Firm Growth During Infancy

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ABSTRACT. In this paper, we study the post-entry patterns of survival and growth of firms established in Portuguese manufacturing in 1983. Our data suggest the existence of a highly turbulent economy, with a very large number of small firms being created, but a great proportion of new firms disappearing in the first years subsequent to their birth. Survivors, however, grow quite fast and we found that small firms grow faster than their larger counterparts. Moreover, we found that the growth decision of firms is affected by a firm specific component, which is also correlated with firm size. These two effects are oppositely signed and, therefore, estimates that fail to take this firm specific effect into account are likely to be strongly biased towards zero.

1. Introduction

There has been, in recent years, a considerable increase in the attention devoted by empirical economists to research on the occurrence of new firm creation.[1] Among the stylized facts that have emerged from this recent literature, three are particularly worth noting. The first is that entry occurs in very large numbers, the second that entrants are generally small, and the third that from the initial pool of entrants, only a few are able to survive and acquire market share. Although not all entrants are small, the general idea one gets from the data is that the most important challenge to market leaders may come from the post-entry penetration rather than from entry itself. Surprisingly, however, the analysis of this post-entry penetration process have been considerably neglected and, to this author's knowledge, has only been studied by Philips and Kirchhoff (1989), Audretsch and Mahmood (1992), Mahmood (1992), and Dunne, Roberts and Samuelson (1989) for the U.S.

A second strand of research developed in parallel studying the relationship between firm size and firm growth. This line of research departs from the test of Gibrat's Law, and has been pursued in a number of studies, but the answers have not been conclusive. Hymer and Pashighian (1962), Prais (1974) and Singh and Wittington (1975) found that firm size and firm growth are roughly independent,[2] but Mansfield (1962) reported conflicting results. He found a negative relationship between firm size and firm growth, that however failed to hold for firms of a certain dimension upwards, and he suggested that the fact that small firms are more prone to die could have biased the results, in favour of the negative relationship found between size and growth. More recently, Evans (1987a, 1987b), Audretsch (1992) and Hall (1987) addressed this issue somewhat more systematically and found that although the probability of survival is positively related to firm size, the negative relationship between size and growth still holds after this effect is taken into account. Other recent studies (Contini and Revelli 1989, Bourlakis 1990, Dunne and Hughes 1990, Huighen, Kleijweg and van Leeuwen 1991, Kumar 1985, Storey et al. 1987) also seem to suggest the existence of a negative effect of firm size on firm growth, contrasting with results in earlier studies.[3]

One possible explanation to this negative relationship between size and growth found in recent studies is related to the age of firms. Jovanovic (1982) proposed a model, in which the first times of the life of firms can be thought as a process in which firms learn about their efficiency. Most new firms would be born small, with imperfect knowledge about their true efficiency levels, and the first times in the market would then be crucial to update their expectations. Firms to whom markets reveal to be inefficient would leave the market, while those to whom it is indicated to be more

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efficient than average would survive and grow. Age and size would then be both indicators of efficiency and it can be not easy to distinguish their effects. Still, Evans (1987a, 1987b) was able to find that both size and age were important determinants of firm survival and growth, thereby giving some empirical support to the model.

This paper builds on these two lines of research, making a bridge between them. It studies survival and growth of recently created firms in Portuguese manufacturing, and seeks to discover what happens to entrants in the first years of their lives. Economic theory of entry has traditionally divided firms in two groups — entrants and incumbents — but offers little guidance for questions such as: what distinguishes entrants from incumbents, or how much time does it take before entrants become incumbents? In this paper, we tried to shed some light on this issue and we confronted the survival, growth and size patterns of firms created in Portuguese manufacturing in 1983 with similar patterns for older firms. We found not only that newer firms are smaller, more prone to die and that survivors grow faster than their older counterparts, but also that this picture holds at least during the first four years of firms' lives.

We then address the issue of the relationship between firm size and growth and analyse it with a sample of firms of the same age. This methodology reduces considerably the heterogeneity among individual firms and allows the research to be concentrated in the size issue. This is important, because there are other explanations, independent of firm age, that can be devised for the negative effect of firm size on growth. For example, Segal and Spivak (1989) present a model, in which firms, facing a fixed cost in case of bankruptcy, attempt to reduce the probability of its occurrence, by pursuing diversification strategies. Diversification is achieved by growth, and since the marginal benefit of diversification is decreasing, optimal growth rates also decrease with firm size. Allowing for the existence of economies of scale, other effects may also be present. In the presence of economies of scale, smaller firms are more likely to leave the industry, since the cost penalty they experience *vis a vis* larger companies may make their position harder to sustain and, on the other hand, they should be more interested in growing, because growth would bring a greater reduction in average costs than would for larger firms.

Starting with the work by Evans (1987a, 1987b) and Hall (1987), most recent studies on the relationship between firm size and firm growth, addressed specifically the sample selection problem involved in the analysis of this issue. This problem arises because in such studies, growth can only be measured for firms that had survived across the period. Since slow growing small firms are more likely to disappear from the sample, small surviving firms are probably the fast growing companies, which may bias the results of the study. However, the empirical results achieved were that survival was roughly independent of firm size (Dunne and Hughes, 1990), that, although the probability of survival was positively related to size, this would not affect the growth size relationship because the errors of the two equations were not correlated (Hall, 1987; Evans, 1987a), or that, although the errors of the two equations were correlated, the bias introduced was not in order to alter qualitatively the results (Evans, 1987b).

