looking at the age distribution presented earlier in Fig. 1.

One crucial variable affecting firm performance is access to financial markets. In that sense, Fig. 8 shows the evolution of three financial variables in terms of ratios with respect to a firm's total assets – the short-term debt ratio (*ST debt ratio*), the long-term debt ratio (*LT debt ratio*), and the equity ratio (*Equity ratio*). In our dataset, short-term and long-term debt are negatively correlated with financial performance, indicating that resorting to debt finance is

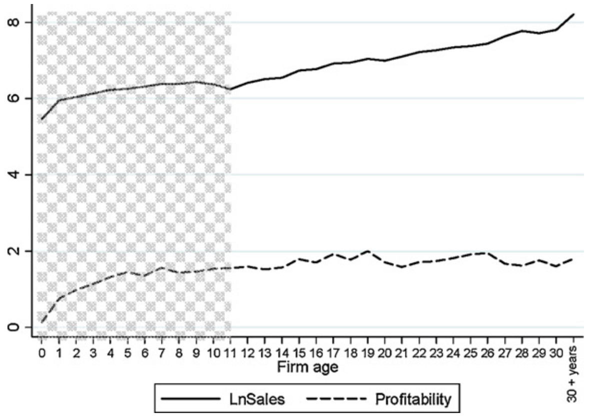

Fig. 5. Evolution of (log) sales and profitability as firms' age in 2006. Median values. Profitability is reported as a percentage. The shaded area highlights observations that we suspect are likely to be affected by sample selection bias.

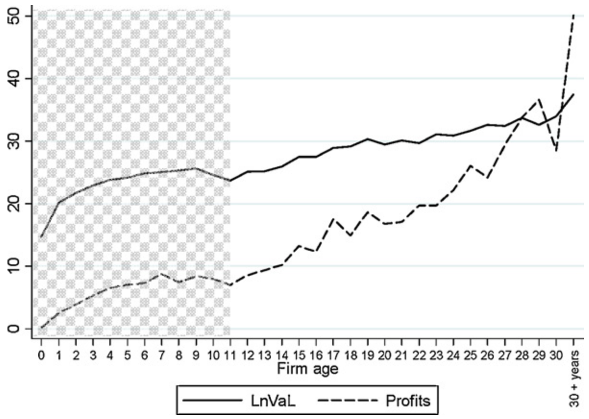

Fig. 6. Evolution of productivity and profit levels as firms age in 2006. Median values. The shaded area highlights observations that we suspect are likely to be affected by sample selection bias.

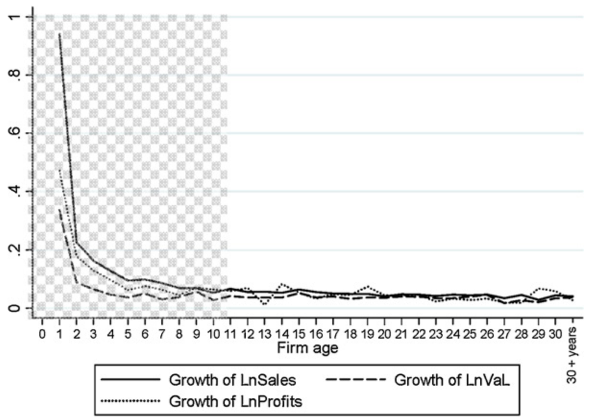

Fig. 7. Evolution of growth of sales, growth of productivity, and growth of profits as firms age in 2006. The shaded area highlights observations that we suspect are likely to be affected by sample selection bias.

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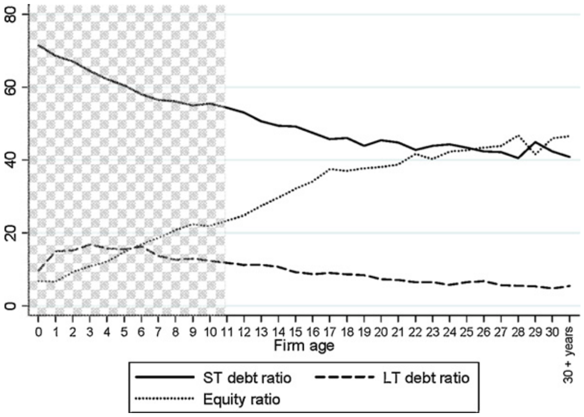

Fig. 8. Evolution of financial variables as firms age – long-term debt ratio, short-term debt ratio, and equity ratio in 2006. The shaded area highlights observations that we suspect are likely to be affected by sample selection bias.

more common in badly performing firms.[11] With financial frictions, young firms probably suffer from a higher need of external finance. On the one hand, our evidence shows that the median value of the short-term debt ratio for young firms is higher than for older firms. Also the long-term debt ratio presents a higher value during the first years. Generally speaking, external debt decreases over time. On the other hand, the ratio of the equity over assets presents a positive trend over time. In other words, young firms have a lower ratio of own financial resources than older firms. Similar results have been previously obtained by Hall et al. (2000), and also Segarra et al. (2010) on a similar database for Catalan manufacturing firms.[12]

Our results show that even the youngest firms in our database have access to long-term debt, and that the long termdebt ratio decreaseswith age,which suggests that the difficulties for young firms in obtaining long-term finance should not be exaggerated.

However, capital structure changes over firm age. During a firm's infancy period the availability to obtain internal equity tends to be extremely limited and younger firms report a relatively high debt finance ratio. As the firm establishes itself, however, it gains access to resources from its own productive activity – commercial borrowings, internal cash flow – and sources of external finance. Hence, over time firms tend to increase their internal equity ratio and decrease the level of debt.[13]

The firm's ability to gain access to external financial sources and their needs to finance can be expected to vary with firm age. Young firms usually obtain less long-term bank debt and have limited equity capital in absolute

Table 2
multivariate LAD regressions.

	Productivity	Profitability	Equity ratio
LnAge	0.0530	−0.1164	3.2366
	(42.67)	(−14.19)	(93.21)
LnSize	0.1135	0.2390	1.3441
	(116.28)	(37.06)	(49.23)
STDR	−0.1551	−1.9734	−33.8239
	(−88.97)	(−171.26)	(−694.75)
LTDR	−0.0338	−0.5341	−8.0998
	(−47.69)	(−114.02)	(−408.49)
Obs.	302,621	302,206	302,584
R^2	0.1235	0.0099	0.1508

Note: *t*-Statistics appear in brackets.

values. Young firms depend basically on internal cash-flow and commercial debt. As the firm matures, equity capital and internal reserves acquire a more important role. Furthermore, internal cash-flow increases with firm age, in particular among those firms older than 50 years (Segarra and Teruel, 2009).[14]

We have observed that older firms are more productive and more profitable, and also that they are of a larger size. Are these older firms more productive because of their size, or is there a distinct age effect that can be detected while controlling for firm size? To investigate this potential age effect, we estimate the following regression equation:

$$P_{it} = \alpha_1 \mathrm{LnAge}_{,t-1} + \alpha_2 \mathrm{LnSize}_{i,t-1} + \alpha_3 \mathrm{STDR}_{i,t-1} + \alpha_4 \mathrm{LTDR}_{i,t-1} + \varepsilon_{it} \quad (4)$$

where P corresponds to either productivity, profitability, or the equity ratio. We include age as a independent variable, and controlling for firm size (i.e. $\log(\mathrm{empl})_{i,t-1}$), short-term (STDR) and long-term debt ratios (LTDR), and also two-digit industry and year effects.