A second sample selection problem may, however, have been present in most previous studies. With the exception of the cited papers by Evans, articles dealing with this issue used data on firms, with respect to which data was publicly available. Typically, data is publicly available for firms quoted in the stock exchange market or for those which are constituted with a legal form such as they are required to publish their accounts in the trade press. This legal form is generally characteristic of larger firms, and the few small firms that adopt this legal form, or which are quoted in the stock market, are not likely to be representative of the universe of small firms. Consider for example the case of quoted companies. Normally, small firms are publicly traded if they need funds to grow faster than they can do only with their internal funds. If the sample only includes these small firms but includes all large firms, then it is very likely that results are pushed towards the conclusion that small firms grow faster. This study does not suffer from this drawback, since the sample it uses includes virtually all firms employing paid labour in the Portuguese economy. In the manufacturing sector, it includes about 25,000 firms for each year and firms are identified in such

a manner that a quite accurate measurement of firm creation and disappearance is possible. With this data set, those firms that started their operations in 1983 could be identified and their paths could be followed until 1987, enabling the study of their patterns of survival and growth. Specifically, the paper reports results of an investigation into the relationship between these patterns and firm size. Given that we concentrate on one cohort of firms, rather than on the whole spectrum of firm ages, we cannot claim to be directly testing Gibrat's Law. Even if our tests fail to uncover any statistical relationship between firm size and growth, we cannot conclude for the applicability of Gibrat's Law. If, however, a significant relationship is discovered to exist for firms of the same age, we can interpret this as very strong evidence against Gibrat's Law.

In the next section the data set employed is briefly described, and an overview of the importance of new firm entry and post-entry expansion is presented. Section 3 reports results of the analysis of the relationship between new firm growth and size, paying special attention to the sample selection problems that may be involved in such an analysis. Section 4 addresses another potential source of bias — omission of relevant variables — and investigates the stability of the relationship when smaller firms are excluded from the sample.

Our results suggest that firms die considerably more during the first year of their lives than in subsequent times, and that smaller firms are more prone to die than their larger counterparts. We found that firm growth varies negatively with firm size, at least during the first years of firms' lives that were considered here. This result is relatively weak, but it does not seem to be affected by consideration of the sample selection problem that may arise from the fact that small firms are less likely to survive, it holds for each one of the years considered and it becomes much stronger when it is controlled for the existence of firm-specific factors that may determine firm growth.

2. Data

Data employed in this work come from a survey, which has been conducted by the Ministry of Employment, on an yearly basis since 1981. This survey has two distinctive characteristics that make it a very good source for the study of market dynamics. The first is its comprehensiveness, since it includes virtually all firms with paid employees in the economy. In manufacturing, this means that it includes nearly all firms with 5 or more employees.[4] The other main advantage is that, unlike the Census which was only conducted twice with more than 10 years of interval, the survey of the Ministry of Employment is conducted on an yearly basis. Moreover, the identifying scheme employed allows quite a precise identification of firms and permits to follow firms' paths during their lives.[5] Naturally, this source also has its own limitations. The most important one to our purposes is that, since it was primarily designed to collect data on the labour market, very little information is collected outside this particular field, and the only reliable measure for firm size is the number of people employed. This survey was first conducted in 1981 and, at the time this study was undertaken, 1988 was the last year for which data was available.

Our purpose was to follow a cohort of firms that had started operations in the same year, during the first years of their lives. Due to data availability constraints, we had to restrict our attention to firms in manufacturing. With respect to this sector, however, we were able to work with raw files containing information on each one of the firms operating in each year from 1982 to 1988. We identified entrants by finding, in the 1983 file, those firms whose identifying number was greater than the highest number in the 1982 file. This assures that firms classified as entrants have not been previously included in the files.[6] The treatment of firms' deaths is somewhat more delicate. A firm may be not included in the firms' file in one particular year for a number of reasons, other than permanent end of operations. It may be absent from the file because it suspended operations, because it employed no paid employees in that year, or because it simply did not fill the survey forms and send them to the Statistics Department of the Ministry in due time. We cannot distinguish between these cases, but at least the last two reasons hardly fit to our idea of what a firm death is. Even if we cannot distinguish between them, if one of these cases occurred, it can be detected, given the identifying scheme previously described. As a consequence we can observe firms which are

recorded in the $t + 2$ files, but not in the $t + 1$ file. We do not want to account these firms among the deaths and, accordingly, their status in $t + 1$ was recoded, and their employment was estimated as the average of their employment in t and $t + 2$. One consequence of this procedure is that we cannot use data for the last year we have a file available, and therefore we present only data until 1987.[7]

Our final sample includes 3308 entrants. Table I reports a number of statistics on these entrants, and Table II and III display similar data for incumbents and for all firms in manufacturing. Incumbents are firms which were already in operation in 1982, and could not be classified according to their age. Therefore, the best we can say, with respect for example to 1987 data, is that data for entrants refers to firms which are exactly four years old, while data for incumbents refers to firms which are, at least, five years old. Data in Table III refers to all firms in each year in manufacturing and includes firms that entered after 1983.

There are a number of interesting observations to be made from these tables. First, the data reported here confirms that new firms are smaller than existing ones. More than one half of the total number of entrants reported in Table I employs less than 5 people, and this figure is still an underestimate, since the source we are using does not include firms with only self-employed people or family workers. The reported average entrant size at the time of entry is about 1/3 of the average incumbent, or about 1/2, if we consider only firms with 5 or more employees. Second, entrants are more prone to die than are incumbents. Only 53% of the newly created firms survived until 1987, while the corresponding percentage for firms in operation before 1983 is 73. In part, this may be due to the fact that new firms are smaller than incumbents. Both among entrants and incumbents the percentage of firms that survived until 1987 is quite lower for firms smaller than 5 people than it is for larger companies. Also, the hazard rates are consistently higher for smaller firms (both for entrants and incumbents), thus revealing that the probability of dying is always higher for smaller firms, no matter how old they are.

The time series behaviour of survival is also instructive. Hazard rates for entrants seem to be rather higher during the first year of life than in subsequent years, and this also applies for entrants with 5 or more people employed. After the first year, the hazard rates seem to be stable or to decrease at a much lower rate, although in 1987 they are still higher for entrants than for incumbents. The higher hazard rates in 1984 could possibly be attributed to other causes than infancy, namely to overall economic conditions. To fully discriminate between the first infancy and the economic conditions effect, we should have data on other cohorts of entrants. However, the hazard rates for incumbents do not seem to experience a similar pattern, and this evidence clearly favours the first infancy hypothesis.[8] Survivors grew and, among them, smaller and newer firms grew faster. The average size of survivors increased steadily from 1984 to 1987, both for entrants and for incumbents, but it increases faster for entrants. New firms, that entered at about 30% of the incumbents' average size (44% for firms with more than 4 people) attained, at the fourth year of living, about 43% of the average size of incumbents that

TABLE I
Entrants

	All entrants					Entrants with more than 4 people employed				
Year	Number	Employment	Average Size	Hazard Rate	Survival Rate	Number	Employment	Average Size	Hazard Rate	Survival Rate
1983	3308	40573	12			1614	36326	23		
1984	2588	38810	15	0.22	0.78	1339	34750	26	0.17	0.83
1985	2282	38167	17	0.12	0.69	1195	34125	29	0.11	0.74
1986	1981	36342	18	0.13	0.60	1070	32883	30	0.10	0.66
1987	1752	36163	21	0.12	0.53	961	32177	33	0.10	0.60

TABLE II
Incumbents

	All incumbents					Incumbents with more than 4 people employed				
Year	Number	Employment	Average Size	Hazard Rate	Survival Rate	Number	Employment	Average Size	Hazard Rate	Survival Rate
1983	20834	829860	40			14936	813842	54		
1984	19028	806656	42	0.09	0.91	14027	788992	56	0.06	0.94
1985	17904	779705	44	0.06	0.86	13347	767227	57	0.05	0.89
1986	16625	748104	45	0.07	0.80	12633	737041	58	0.05	0.85
1987	15225	729148	48	0.08	0.73	11858	719875	61	0.06	0.79

TABLE III
All firms

	All firms			Firms with more than 4 people employed		
Year	Number	Employment	Average Size	Number	Employment	Average Size
1983	24249	871103	36	16590	850676	51
1984	24358	867757	36	16720	847367	51
1985	24805	870097	35	16936	849214	50
1986	25722	864298	34	17504	842568	48
1987	26901	886786	33	18359	864387	47

survived until 1987 (54% for firms with more than 4 people). Among each type of firms, smaller firms grew faster. The average entrants' size increased 75% during the first four years of their lives, but the corresponding percentage is only 44 for firms with more than 4 people, and a similar pattern of results can be also observed for incumbents. The average size of 1983 entrants increases, but it does so at a decreasing rate and, although in a somewhat more limited way, the same applies to the average size of incumbents.[9]

This evidence seems to support the view that sees entry and post-entry performance as different stages of the same decision process. If the entry costs are sunk and firms are not sure about their efficiency, risk aversion recommends that they should enter at a small scale, a decision which becomes mandatory if, moreover, they face liquidity constraints. Actual experience in the market updates their expectations about their own efficiency, and those that were efficient in the past become more optimistic about their future efficiency. Furthermore, as these firms were also able to generate the funds needed to expand, they are able to grow. As firms gain experience in the market, they become gradually more sure about their optimal sizes and their growth rates decrease towards zero as they approach what they have learned to be these optimal sizes. Our results also seem to fit well to the idea that the large pool of entrants may play an important role as a seedbed from which winners are picked up by the competition process.[10]

A large amount of entry continued to occur after 1983, and this entry flow is probably the main responsible for the decrease in the average firm size, which occurs in spite of the continuing growth of the average size of both 1983 entrants and incumbents. Note that more than 1/3 (1/4 for firms with more than 4 people) of the total number of firms in 1987 were not in activity before 1983 nor started their operations in that year. As a consequence of these high flows of entry that meanwhile occurred, and to the employment share

attained by these latter entrants, the employment share of 1983 entrants decreased during the period from 4.7% to 4.1% and from 4.3% to 3.7%, for firms of all sizes and for firms with more than 4 people, respectively.

3. Firm size and growth: the sample selection problem

We start now the analysis of the relationship between the size of the newly created firms and their rates of growth, by defining the variables to be employed and making some qualifications to the sample. *Size* was defined as the logarithm of the firm's employment and *Growth* as the difference of *Size* in two consecutive years.

For the subsequent analysis, very small firms were not considered. The first reason for this is that firms smaller than 5 people were not randomly included in our sample. The sample only includes those very small firms that employ paid labour, and therefore may not be representative of the universe of firms of that size. This would only be important if these firms behave differently than excluded firms, in what respects to growth, but it is not hard to believe that they may be more likely to grow than firms with only self-employed or family workers.