These regression results (Table 2) show that there is a distinct age effect, operating independently of firm size. We observe that age has a positive effect on productivity, even after controlling for other influences. Interestingly enough, however, age has a negative effect on profitability. Although Fig. 5 shows that profitability increases with age, when we control for other factors such as size, the effect of age becomes negative. While older firms are more profitable, on average, this is mainly because they are bigger. This is because their large size confers higher profitability levels, but the distinct effect of age is negative. Finally, the results in Table 2 show that age also has a large positive effect on the equity ratio.

Here, we present evidence related to firm performance and financial sources. How does theory link firm financial structure with age? Recently Berger and Udell (1998) developed a Financial Growth Cycle Model for small firms

[11] The rank correlations between the short-term debt ratio and profitability, and long-term debt and profitability, respectively, are −0.2946 and −0.1135.

[12] Their results show an inverse link between firm age and debt ratios but a positive relationship between firm age and debt absolute values.

[13] In general, these results are in line with Financial Corporate Theories (Hamilton and Fox, 1998). This evidence shows that firm age is critical. There is a monotonic improvement of the equity ratio as the firm age increases. There is strong evidence that at least some aspects of the financing patterns change over time.

[14] For an extensive sample of Spanish manufacturing firms in the year 2006, for young firms (less than six years) equity capital represents just 6.9% of their total liabilities, while commercial borrowings account for up to 71.1%; and for older firms (with more than fifty years) their equity capital is equivalent to 27.3%; their short-term bank debt is equal to 36.5%, and their long-term bank debt is equal to 11.2% of total liability. Furthermore, internal cash flow increases with a firm's age, in particular among those firms older than fifty years.

where the financial needs and financing options change as the size, age and information. When firms become older, more experienced, and more transparent, it is more likely that they will gain access to public equity or long-term debt financing.[15] Berger and Udell's (1998) model offers a complementary vision of the pecking order theory, proposed by Myers (1984). Myers proposes that firms prefer to use internal sources of capital first and will use external sources only if internal sources are inadequate. Pecking order theory has been found to be particularly relevant in the small-business arena. Holmes and Kent (1991) found that small businesses experience a more intense version of pecking order in their decisions because their access to appropriate external sources of capital is limited. While it has been noted that small businesses differ from larger firms in terms of capital structure decisions, their intense reliance on pecking order is only one of the variables that make small-business financing decisions unique.

4.4. Regression analysis for different ages

We continue our investigation of how firm performance changes with age by plotting the evolution of some key regression coefficients relating to the dynamics of sales growth and profits growth (but not employment growth).[16] The autocorrelation coefficients are obtained through use of the following equation:

$$\mathrm{Gr\_Sales}_{it} = \beta_1 \mathrm{Gr\_Sales}_{i,t-1} + \beta_2 \mathrm{CTRL}_{i,t-1} + \varepsilon_{it} \qquad (5)$$

$$\mathrm{Gr\_Profits}_{it} = \gamma_1 \mathrm{Gr\_Profits}_{i,t-1} + \gamma_2 \mathrm{CTRL}_{i,t-1} + \varepsilon_{it} \qquad (6)$$

where Gr_Sales is the growth rate of sales, and Gr_Profits is the growth rate of profits (both are calculated by taking log-differences of levels). Our control variables ("CTRL") include lagged log size measured as number of employees (LnSize) and, following Sogorb-Mira (2005), also long-term and short-term financial ratios over assets (LTDR and STDR), as well as sets of dummy variables to control for specific years and two-digit industrial sectors. The regression equations are estimated using LAD (i.e. median regressions) that are less sensitive to outliers than OLS. This is especially important here, because previous work has shown that OLS and LAD give quite different estimates of autocorrelation coefficients for firm growth (Bottazzi et al., 2011).

We plot the evolution of the regression coefficients β_1 and γ_1 in Figs. 9 and 10. While the magnitudes of the autocorrelation coefficient profiles differ for sales growth and profits growth, the shape of the profiles across age classes is similar for these two growth variables.

Very young firms have the most positive autocorrelation coefficients, suggesting that their previous performance will, on average, tend to repeat itself in the early years. However, this result contrasts with previous work emphasizing the prevalence of growth setbacks for young firms (Garnsey et al., 2006) and so we view our results for very young firms with a little caution.[17]

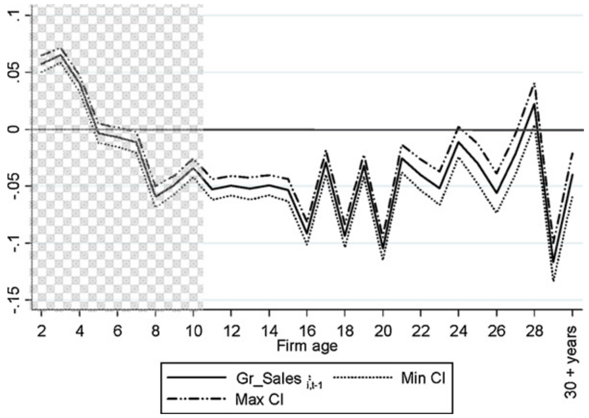

Fig. 9. Autocorrelation coefficient for the growth of sales – i.e. β_1 from Eq. (5), for firms of different ages. LAD coefficient estimate, with 95% error bars. The shaded area highlights observations that we suspect are likely to be affected by sample selection bias.

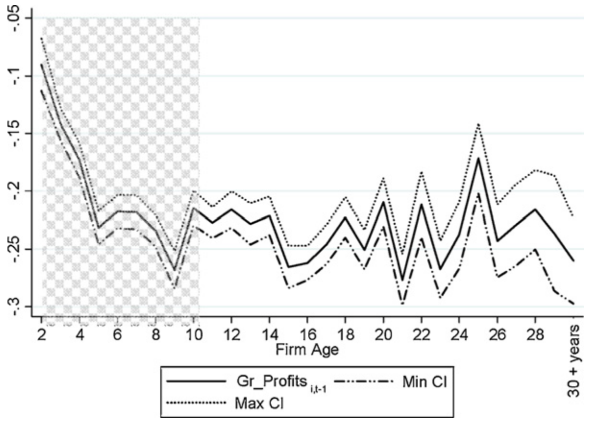

Fig. 10. Autocorrelation coefficient for the growth of profits – i.e. γ_1 from Eq. (6), for firms of different ages. LAD coefficient estimate, with 95% error bars. The shaded area highlights observations that we suspect are likely to be affected by sample selection bias.

[15] Using an extensive sample with 22,842 firms for year 2003 from Spanish SABI database, Sánchez-Vidal and Martín-Ugedo (2008) test the Berger and Udell's (1998) model. Results show that firms tend to have different financing structures depending on age and size. The main results are: (i) the hypothesis about equity is not confirmed, because older firms tend to have higher equity values, caused by the increasing reserves; (ii) risk of the firm decrease with age. Also, López-Gracia and Aybar-Arias (2000) and Sánchez-Vidal and Martín-Ugedo (2005) empirically test the pecking order theory with samples of Spanish firms.