The second reason has to do with the interval in which growth rates can vary for small firms. Consider, for example, the most extreme case, firms that were born with 1 employee. There is no upper bound for these firms to grow, but there is a very clear lower bound: their size cannot decrease, unless they die. In our sample, the maximum value attained by the growth rate is 4.477, which corresponds to a firm that had started operations with 1 employee and grew to 88 employees in 1984. A similar (but negative) growth rate would only be possible for firms starting their activities in 1983 with 88 people or more. Growth rates of very small firms would then be concentrated in very high values, which may induce a bias in favour of the negative relationship between growth and size. This is readily apparent in Figure 1, which plots $Growth_{84}$ against $Size_{83}$.

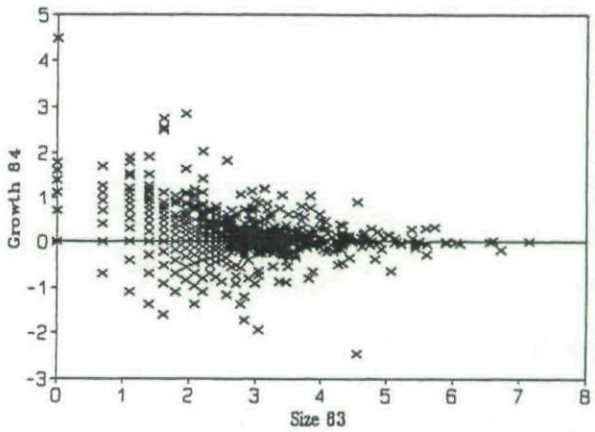

Fig. 1. $Growth_{84}$ versus $Size_{83}$.

The same problem still holds even after restricting the sample to firms with more than 4 people, but it disappears when it is restricted to firms with more than 9 people. The highest ratio $Employment_{1984}/Employment_{1983}$ is 6.231, and it is possible to firms with 9 people in 1983 to attain ratios smaller than 1/6.231 without dying. Accordingly, in the rest of the paper we restrict our attention to the analysis of behaviour of firms greater than 9 people. Note that this is not the whole story, in

TABLE IV
Growth of entrants that survived until 1987 — Summary statistics

	All entrants				Entrants larger than 4 people				Entrants larger than 9 people			
Year	1984	1985	1986	1987	1984	1985	1986	1987	1984	1985	1986	1987
Mean	0.1462	0.0640	0.0581	0.0585	0.0959	0.0467	0.0357	0.0475	0.0770	0.0522	0.0136	0.0296
Std. dev.	0.4152	0.3318	0.3322	0.3599	0.3592	0.2763	0.3022	0.3334	0.3022	0.2443	0.2900	0.3209
Min.	−2.464	−1.609	−2.210	−3.951	−2.464	−1.099	−2.210	−3.951	−2.464	−0.836	−2.210	−3.951
Max.	4.477	3.738	2.079	1.705	2.833	1.452	1.833	1.692	1.830	1.452	1.833	1.387
Obs.	1752				961				555			

what the sample selection problem is concerned. Even for firms larger than 9 people, it is possible that those who are smaller have a greater propensity to die, and that this greater propensity may be in order to compensate the higher growth rates that small surviving firms may experience.

If this sample selection problem was ignored, we would want to fit a line to the points in Fig. 1 for which $Size_{83} > 2.20$, which is to estimate equation (1) for that sample.[11]

$$Growth_t = \gamma + \delta\ Size_{t-1} \tag{1}$$

Estimation of this equation by *OLS* may however give biased estimates of the true relationship between size and growth, due to the aforementioned sample selection problem. Specifically, we expect the probability of survival to be positively related to *Size*, as described in equation (2).

$$Survival_t = \alpha + \beta\ Size_{t-1} \tag{2}$$

To obtain unbiased estimates of parameters in equations (1) and (2) maximum likelihood methods can be employed. Equation (1) alone can be estimated with a probit model, and the sample selection bias in equation (2) can be corrected by joint estimation of equation (1) and (2), with the generalized tobit model, called the Type II Tobit by Amemiya (1984). Results of estimation of *OLS*, probit and tobit models for each year between 1984 and 1987 are presented in Table V.

It is well known that tobit models are not robust to departures from standard assumptions about the error term and, in the context of studies relating firm size to firm growth, heteroscedasticity is one of these problems which is likely to occur. Evans (1987a, 1987b) and Hall (1987) found evidence of heteroscedasticity in their samples, and this may be a particular difficult problem, since it may be not easy to distinguish it from mispecification or from the sample selection problems. One crucial reason for the presence of heteroscedastic errors in studies of the relationship between size and growth is closely related with the experience information which may be embodied in firm size. If firms growth rates become less variable with age, and if firms' size increases with age, as it is implied in Jovanovic's (1982) model, then it is reasonable to expect heteroscedasticity in models of firm size and firm growth. In our case, however, since firms are all of the same age, this may be less important and, in fact, we did not find evidence of size related heteroscedasticity.[12] However, to account for the possibility of heteroscedasticity of unknown form, White's (1980, 1982) estimates of standard deviations were also computed but, although these estimates do not coincide exactly with normal estimates, qualitative results remain unchanged.

Results in Table V confirm the hypotheses that firm size influences positively the probability of survival and negatively the rate of growth. Results are not very strong, however. Coefficients β and δ

TABLE V
Regression results: Firms with more than 9 employees

		1984		1985		1986		1987	
Method	Parameter	Coeff.	Std. dev.	Coeff.	Std. dev.	Coeff.	Std. dev.	Coeff.	Std. dev.
Tobit	α	0.611	(0.234) a	0.935	(0.296) a	1.381	(0.274) a	0.858	(0.297) a
	β	0.142	(0.075) b	0.152	(0.096) c	0.011	(0.084)	0.157	(0.095) b
	γ	0.199	(0.053) a	0.155	(0.045) a	0.131	(0.045) a	0.167	(0.049) a
	δ	−0.032	(0.016) b	−0.029	(0.014) b	−0.025	(0.013) b	−0.029	(0.014) b
Probit	α	0.568	(0.235) a	0.874	(0.292) a	1.328	(0.273) a	0.672	(0.297) b
	β	0.161	(0.075) b	0.177	(0.094) b	0.046	(0.084)	0.235	(0.095) a
OLS	γ	0.114	(0.048) a	0.113	(0.042) a	0.091	(0.042) b	0.099	(0.046) b
	δ	−0.021	(0.015) c	−0.023	(0.013) b	−0.022	(0.013) b	−0.018	(0.014) c

Letters a, b and c near standard-deviations mean that the respective coefficient is statistically significant at the 1, 5 and 10% levels, respectively, in a one-tailed test.

are never statistically different from zero at the 1% level, except in one case, and in the 1986 equation β is not even statistically different from zero at the 10% level. This indicates that, for firms of the same age, we cannot put too much confidence in size as a predictor of success, and suggests that the bias provoked by the fact that only surviving firms are included in the analysis of firm growth, may not be very important. In fact, and in spite of the fact that the correlations between the errors of the two equations are significant, not only the qualitative results derived from *OLS* and maximum likelihood estimates do not change, as the estimates themselves are never different for more than one standard-deviation.

The same applies to the comparison of the estimates of coefficient δ across periods, indicating that, for new firms of the same age, the relationship between size and growth does not seem to be significantly changed with the passing of time.

4. Firm size and growth: the effect of firm heterogeneity

Until now, we have implicitly ignored any other non-stochastic determinants of firm growth and concentrated in the relationship between size and growth. However, it is quite sensible to admit that industry wide conditions (e.g. industry growth) or firms specific factors (e.g., management) may play an important role in firms' growth. If firms' growth depends on other firms' characteristics than size, our model will suffer from mispecification from omitted variables and, in this case, *OLS* will be biased.

One way to overcome this problem is to explicitly include in the model all the variables that are deemed to be relevant for the growth decision of firms. This is, for example the approach followed in Bourlakis (1990). For very comprehensive data sets, as in our case, this approach would, however, encounter great difficulties, since normally comprehensiveness is achieved at the expense of detail, and information is available only for a few variables. But, worse of all, would be the intrinsic difficulty in finding good proxies to measure, for example, management characteristics.

An alternative procedure, followed in this section, is to assume that, although the specific factors that determine firm growth cannot be measured, they are largely time-invariant, and to capture the contribution of these factors by explicitly modelling these firm and industry specific effects. This could be well justified if we think, for example, in structural conditions prevailing in the industry where the firm operates, like economies scale or the stage of the industry life cycle, or in firm-specific factors like entrepreneurial talent, ownership structure or organizational form.[13]

We estimated four models using pooled *cross-section time-series* data on the 555 firms that started operations with more than 9 people and that survived until 1987. The relationship between firm growth and size was estimated by *OLS, OLS* with 25 three-digit industry dummies, *OLS* with firm dummies (or firm fixed effects) and with a random effects model. The regressions also included time-specific dummies, to control for the effects of age and of the overall economic environment on the growth of firms, and the obtained estimates of δ are reported in Table VI.

The F statistics for the tests to the collective significance of the industry and firm dummies are respectively 2.925 and 2.802, well above the critical F values at the conventional significance

TABLE VI
Estimates of δ with pooled data

	OLS	With industry dummies	Firm fixed effects	Firm random effects
Coefficient	−0.020	−0.031	−0.570	−0.081
St. deviation	(0.007)	(0.007)	(0.022)	(0.001)
SSR	186.632	180.017	96.462	149.254

All the estimates are statistically significant at the 1% level in a one-tailed test.

levels, and therefore the hypotheses that there are no industry or firm specific effects are rejected. The statistical significance of the industry dummies seems to indicate that the growth of firms is conditioned by the sectoral environment in which they operate. The rationale to employ a firm fixed effects model is to presume that, besides from this sectoral contribution, there may be a firm specific effect affecting the growth decision of firms. Note that sectoral effect is still captured in this model, and that the industry dummy model can be seen as a model with firm individual effects, in which the constraints that individual effects are equal for firms in the same industry is imposed. Accordingly, an F test can be performed to ascertain if the model fit improves significantly due to the substitution of the firm dummies for the industry dummies, and since the computer F value is 2.720, we are led to the conclusion that there is a firm specific effect, which goes far beyond the effect of the industry in which the firm operates.

The *OLS* estimate of δ is always smaller (in absolute value) than those from the other models, and the percentage difference between the estimates for δ produced by the models with and without industry dummies is somewhat greater than the differences reported in other studies that included industry dummies (Hall 1987; Huighen, Kleijweg and van Leeuwen 1991). The most striking result, however, is the substantial bias in the estimate of δ that omission of these firm specific effects leads to. The estimate in the fixed effects model comes multiplied by a factor, which is greater that 25, when compared with the plain *OLS* estimates, and greater than 15, when compared with those produced by the industry dummies model. Besides, although the estimates of δ are significantly different from zero in all the models, the degree of confidence we have in this result also increases substantially in the fixed effects model (the t statistic associated with size experiences an increase from 2.77 to 25.79).