[16] We investigated the autocorrelation of employment growth, but since many (small) firms do not change the number of employees from one year to the next, the autocorrelation coefficients estimated by median regressions (LAD) are 0.0000 in many cases, which makes the results relatively uninteresting.

[17] We already mentioned, in our comments on the aggregate age distribution in Fig. 1, that very young firms might be underrepresented in our database (and also in other related empirical studies such as Huergo and Jaumandreu (2004a,b) and Fagiolo and Luzzi (2006)) if the true age distribution is supposed to be approximately exponential. If our dataset is biased towards including only those more successful young firms, then the autocorrelation coefficients might be biased upwards for very young firms, if those young firms that enjoy sustained success in their early years

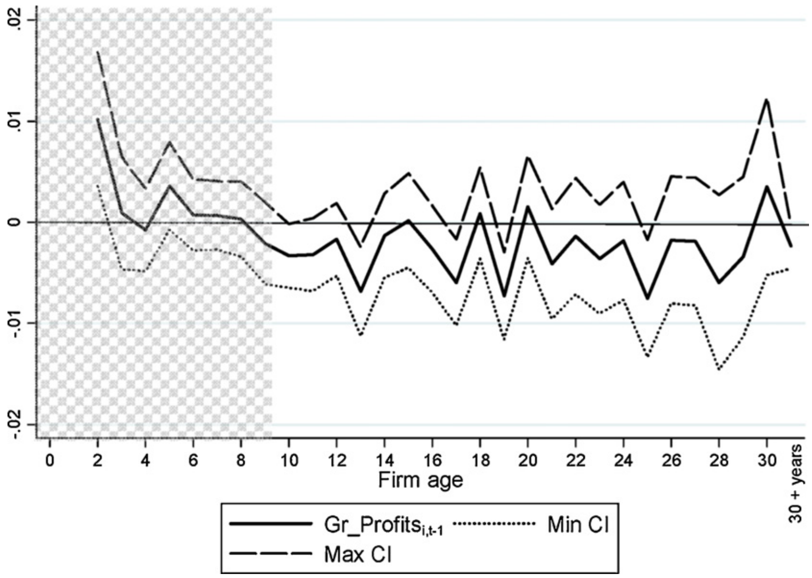

Fig. 11. Sensitivity of firm growth to growth of profits – i.e. δ_1 from Eq. (7), for firms of different ages. LAD coefficient estimate, with 95% error bars. The shaded area highlights observations that we suspect are likely to be affected by sample selection bias.

After a few years, however, the autocorrelation coefficient decreases, and stabilizes at this lower level, and does not change in any clear way as firms age. It is interesting that older firms, that have more experience, still experience negative growth rate autocorrelation, suggesting that their growth events are marked by an erratic 'start-and-stop' dynamics as opposed to a smoother, more gradual growth. This negative autocorrelation in growth rates therefore seems to be a regular feature of the growth process, across a wide range of firms of all ages.

We now investigate the evolution of some other key coefficients of firm behaviour. The relationship between financial performance and growth is of major interest to scholars of industrial development (Bottazzi et al., 2010). To investigate this, we estimate the following regression equation:

$$\begin{aligned}\text{Gr\_Sales}_{it} = {} & \delta_1 \text{Gr\_Profits}_{i,t-1} + \delta_2 \text{STDR}_{i,t-1} + \delta_3 \text{LTDR}_{i,t-1} \\ & + \delta_4 \text{CTRL}_{i,t-1} + \varepsilon_{it} \end{aligned} \tag{7}$$

where Gr_Sales is the log growth of sales, Gr_Profits is the log growth of profits, and STDR and LTDR correspond to the short-term and long-term debt ratios, respectively. Our control variables here are lagged size, measured in terms of log(employees), and also year and two-digit industry dummies. Bearing in mind that we have shown above that the growth rate possesses an autoregressive structure, we also include the lagged growth rate of sales as a control variable. We focus our attention on the coefficients δ_1, δ_2, and δ_3, and we plot these coefficients in the following graphs (Figs. 11–13).

are over-represented. We hope that future work will shed light on this issue.

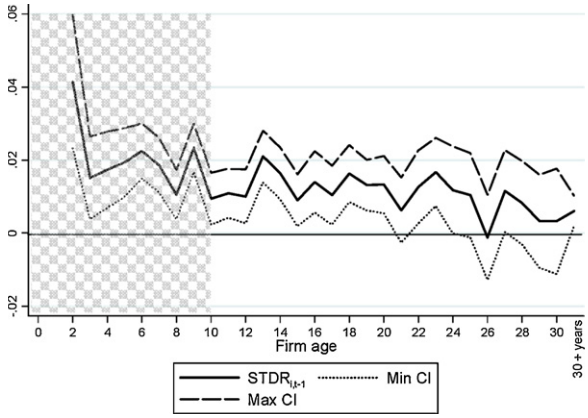

Fig. 12. Sensitivity of firm growth to the short-term debt ratio – i.e. δ_2 from Eq. (7), for firms of different ages. LAD coefficient estimate, with 95% error bars. The shaded area highlights observations that we suspect are likely to be affected by sample selection bias.

Fig. 11 shows the evolution of the sensitivity of firm growth to the growth of profits – that is, the coefficient δ_1 from Eq. (7).[18] The growth of young firms is positively related to financial performance, which can be interpreted in terms of financial constraints and selection effects. Profitable young firms have higher expected growth rates than less profitable young firms. As age increases, however, firm growth becomes less dependent on financial performance (the coefficient is significantly negative in many cases) suggesting that selection pressures are less strong for older firms.

[18] Replacing lagged profits growth with lagged profitability levels did not change the results in any substantial way.

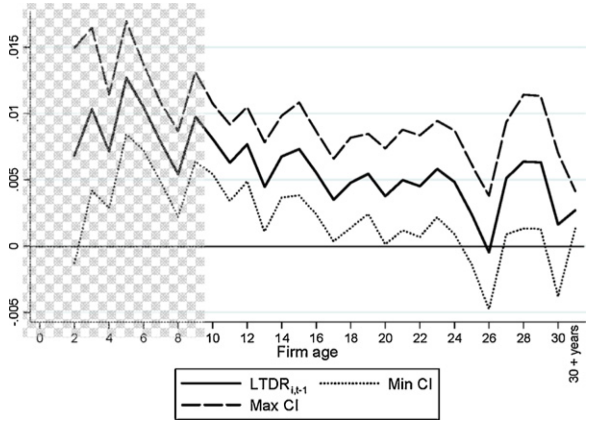

Fig. 13. Sensitivity of firm growth to the long-term debt ratio – i.e. δ_3 from Eq. (7), for firms of different ages. LAD coefficient estimate, with 95% error bars. The shaded area highlights observations that we suspect are likely to be affected by sample selection bias.

Figs. 12 and 13 show how sales growth depends on the short-term and long-term debt ratios, for firms of different ages. Similar patterns are displayed in both these figures, and we offer some speculative interpretation of these results. Young firms who have higher debt ratios (both short-term and long-term) experience faster growth, which is consistent with the hypothesis that those young firms who are able to obtain access to financial resources (as evidenced by their debt ratios) can use these resources to grow. The coefficients for older firms are also positive and significant (in most cases), but lower in magnitude. Firms that are indebted might be spurred on to higher growth in order to repay their debts promptly. Indebtedness might therefore put pressure on firms to improve their performance.

Furthermore, indebtedness might also make firms pursue more risky strategies, that lead to both faster growth rates and also higher exit hazards. Although we do not investigate exit hazards here, we do observe that the debt ratio is associated with faster growth of sales.

5. Vector autoregressions

How does the growth process change for firms of different ages? In this section, we investigate the co-evolution of a number of growth rate variables in order to observe the interactions between these variables for firms of different ages. To this end, we apply a vector autoregression model of sales growth, employment growth, growth of profits and growth of productivity (following Coad (2010b)) for different age groups.

We begin by looking at the matrix of contemporaneous correlations for the main VAR series (Table 3): employment growth (Gr_Empl), productivity growth (Gr_LabProd), sales growth (Gr_Sales) and profits growth (Gr_Profits). These variables are correlated with each other, but the correlations are far from perfect. Particularly striking is the strong negative correlation between employment growth and labour productivity growth in our sample. Given that labour productivity growth is calculated as value added per employee, it appears that new employees are not able to make a proportionate contribution to value added within the space of 1 year, and so employment growth is associated with a reduction in labour productivity growth.

Table 3
Contemporaneous correlations.

	Gr_Empl	Gr_LabProd	Gr_Sales	Gr_Profits
Gr_Empl	1.000			
Gr_LabProd	−0.694	1.000		
Gr_Sales	0.210	0.226	1.000	
Gr_Profits	0.034	0.258	0.317	1.000

Source: Own elaboration.

Moving on from this simple examination of contemporaneous correlations, we now turn to our vector autoregression estimation. Our regression equation is:

$$w_{it} = \zeta_1 w_{i,t-1} + \zeta_2 w_{i,t-2} + \mathrm{CTRL}_{i,t-1} + \varepsilon_{it} \quad (8)$$

where w_{it} is an $m \times 1$ vector of random variables for firm i at time t. ζ corresponds to an $m \times m$ matrix of slope coefficients that are to be estimated. In this particular case, $m = 4$ and corresponds to the vector [employment growth (i, t), labour productivity growth (i, t), sales growth (i, t), profits growth (i, t)]. This regression equation is estimated by OLS and LAD, and although 2 lags of the VAR series are included in all of our VAR regressions, as well as control variables[19], we only report coefficients for the first lag in our results tables.

Table 4 contains the regression results for the full sample, which are broadly in line with results from other databases.[20] We observe negative correlation for each of the growth rate series, which is strongest for growth of labour productivity and growth of profits. Among the other coefficients, the largest relationship is between lagged sales growth and subsequent growth of profits. An interesting feature of our dataset (which includes more small firms than in comparable studies) is that employment growth has a much smaller association with subsequent growth of sales and growth of profits.

OLS and LAD regression results are observed to differ in two important ways. First, the autocorrelation coefficients are much more strongly negative in the OLS case, as has been found in previous work (Bottazzi et al., 2011). This is presumably because OLS is more sensitive to extreme observations (‘outliers’). Second, the LAD coefficients for the employment growth equation are all equal to 0.0000, which has also been found in other comparable work, and presumably reflects the fact that the median firm has an employment growth rate of exactly zero (due to indivisibilities in employment growth).

[19] That is, we control for firm size (measured in terms of log(employees)), the ratio of short-term debt to total assets, and the ratio of long-term debt to total assets, year dummies, and two-digit industry dummies.

[20] See Coad (2010a,b) for an analysis of French data, Coad and Rao (2010) for US data, and Coad et al. (2011) for an analysis of Italian data.

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Table 4
OLS and LAD regressions.

	L_Gr_Empl	L_Gr_LabProd	L_Gr_Sales	L_Gr_Profits	R^2	Obs.
OLS regression						
Gr_Empl	−0.3136	0.0215	0.0239	0.0144	0.1488	120,321
	(−27.41)	(2.40)	(3.04)	(11.63)		
Gr_LabProd	−0.0604	−0.4593	0.0452	0.0185	0.1581	120,056
	(−4.86)	(−29.40)	(4.85)	(12.60)		
Gr_Sales	−0.0091	−0.0559	−0.3122	0.0241	0.1075	120,265
	(−0.71)	(−4.46)	(−22.24)	(14.70)		
Gr_Profits	0.0195	0.0401	0.1955	−0.3904	0.1285	106,733
	(1.12)	(2.24)	(12.56)	(−76.90)		
LAD regression						
Gr_Empl	0.0000	0.0000	0.0000	0.0000	0.0000	120,321
	(0.00)	(0.00)	(0.00)	(0.00)		
Gr_LabProd	−0.0325	−0.2845	0.0447	0.0036	0.0386	120,056
	(−10.33)	(−92.38)	(16.04)	(5.35)		
Gr_Sales	0.0617	0.0293	−0.0733	−0.0022	0.0094	120,265
	(20.92)	(10.14)	(−27.98)	(−3.49)		
Gr_Profits	0.0050	0.0123	0.1583	−0.2820	0.0374	106,733
	(0.47)	(1.16)	(16.59)	(−117.90)		

Note: *t*-Statistics appear in brackets.

Our main interest in these vector autoregressions of firm growth, however, concern changes in growth patterns for firms belonging to different age groups. Tables 5–6 contain the VAR results for three separate age groups (Age group 1 refers to firms aged 0–9, age group 2 refers to firms aged 10–19, age group 3 refers to firms aged 20+).

To begin with, we comment on the autocorrelation coefficients across age groups (Table 5). The autocorrelation coefficients do not show any clear pattern across age groups, although we can reject the hypothesis that autocorrelation coefficients become more positive as firms age. In other words, we can tentatively reject the hypothesis that firm growth is smoother and less erratic for older firms.

Our results also suggest that employment growth plays a different role in firms of different ages. Younger firms are better able to convert employment growth into subsequent growth of sales, productivity and profits. Older firms, on the other hand, are less successful at deriving growth of sales, productivity and profits from previous employment growth. Our results therefore suggest that employment growth is more appropriate in the case of young firms than for old firms. We speculate that this could be because young firms are more flexible, have a superior capacity to learn and adapt to new human resource configurations, and better able to internalize new employees into the workforce. Older firms may be too entrenched in existing routines to see how they can put new employees to their best use.

Furthermore, our results suggest that sales growth undertaken by older firms is more profitable than for younger firms. For older firms, there are higher regression coefficients for the associations between sales growth, on the one hand, and growth of productivity and profitability, on the other. While younger firms may be better able to benefit from employment growth, older firms are better able to turn sales growth into higher profits and higher productivity levels.

Several potential factors affecting firm growth are firm size and access to financial variables. For this reason, we examine the extent to which those variables affect the growth VAR equations. Table 6 reports the results for OLS and LAD estimations. As we have previously commented, our results for OLS are different from the LAD estimations due to the presence of extreme values. However, the sign of the coefficients are in essence similar to LAD.

Our results show that firm growth is positively related to the financial variables reported by firms. One question that may arise is whether the financial structure of the firm may have an effect on firm performance. Cabral and Mata (2003) have argued that financial constraints may be a factor of the evolution of the firm size distribution. Following empirical evidence on corporate finance (Petersen and Rajan, 1994; Berger and Udell, 1995), this result indicates the existence of financial constraints. In contrast, authors such as Angelini and Generale (2008) conclude that financial constraints are not very important in developed countries. Additionally, it is remarkable that short-term debt has a higher impact on firm growth compared to long-term debt. The higher sensitivity of the coefficient of the short-term debt may be an indicator of higher financial constraints in the short term.