To this author's knowledge, there is no other study that had estimated the relationship between firm size and firm growth with a firm fixed effects model, with which our results could be compared. However, Huighen, Kleijweg and van Leeuwen (1991) estimated a firm random effects model, and reported modest departures from *OLS* results. In our sample, the difference between the *OLS* and the random effects estimate is much larger, but this specification is clearly rejected in favour of the fixed effects model. In the random effects model it is assumed that the individual effects are uncorrelated with the regressors and, unlike in the fixed effects case, the estimator is inconsistent if this is not so, and the procedure suggested by Hausman (1978) can be used to test the hypothesis of no correlation. In our case, there is little reason to expect that the individual effects are not correlated with size, since that, at least some factors that we expect to strongly determine the individual firm effect, such as ownership structure or management characteristics, are very likely to vary with firm size. In fact, the computed value of the Hausman statistic (669.82) clearly indicates that the hypothesis of no correlation should be rejected. In this case, the random effects model is inconsistent, and the fixed effects should be preferred.

Furthermore, the direction of the bias in the δ estimate when these firm effects are omitted shows that the firm specific intercepts are positively associated with firm size. What this means is that, if firms were all of the same size, those firms that are indeed larger would grow faster or, put in other words, that the firm growth potential (or motivation) varies positively with firm size, which seems to fit well to the early theories on the objectives of the firm.[14]

One of the less well discussed aspects of Gibrat's Law is that it states that firm growth in one period should be independent of growth in the previous period.[15] Also here, our results are strongly against the validity of the Law. Instead, they seem to confirm some other studies (e.g. Wagner, 1992) that have found a phenomenon of persistence of growth. One of the possibilities that have been raised in the literature (e.g. Mansfield, 1962) is that Gibrat's Law would only hold for firms of a certain dimension upwards. The rationale for this hypothesis is that long-run equilibrium positions are achieved in the flat portion of cost curves, and that firms smaller than the minimum efficient scale will always have an increased incentive to growth. To test the robustness of our results to different sample definitions, we estimated two of the previous models (pooled data, with and without firm fixed effects) in different samples, in which the smallest firms were excluded. The different

estimates for δ, when the threshold that limits the inclusion of firm in the sample varies from 9 to 99 people, are reported in Table VII. In the model without firm dummies, the negative relationship between size and growth stops holding when only firms with more than 29 employees are included, but it holds in all samples, when the firm dummies set is included.[16] In this case, not only the relationship remains robust, as the estimate of δ is quite stable, at least until the point when only firms with more than 94 people are considered.

5. Conclusion

The data displayed here on the post-entry behaviour of firms created in Portuguese manufacturing in 1983 reveal a highly turbulent economy, characterized by a very high flow of new firm creation and contemporary exit movements. These recently created firms are much smaller and face a higher risk of dying than their older counterparts, and a large proportion of them disappear quite shortly after entry. The survivors, however, grow rather fast in the post-entry period, which seems to confirm the seedbed role that small new firms are sometimes claimed to play. Moreover, these results hold during the four first years of their lives. Hazard rates are persistently higher for entrants than for incumbents. This also applies to the rates at which survivors of these two groups grow, but entrants remain, nevertheless, smaller than incumbents. This suggests that, after entry, there is a period of *incubation*, during which entrants are not yet established firms, and during which the selection process is particularly important. One could also interpret our results as evidence that the entry move is only the first stage of a more complete decision process, that includes the post-entry adjustments and that lasts until the new firm becomes an established competitor. Our results thus suggest that, if this distinction between entrants and established firms could be based on the differences in size, growth or risk of failure, this *incubation* period is certainly larger than four years.

The relationship between firm size and firm

TABLE VII
Regression results: Firms with more than x employees

		Model without firm dummies		Model with firm dummies	
x	Number of firms	δ	std. dev.	δ	std. dev.
9	555	−0.020	0.007 a	−0.570	0.022 a
14	362	−0.017	0.009 b	−0.519	0.026 a
19	262	−0.022	0.011 b	−0.517	0.031 a
24	203	−0.016	0.012 c	−0.480	0.037 a
29	161	−0.017	0.014	−0.522	0.044 a
34	130	−0.010	0.017	−0.497	0.051 a
39	115	−0.005	0.018	−0.483	0.054 a
44	100	0.002	0.020	−0.479	0.060 a
49	85	0.011	0.023	−0.468	0.066 a
54	78	0.023	0.025	−0.456	0.070 a
59	70	0.011	0.021	−0.475	0.050 a
64	64	0.022	0.022	−0.483	0.052 a
69	59	0.027	0.023	−0.489	0.054 a
74	53	0.014	0.024	−0.526	0.052 a
79	48	0.020	0.026	−0.533	0.055 a
84	42	0.038	0.029	−0.534	0.058 a
89	40	0.039	0.030	−0.531	0.059 a
94	38	0.020	0.028	−0.275	0.075 a
99	36	0.025	0.030	−0.274	0.077 a

Letters a, b and c near standard-deviations mean that the respective coefficient is statistically significant at the 1, 5 and 10% levels, respectively, in a one-tailed test.

growth is weakly negative when analysed in a cross section of firms of the same age. This result holds during the first four years of firms lives, and does not seem to be significantly affected by consideration of the sample selection problem that may arise from the fact that smaller firms have a greater propensity to die. In fact, we found that this relationship, when measured with firms of the same age, is not also very strong.