Another question that deserves our attention concerns firm size. Traditionally, the literature related to firm growth and financial access assumes that firm size and firm age are similar, considering that small firms have a similar behaviour to young firms. However, on average young firms are smaller than their counterparts, there exists a heterogeneity on the entrance decision. For that reason, it can be interesting to distinguish the effect of firm size on firm growth in the VAR regressions. In fact our results show an interesting pattern. For OLS estimations the impact of firm size on firm growth is negative on firm growth for employees, sales and profits, but positive for the growth of firm productivity. However, this pattern changes once we consider the LAD estimations for middle-aged firms and older firms. For those firms, LAD shows a positive impact of firm size on firm growth.

Table 5
Vector autoregressions according to firm age group. OLS and LAD. Age group 1 refers to firms aged 0–9, age group 2 refers to firms aged 10–19, age group 3 refers to firms aged 20+.

	Firm age 1					
	L_Gr_Empl	L_Gr_LabProd	L_Gr_Sales	L_Gr_Profits	R^2	Obs.
OLS						
Gr_Empl	−0.2439	0.0617	0.0408	0.0147	0.1525	36,933
	(−13.98)	(4.07)	(3.27)	(6.25)		
Gr_LabProd	−0.0692	−0.4649	0.0444	0.0187	0.1707	36,846
	(−2.84)	(−14.46)	(2.67)	(6.48)		
Gr_Sales	0.0284	−0.0387	−0.2627	0.0234	0.0762	36,912
	(0.02)	(0.02)	(0.02)	(0.00)		
Gr_Profits	0.0395	0.0694	0.2061	−0.3813	0.1261	32,483
	(1.20)	(1.89)	(7.68)	(0.01)		
LAD regressions						
Gr_Empl	−0.0056	0.014	0.0095	0.0002	0.0001	36,933
	(−8.95)	(22.41)	(17.53)	(1.75)		
Gr_LabProd	−0.0169	−0.2793	0.0267	0.0026	0.044	36,846
	(−2.77)	(−45.43)	(5.01)	(1.88)		
Gr_Sales	0.0814	0.0431	−0.0676	−0.0005	0.0093	36,912
	(14.56)	(7.66)	(−13.84)	(−0.39)		
Gr_Profits	0.0509	0.0475	0.1387	−0.2677	0.0362	32,483
	(2.64)	(2.40)	(8.26)	(−58.40)		
	Firm age 2					
	L_Gr_Empl	L_Gr_LabProd	L_Gr_Sales	L_Gr_Profits	R^2	Obs.
OLS						
Gr_Empl	−0.3314	−0.0003	0.0337	0.0115	0.1435	52,491
	(−18.65)	(−0.02)	(0.01)	(0.00)		
Gr_LabProd	−0.0654	−0.4487	0.0397	0.0173	0.151	52,382
	(−4.03)	(−23.65)	(3.42)	(3.42)		
Gr_Sales	−0.0305	−0.0710	−0.3176	0.0219	0.1068	52,467
	(−1.60)	(−3.75)	(−15.48)	(0.00)		
Gr_Profits	0.0168	0.0187	0.1864	−0.4022	0.1375	46,667
	(0.66)	(0.73)	(7.86)	(−52.52)		
LAD regressions						
Gr_Empl	0.0000	0.0000	0.0000	0.0000	0.0000	52,491
	(0.00)	(0.00)	(0.00)	(0.00)		
Gr_LabProd	−0.0417	−0.2903	0.0489	0.0033	0.0397	52,382
	(−8.00)	(−57.26)	(10.67)	(3.16)		
Gr_Sales	0.0552	0.027	−0.0912	−0.0044	0.0100	5246
	(11.51)	(5.80)	(−21.53)	(−4.61)		
Gr_Profits	−0.0064	−0.0055	0.1547	−0.2939	0.0414	46,667
	(−0.36)	(−0.32)	(9.97)	(−78.70)		
	Firm age 3					
	L_Gr_Empl	L_Gr_LabProd	L_Gr_Sales	L_Gr_Profits	R^2	Obs.
OLS						
Gr_Empl	−0.4138	0.0005	−0.0223	0.0155	0.2046	30,897
	(−15.39)	(0.04)	(−1.30)	(7.18)		
Gr_LabProd	−0.0686	−0.4901	0.0498	0.021	0.168	30,828
	(−2.60)	(−16.45)	(2.32)	(7.28)		
Gr_Sales	−0.0709	−0.0597	−0.4068	0.0256	0.1955	30,886
	(−2.63)	(−2.58)	(−13.67)	(8.56)		
Gr_Profits	−0.0518	0.0178	0.1919	−0.3851	0.1201	27,583
	(−1.43)	(0.56)	(6.03)	(0.01)		
LAD regressions						
Gr_Empl	0.0000	0.0000	0.0000	0.0000	0.0000	30,897
	(0.00)	(0.00)	(0.00)	(0.00)		
Gr_LabProd	−0.0738	−0.2984	0.073	0.0048	0.0339	30,828
	(−12.83)	(−56.36)	(14.35)	(4.29)		
Gr_Sales	0.0223	0.0128	−0.0798	−0.0005	0.0111	30,886
	(4.33)	(2.71)	(−17.54)	(−0.50)		
Gr_Profits	−0.0706	−0.0272	0.1838	−0.2765	0.035	27,583
	(−3.12)	(−1.31)	(9.19)	(−59.39)		

Note: *t*-Statistics appear in brackets.

Table 6
Vector autoregressions according to firm age group. Financial variables and firm size. Age group 1 refers to firms aged 0–9, age group 2 refers to firms aged 10–19, age group 3 refers to firms aged 20+.

	Firm age 1					Firm age 2					Firm age 3				
	LnSize	LTDR	STDR	R^2	Obs.	LnSize	LTDR	STDR	R^2	Obs.	LnSize	LTDR	STDR	R^2	Obs.
OLS															
Gr_Empl	−0.0808	0.0080	0.0151	0.1525	36,933	−0.0450	0.0050	0.0205	0.1435	52,491	−0.0165	0.0040	0.0221	0.2046	30,897
	(−33.06)	(5.42)	(3.80)			(−25.40)	(5.11)	(7.80)			(−9.93)	(4.23)	(6.59)		
Gr_LabProd	0.0479	0.0141	0.0308	0.1707	36,846	0.0331	0.0113	0.0278	0.151	52,382	0.0120	0.0082	0.0256	0.168	30,828
	(19.85)	(8.76)	(6.18)			(18.31)	(9.96)	(9.33)			(6.48)	(6.69)	(6.65)		
Gr_Sales	−0.0205	0.0194	0.0279	0.0762	36,912	−0.0019	0.0140	0.0398	0.1068	52,467	0.0052	0.0094	0.0374	0.1955	30,886
	(−8.81)	(11.91)	(5.98)			(−1.12)	(12.07)	(12.35)			(2.97)	(7.47)	(8.91)		
Gr_Profits	−0.0207	0.0399	0.1681	0.1261	32,483	−0.0162	0.0187	0.1243	0.1375	46,667	−0.0087	0.0040	0.1054	0.1201	27,583
	(−3.52)	(9.51)	(14.65)			(−3.62)	(6.49)	(15.58)			(−1.68)	(1.17)	(10.33)		
LAD regressions															
Gr_Empl	−0.0017	0.0003	0.0005	0.0001	36,933	0.0000	0.0000	0.0000	0.0000	52,491	0.0000	0.0000	0.0000	0.0000	30,897
	(−11.62)	(2.51)	(1.94)			(0.00)	(0.00)	(0.00)			(0.00)	(0.00)	(0.00)		
Gr_LabProd	0.0199	0.0090	0.0318	0.044	36,846	0.0122	0.0068	0.0228	0.0397	52,382	0.0012	0.0051	0.0169	0.0339	30,828
	(13.62)	(8.42)	(11.57)			(12.00)	(9.93)	(12.91)			(1.24)	(8.04)	(9.00)		
Gr_Sales	−0.0050	0.0084	0.0174	0.0093	36,912	0.0027	0.0061	0.0184	0.0100	5246	0.0035	0.0031	0.0130	0.0111	30,886
	(−3.76)	(8.61)	(6.91)			(2.90)	(9.77)	(11.39)			(4.17)	(5.57)	(7.72)		
Gr_Profits	−0.0038	0.0284	0.1161	0.0362	32,483	0.0009	0.0134	0.0885	0.0414	46,667	0.0024	0.0024	0.0631	0.0350	27,583
	(−0.84)	(8.63)	(13.57)			(0.27)	(5.84)	(14.92)			(0.66)	(1.00)	(8.62)		

Note: *t*-Statistics appear in brackets.

6. Conclusions

As firms grow older, they experience many changes and transformations: from vitality to stability, from flexibility to rigidity, from learning capacity to exploitation of routines, from institutional opacity and uncertainty to an established organization, and from external financial dependence to accumulated internal resources. In this empirical analysis, we sought to provide new evidence on the effects of age on firm performance and behaviour.

We begin our conclusion by reconsidering our cheesy title – do firms deteriorate with age (like milk) or do they improve with age (like wine)? In this paper we found evidence supporting both the milk hypothesis and the wine hypothesis. As evidence that firms improve with age, we found that ageing firms experience rising levels of productivity, profits, larger size, lower debt ratios, and higher equity ratios. Furthermore, older firms are better able to convert sales growth into subsequent growth of profits and productivity. On the other hand, we also found evidence that firm performance deteriorates with age. Older firms have lower expected growth rates of sales, profits and productivity, they have lower profitability levels (when other variables are controlled for), and also that they appear to be less capable to convert employment growth into growth of sales, profits and productivity. Analysis of the growth rate distributions for different age groups shows that older firms are less likely to experience fast growth, while they are just as likely as younger firms to experience rapid decline.

Theoretical work has frequently suggested that young firms are particularly vulnerable to selection pressures. In our sample, firms have higher expected growth rates in their first few years. As they grow older, they grow not only in terms of sales and employees, but also in terms of productivity and profitability. Young firms have higher levels of short and long term debt (and a lower equity ratio) but as they age their ratio of debt decreases and their equity ratio increases. Across the business life course, firms reduce their information problems with external investors and may enjoy an increased potential to finance themselves via cash-flow and equity.

We observed that autocorrelation coefficients are negative over most of the age distribution, and that autocorrelation coefficients show no clear tendency of becoming more positive with age. This suggests that growth projects undertaken by older firms are no smoother and no less erratic than the growth of their younger counterparts. Put differently, it would appear that the negative autocorrelation often observed in the growth rates of small firms is an inherent feature of the growth process that cannot be explained in terms of the lack of experience of small young firms.

Interestingly enough, the results of our vector autoregressions suggest that younger firms are more successful at converting employment growth into growth of sales, profits, and productivity. Meanwhile, older firms seem to do better at converting sales growth into growth of profits and productivity. As such, we speculate that employment growth is more appropriate during youth, while a focus on sales growth appears to be more appropriate during maturity.

Another interesting question concerns how initial conditions (e.g. initial size) affect firm performance many years later. Presumably there is a relationship between start-up conditions and subsequent performance. Although we have shown that firm age is an important variable, initial conditions and start-up size can be expected to have long-lasting effects on the firm. It would be interesting to investigate this in further work, using an appropriately selected subsample of our database.

Appendix.

Table A1
Descriptive statistics.

Percentiles	Age > 2 years		Age > 5 years		Age > 10 years		Age > 20 years		Age > 30 years		Age > 50 years	
	LnTreb	LnSales	LnTreb	LnSales	LnTreb	LnSales	LnTreb	LnSales	LnTreb	LnSales	LnTreb	LnSales
1%	1.0986	3.0917	1.0986	3.2721	1.0986	3.4575	1.0986	4.0162	1.0986	3.7525	1.0986	3.0310
5%	1.0986	4.6567	1.0986	4.7389	1.0986	4.8680	1.3863	5.3033	1.6094	5.5881	1.6094	5.6899
10%	1.3863	5.0913	1.3863	5.1626	1.3863	5.2992	1.7918	5.7940	1.9459	6.2125	1.9459	6.3844
25%	1.7918	5.8024	1.7918	5.8708	1.9459	6.0197	2.3026	6.5960	2.7081	7.1589	2.7726	7.4189
50%	2.3026	6.6521	2.3979	6.7343	2.5649	6.9245	2.9957	7.5511	3.4340	8.1381	3.7612	8.5832
75%	3.0910	7.6587	3.1781	7.7513	3.2958	7.9420	3.7377	8.5180	4.2341	9.2387	4.6444	9.8180
90%	3.8286	8.6665	3.8712	8.7579	3.9890	8.9362	4.4773	9.5696	5.0434	10.2568	5.4293	10.7297
95%	4.3694	9.4271	4.4308	9.5098	4.5326	9.6447	4.9904	10.1946	5.5134	10.8415	5.9162	11.6527
99%	5.4972	10.8642	5.5334	10.9348	5.6168	11.0093	5.9282	11.4870	6.4708	12.1191	7.3179	13.0791
Obs.	57,594	63,600	50,679	55,701	36,741	40,139	13,400	14,470	4041	4310	637	671
Mean	2.4897	6.7737	2.5421	6.8566	2.6518	7.0227	3.0672	7.6009	3.4890	8.1791	3.7684	8.5864
Standard deviation	1.0104	1.5167	1.0202	1.5127	1.0326	1.5106	1.0719	1.5352	1.1691	1.6638	1.3590	1.8608
Variance	1.0209	2.3003	1.0407	2.2884	1.0663	2.2818	1.1490	2.3567	1.3667	2.7683	1.8468	3.4626
Skewness	0.9142	0.1898	0.8692	0.2097	0.7689	0.2079	0.5061	0.0003	0.3781	−0.1337	0.4079	−0.1253
Kurtosis	4.0672	4.7706	3.9738	4.6527	3.7680	4.3186	3.3777	4.3728	3.2361	4.2376	3.4715	4.0858
Shapiro–Wilk *W* test for normal data												
W	0.9650	0.9801	0.9681	0.9812	0.9743	0.9852	0.9877	0.9884	0.9915	0.9906	0.9847	0.9900
V	719.6940	440.2970	596.1310	377.3030	374.5130	230.5860	78.7370	79.3950	19.0070	22.2760	6.3950	4.3720
Z	18.2890	16.9500	17.7280	16.4850	16.3430	15.0310	11.7780	11.8230	7.6750	8.1050	4.5090	3.5920
Prob>Z	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002
Shapiro–Francia *W′* test for normal data												
W	0.9653	0.98	0.9684	0.9811	0.9747	0.9852	0.9883	0.9883	0.9925	0.9903	0.9872	0.9891
V	27.9810	16.152	25.3670	15.1790	20.3580	11.8690	10.8070	10.6360	8.9590	11.5600	5.7120	5.1230
Z	0.0040	0.002	0.0070	0.0040	0.0280	0.0190	0.6790	0.5660	3.4890	3.5610	3.8020	3.5810
Prob>Z	0.4986	0.4991	0.4973	0.4983	0.4887	0.4922	0.2487	0.2856	0.0002	0.0002	0.0001	0.0002
Skewness–Kurtosis tests for normality												
Pr (Skewness)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.9875	0.0000	0.0004	0.0000	0.1819
Pr (Kurtosis)	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0049	0.0000	0.0305	0.0001