The results are, however, quite altered by consideration of the unobserved industry and firm specific effects that may influence firm growth. After controlling for these effects (particularly for the firm specific effects), the negative relationship between firm size and firm growth becomes much more pronounced, and its statistical significance is much increased. Besides, when these effects are considered, the relationship is robust to exclusion of the smallest firms from the sample. This set of results clearly point to the conclusion that there is a firm specific effect that determines that rate at which (young) firms persistently grow, and that failure to take this effect into account can lead to substantially biased estimates of the effect of firm size on growth rates.

We also found the firm individual effects to be correlated with firm size which, given the direction of the bias that omission of these individual effects leads to, reveals that, although firm growth decreases with size, the growth potential (or the motivation for growth) is greater in larger firms. This seems to suggest that underlying the individual firm effect may be questions such as the ownership structure, or management characteristics, which have been traditionally claimed by economic theory to be relevant to the growth decision of firms. The explicit discovery of such factors is, however, left for further work.

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Notes

[1] See Geroski and Schwalbach (1991) for a collection of studies on entry and Geroski (1991) for a survey.

[2] See Hay and Morris (1991) p. 537–541 for references to earlier studies, in which this conclusion was generally reached.

[3] These differences in results may be attributable to a number of reasons, and perhaps not the least important is the difference in the periods studied. While earlier studies addressed a period in which concentration was generally increasing, which is consistent with Gibrat's Law, recent studies focusing in most recent times, deal with periods of an increased importance of small firms in the economy (see Loverman and Sengenberger (1991) for an overview of the evolution of the importance of small business in six OECD countries). Using different methodologies to control for sample selection, Acs and Audretsch (1990) found, however, a much weaker relationship, and Dunne, Roberts and Samuelson (1989) found a non monotonic relationship between size and growth.

[4] Comparison between the data from the Census of Manufacturing and data from our source reveals that even though the survey of the Ministry of Employment investigates only 1/4 of the total number of firms employing less than 5 people that were considered by the Census, it reports more firms in all the other employment classes and records a greater employment figure than the Census itself. Hence, except for very small firms, it can be seen as a highly reliable source.

[5] The identifying scheme consists in numbers given sequentially to firms by the time they first report to the survey. Before a new identifying number is given to a particular firm, the Ministry staff makes sure that the firm was not included in their files in previous years. This check can be quite accurate, since firms include in their statements two other identifying number which are given to them by other State Departments, and that are also unique. One of these numbers is given to firms by the Firms Register, when they are legally established as an autonomous legal entity, and the other one is given by the Tax Administration when firms first report their activities for tax purposes.

[6] Although data is available since 1981, we did not measure entry in 1982 because in 1981 a number of problems in the data collection and data processing stages came about, and data is generally considered as not being very reliable. Given the way we measured entry, availability of reliable data for the year before the one we are interested in, is crucial for the accuracy of the measurement. Besides, the fact that we only count as entrants those firms that did not appear in the 1981 nor in the 1982 files increases our confidence that our entrants are, in fact, new firms.

[7] It is, of course, possible that a firm, which is absent from the files for more than one year, appears later in the file. These firms' status could have recoded as well, but the price we would have to pay would be the corresponding decrease in the number of years available. We decided instead to exclude firms in these conditions (about 3% of the total number of entrants) from our sample.

[8] Given the limited time span available, an indepth analysis of the post-83 entry cohorts is not yet possible. Nevertheless, for the 1984 and 1985 cohorts, we could confirm that the hazard rates are higher in the first year of life than in the subsequent years.

[9] The exception to the rule of decreasing growth rates seems to be the year 1987, in which the growth of both entrants and incumbents experiences a notable impulse. The good overall economic conditions in 1987 seem to be on the basis of this

push. Note, for example, that 1987 is an year during which the overall employment in manufacturing experienced a notable increase, in contrast with the almost complete stability during the rest of the period under scrutiny (see Table III).

[10] Beesley and Hamilton (1984) emphasised this role and made the point that turbulent environments, characterized by both high entry and exit rates, are those that serve best this selection process.

[11] Other functional forms could be expected, namely the one that includes both *Size* and $Size^2$ as explanatory variables, a specification that proved to fit well to the data in Evans (1987a, 1987b). However, in our sample, these two variables were highly correlated, thus creating a colinearity problem. Contini and Revelli (1989) report a similar problem.

[12] We regressed the square of the residuals of the positive observations of the tobit model on *Size*, its square and a constant, but the *F*-statistic of these regressions for the hypothesis of zero slopes were always lesser than 1.

[13] Some of these effects were clearly identified by earlier writers on the theory of the firm. Baumol suggested that firms run by managers would be more prone to pursue objectives of sales (Baumol, 1958 and 1959) or growth (Baumol, 1962) maximization, in contrast with the profit maximization objectives that would be carried by the companies directed by owners. Penrose (1959) and Marris (1963) noted the existence of a managerial constraint to the growth of firms, and Lucas (1978) stressed the importance of recognising the differences in the managerial ability among firms to explain differences in firm performance.