Source: Own elaboration.

References

Aghion, P., Angeletos, G., Banerjee, A., Manova, K., 2007a. Volatility and growth: credit constraints and productivity-enhancing investment. Unpublished manuscript.

Aghion, P., Fally, T., Scarpetta, S., 2007b. Credit constraints as a barrier to the entry and post-entry growth of firms. Economic Policy 22, 731–790.

Angelini, P., Generale, A., 2008. On the evolution of firm size distributions. American Economic Review 98, 426–438.

Arrow, K.J., 1962. The economic implications of learning by doing. Review of Economic Studies 29, 155–173.

Autio, E., Sapienza, H.J., Almeida, J.G., 2000. Effects of age at entry, knowledge intensity, and imitability on international growth. Academy of Management Journal 43, 909–924.

Barron, D.N., West, E., Hannan, M.T., 1994. A time to growth and a time to die: growth and mortality of credit unions in New York, 1914–1990. American Journal of Sociology 100, 381–421.

Bartelsman, E., Scarpetta, S., Schivardi, F., 2005. Comparative analysis of firm demographics and survival: evidence from micro-level sources in OECD countries. Industrial and Corporate Change 3, 365–391.

Beck, T., Degirgüc-Kunt, A., Maksimovic, V., 2005. Financial and legal constraints to growth: does firm size matter? The Journal of Finance 60, 137–177.

Beck, T., Demirguc-Kunt, A., 2006. Small and medium-size enterprises: access to finance as a growth constraint. Journal of Banking & Finance 30, 2931–2943.

Bellone, F., Musso, P., Nesta, L., Quere, M., 2008. Market selection along the firm life cycle. Industrial and Corporate Change 17, 753–777.

Berger, A.N., Udell, G.F., 1995. Relationship lending and lines of credit in small firm finance. Journal of Business 68, 351–381.

Berger, A.N., Udell, G.F., 1998. The economics of small business finance: the roles of private equity and debt markets in the financial growth cycle. Journal of Banking & Finance 22, 613–673.

Binks, M.R., Ennew, C.T., 1996. Growing firms and the credit constraint. Small Business Economics 8, 17–25.

Bottazzi, G., Secchi, A., 2006. Explaining the distribution of firms growth rates. Rand Journal of Economics 37, 234–263.

Bottazzi, G., Coad, A., Jacoby, N., Secchi, A., 2011. Corporate growth and industrial dynamics: evidence from French manufacturing. Applied Economics 43, 103–116.

Bottazzi, G., Dosi, G., Jacoby, N., Secchi, A., Tamagni, F., 2010. Corporate performances and market selection. Some comparative evidence. Industrial and Corporate Change 19, 1953–1996.

Bottazzi, G., Secchi, A., Tamagni, F., 2008. Productivity, profitability and financial performance. Industrial and Corporate Change 17, 711–751.

Brown, C., Medoff, J.L., 2003. Firm age and wages. Journal of Labor Economics 23, 677–697.

Bruderl, J., Schussler, R., 1990. Organizational mortality: the liabilities of newness and adolescence. Administrative Science Quarterly 35, 530–547.

Cabral, L.M.B., Mata, J., 2003. On the evolution of the firm size distribution: facts and theory. American Economic Review 93, 1075–1090.

Calvo, J.L., 2006. Testing Gibrat's law for small, young and innovating firms. Small Business Economics 26, 117–123.

Chang, Y., Gomes, J.F., Schorfheide, F., 2002. Learning-by-doing as a propagation mechanism. American Economic Review 92, 1498–1520.

Cirillo, P., 2010. An analysis of the size distribution of Italian firms by age. Physica A: Statistical Mechanics and Its Applications 389, 459–466.

Coad, A., Rao, R., Tamagni, F., 2011. Growth processes of Italian manufacturing firms. Structural Change and Economic Dynamics 22 (1), 54–70.

Coad, A., 2009. The Growth of Firms: A Survey of Theories and Empirical Evidence. Edward Elgar, Cheltenham, UK.

Coad, A., 2010a. Investigating the exponential age distribution of firms. Economics: the open-access. Open-Assessment E-Journal 4, 2010–2017.

Coad, A., 2010b. Exploring the processes of firm growth: evidence from a vector auto-regression. Industrial and Corporate Change 19 (6), 1677–1703.

Coad, A., Rao, R., 2010. Firm growth and R&D expenditure. Economics of Innovation and New Technology 19, 127–145.

Correa, A., Acosta, M., González, A., Medina, U., 2003. Size, age and activity sector on the growth of the small and medium firm size. Small Business Economics 21, 289–307.

Das, S., 1995. Size, age and firm growth in an infant industry: the computer hardware industry in India. International Journal of Industrial Organization 13, 111–126.

Dunne, P., Hughes, A., 1994. Age, size, growth and survival: UK companies in the 1980s. Journal of Industrial Economics 42, 115–140.

Dunne, T., Roberts, M., Samuelson, L., 1989. The growth and failure of US manufacturing plants. Quarterly Journal of Economics 104, 671–698.

Evans, D.S., 1987a. The relationship between firm growth, size and age: estimates for 100 manufacturing industries. Journal of Industrial Economics 35, 567–581.

Evans, D.S., 1987b. Tests of alternative theories of firm growth. Journal of Political Economy 95, 657–674.

Fagiolo, G., Luzzi, A., 2006. Do liquidity constraints matter in explaining firm size and growth? Some evidence from the Italian manufacturing industry. Industrial and Corporate Change 15, 1–39.

Fariñas, J., Moreno, L., 2000. Firms' growth, size and age: a nonparametric approach. Review of Industrial Organization 17, 249–265.

Fichman, M., Levinthal, D., 1991. Honeymoons and the liability of adolescence: a new perspective on duration dependence in social and organizational relationships. Academy of Management Review 16, 442–468.

Fizaine, F., 1968. Analyse statistique de la croissance des entreprises selon l'age et la taille. Revue d'economie politique 78, 606–620.

Fluck, Z., Holtz-Eakin, D., Rosen, H., 1997. Where Does the Money Come From? An Empirical Investigation of Small Entrepreneurial Enterprises, Syracuse University. Metropolitan Studies Program Series Occasional Paper No. 191.

Garnsey, E., 1998. A theory of the early growth of the firm. Industrial and Corporate Change 7, 523–556.

Garnsey, E., Stam, E., Heffernan, P., 2006. New firm growth: exploring processes and paths. Industry and Innovation 13, 1–20.

Geroski, P.A., Gugler, K., 2004. Corporate growth convergence in Europe. Oxford Economic Papers 56, 597–620.

Gibrat, R., 1931. Les inegalites economiques: applications, aux inegalites des richesses, a la concentration des entreprises, aux populations des villes, aux statistiques des familles, etc.: d'une loi nouvelle la loi de l'effet proportionnel. Recueil Sirey, Paris.

Greiner, L., 1972. Evolution and revolution as organizations grow. Harvard Business Review 76, 37–46.

Hall, B.H., 1987. The relationship between firm size and firm growth in the US manufacturing sector. Journal of Industrial Economics 35, 583–600.

Hall, G., Hutchinson, P., Michaelas, N., 2000. Industry effects on the determinants of unquoted SMEs capital structure. International Journal of the Economics of Business 7, 297–312.

Haltiwanger, J., Lane, J., Spletzer, J., 1999. Productivity differences across employers: the roles of employer size, age, and human capital. American Economic Review Papers and Proceedings 89, 94–98.

Hamilton, R.T., Fox, M.A., 1998. The financing preferences of small firm owners. International Journal of Entrepreneurial Behaviour & Research 4, 239–248.

Hannan, M.T., Freeman, J., 1984. Structural inertia and organizational change. American Sociological Review 49, 149–164.

Hart, P., Prais, S., 1956. The analysis of business concentration: a statistical approach. Journal of the Royal Statistical Society 119, 150–191.

Hart, P.E., Oulton, N., 1996. The growth and size of firms. Economic Journal 106, 1242–1252.

Headd, B., Kirchhoff, B., 2009. The growth, decline and survival of small businesses: an exploratory study of life cycles. Journal of Small Business Management 47, 531–550.

Helfat, C.E., Peteraf, M.A., 2003. The dynamic resource-based view: capability lifecycles. Strategic Management 24, 977–1010.

Holmes, S., Kent, P., 1991. An empirical analysis of the financial structure of small and large Australian manufacturing enterprises. The Journal of Small Business Finance 1, 141–154.

Huergo, E., Jaumandreu, J., 2004a. How does probability of innovation change with firm age? Small Business Economics 22, 193–207.

Huergo, E., Jaumandreu, J., 2004b. Firms' age, process innovation and productivity growth. International Journal of Industrial Organization 22, 541–559.

Jovanovic, B., 1982. Selection and the evolution of industry. Econometrica 50, 649–670.

Kandilov, I.T., 2009. Do exporters pay higher wages? Plant-level evidence from an export refund policy in Chile. World Bank Economic Review 23, 269–294.

Levinthal, D.A., 1991. Organizational adaptation and environmental selection – interrelated processes of change. Organization Science 2, 140–145.

López-Gracia, J., Aybar-Arias, C., 2000. An empirical approach to the financial behaviour of small and medium sized companies. Small Business Economics 14, 55–63.

Lotti, F., Santarelli, E., Vivarelli, M., 2009. Defending Gibrat's law as a long-run regularity. Small Business Economics 32, 31–44.
Mata, J., Portugal, P., 2004. Patterns of entry, post-entry growth and survival: a comparison between domestic and foreign owned firms. Small Business Economics 22, 283–298.
Mishina, Y., Pollock, T.G., Porac, J.F., 2004. Are more resources always better for growth? Resource stickiness in market and product expansion. Strategic Management Journal 25, 1179–1197.
Moreno, A., Casillas, J., 2007. High-growth SMEs versus non-high growth SMEs: a discriminant analysis. Entrepreneurship and Regional Development 19, 69–88.
Myers, S.C., 1984. The capital structure puzzle. Journal of Finance 39, 575–592.
Myers, S.C., 2001. Capital structure. Journal of Economic Perspectives 15, 81–102.
Myers, S.C., Majluf, N., 1984. Corporate financing and investment decisions when firms have information that investors do not have. Journal of Financial Economics 13, 187–222.
Oliveira, B., Fortunato, A., 2006. Firm growth and liquidity constraints: a dynamic analysis. Small Business Economics 27, 139–156.
Petersen, M.A., Rajan, R.G., 1994. The benefits of lending relationships: evidence from small business data. Journal of Finance 49, 3–37.
Reichstein, T., Dahl, M.S., Ebersberger, B., Jensen, M.B., 2010. The devil dwells in the tails: a quantile regression approach to firm growth. Journal of Evolutionary Economics 20, 219–231.
Reid, G.C., 2003. Trajectories of small business financial structure. Small Business Economics 20, 273–285.
Sánchez-Vidal, J., Martín-Ugedo, J.F., 2005. Financing preferences of Spanish Firms: evidence on the pecking order theory. Review of Quantitative Finance and Accounting 25, 341–355.
Sánchez-Vidal, J., Martín-Ugedo, J.F., 2008. Edad y tamaño empresarial y ciclo de vida financiero , IVIE, WP-EC 2008-12.
Segarra, A., Teruel, M., Vidal, A., Alarcón, S., 2010. Creixement i restriccions financeres a les empreses Industrials de Catalunya. Catalan Government, Departament of Economics, Monografies núm. 12.
Segarra, A., Teruel, M., 2009. Small firms: the effects of financial constraints on their growth. XREAP, WP XREAP2009-11.
Serrasqueiro, Z., Nunes, P.M., Leitao, J., Armada, M., 2010. Are there non-linearities between SME growth and its determinants? A quantile approach. Industrial and Corporate Change 10, 1071–1108.
Shanmugam, K., Bhaduri, S., 2002. Size, age and firm growth in the Indian manufacturing sector. Applied Economics Letters 9, 607–613.
Simon, H., Bonini, C., 1958. The size distribution of business firms. American Economic Review 48, 607–617.
Sogorb-Mira, F., 2005. How SME uniqueness affects capital structure: evidence from a 1994–1998 Spanish data panel. Small Business Economics 25, 447–457.
Sorensen, J., Stuart, T., 2000. Aging, obsolescence and organisational innovation. Administrative Science Quarterly 45, 81–112.
Stam, E., Wennberg, K., 2009. The roles of R&D in new firm growth. Small Business Economics 33, 77–89.
Stinchcombe, A., 1965. Social structure and organizations. In: March, J.G. (Ed.), Handbook of Organizations. Rand McNally, Chicago, pp. 142–193.
Sutton, J., 1997. Gibrat's legacy. Journal of Economic Literature 35, 40–59.
Teruel-Carrizosa, M., 2010. Gibrat's law and the learning process. Small Business Economics 34 (4), 355–373.
Vassilakis, S., 2008. Learning-by-doing. In: Durlauf, S.N., Blume, L.E. (Eds.), The New Palgrave Dictionary of Economics. , 2nd ed. Palgrave Macmillan.
Winker, P., 1999. Causes and effects of financing constraints at the firm level. Small Business Economics 12, 169–181.