[14] The finding that firm growth is affected by a firm specific effect, which is correlated with firm size, may raise some doubts on the validity of cross-section analysis of survival and size, since it may be argued that this firm effect would also affect survival. It may be claimed, for example, that the desire for security by managers may prevent exits of unprofitable firms, that would be closed if directly run by their owners. This may be true, but the problem seems to be less acute here than in the growth problem, since the expected effect of this firm specific factor would reinforce rather than contradict the effect of size on survival. This effect would, therefore, be overestimated rather than underestimated, as in the case of the growth size relationship. Besides, the nature of the problem is also slightly different. Because firms that die in one period do not appear again in the panel, the recently developed methods for limited dependent variables in panel data, surveyed in Maddala (1988), are not appropriate to deal with this problem. Instead, econometric duration models should be used to analyse the timing of the exit decisions, as in Mata and Portugal (1993). Combining these two different approaches, by integrating the analysis of duration with the analysis of firm growth in a panel of firm is, however, clearly beyond the scope of this paper.

[15] See Hay and Morris (1991).

[16] A similar procedure was performed with the *cross-section* data of the previous section. Although the critical threshold, up from which the relationship between growth and size is no longer significant, is not so well defined as with pooled data, the qualitative conclusion is the same: the negative relationship becomes less pronounced as smaller firms are being left out of the sample.

References

Acs, Z. and D. Audretsch, 1989, *Innovation and Small Firms*, Cambridge, Mass.: MIT Press.

Audretsch, D. B., 1991, 'New Firm Survival and the Technological Regime', *Review of Economics and Statistics* **60**(3), 441–450.

Audretsch D. B. and T. Mahmood, 1992, 'Firm Selection and Industry Evolution: The Post-Entry Performance of New Firms', Discussion Paper FS IV 92–7, Wissenschaftszentrum Berlin.

Amemiya, T., 1984, 'Tobit Models: A Survey', *Journal of Econometrics* **24**, 3–61.

Baumol, W., 1958, 'On the Theory of Oligopoly', *Economica* **25**, August, 187–198.

Baumol, W., 1959, *Business Behavior, Value and Growth*, New York: MacMillan.

Baumol, W., 1962, 'On the Theory of Expansion of the Firms', *American Economic Review* **52**, 1078–1087.

Beesley, M. and R. Hamilton, 1984, 'Small firms' Seedbed Role and the Concept of Turbulence', *Journal of Industrial Economics* **33**, 217–232.

Bourlakis, C., 1990, 'Probability of Survival and Firm Growth in Greek Manufacturing Industries', *Paper presented at the 17th EARIE Conference*, Lisbon.

Contini, B. and R. Revelli, 1989, 'The Relationship between Firm Growth and Labor Demand', *Small Business Economics* **1**(4), 309–315.

Dunne, P. and A. Hughes, 1990, 'Small Firms, Age, Growth and Survival in the, 1990's', *Paper presented at the 17th EARIE Conference*, Lisbon.

Dunne, T., M. Roberts and L. Samuelson, 1989, 'The Growth and Failure of U.S. Manufacturing Plants', *Quarterly Journal of Economics* **104**(4), 671–688.

Evans, D., 1987a, 'Tests of Alternative Theories of Firm Growth', *Journal of Political Economy* **95**(4), 657–674.

Evans, D., 1987b, 'The Relationship Between Firm Growth, Size, and Age — Estimates for 100 Manufacturing Industries', *Journal of Industrial Economics* **35**(4), 567–581.

Geroski, P., 1991, *Market Dynamics and Entry*, Oxford: Basil Blackwell.

Geroski, P. and J. Schwalbach (eds.), 1991, *Entry and Market Contestability: An International Comparison*, Oxford: Basil Blackwell.

Hall, B., 1987, 'The Relationship Between Firm Size and Firm Growth in the United-States Manufacturing Sector', *Journal of Industrial Economics* **35**(4), 583–606.

Hausman, J. A., 1978, 'Specification Tests in Econometrics', *Econometrica* **46**(6), 1251–1271.

Hay, D. and D. Morris, 1991, *Industrial Economics and Organization*, Oxford: Oxford University Press.

Huighen, R., A. Kleijweg and G. van Leeuwen, 1991, 'The Relationship Between Firm Size and Firm Growth in Dutch Manufacturing Estimated on Panel Data', *Research Paper 9105*, Research Institute for Small and Medium Sizes Business in the Netherlands.

Jovanovic, B., 1982, 'Selection and Evolution of Industry', *Econometrica* **50**(2), 649–670.

Kumar, M., 1985, 'Growth, Acquisition Activity and Firm

Size — Evidence from the United Kingdom', *Journal of Industrial Economics* **33**(3), 327—338.

Loverman, G. and W. Sengenberger, 1991, 'The Re-emergence of Small-Scale Production: An International Comparison', *Small Business Economics* **3**(1), 1—38.

Lucas, R. E., 1978, 'On the Size Distribution of Business Firms', *Bell Journal of Economics* **9**(3), 508—523.

Maddala, G., 1988, 'Limited Dependent Variable Models Using Panel Data', *Journal of Human Resources* **23**(3), 307—338.

Mahmood, T., 1992, 'Does the Hazard Rate for New Plants Vary Between Low- and High-Tech Industries?' *Small Business Economics* **4**(3), 201—209.

Mansfield, E., 1962, 'Entry, Gibrat's Law, and the Growth of Firms', *American Economic Review* **52**(5), 1023—1051.

Marris, R., 1963, 'A Model of the Managerial Enterprise', *Quarterly Journal of Economics* **77**(2), 185—209.

Mata, J. and P. Portugal, 1993, 'The Effect of Demand and Technological Conditions on the Life Expectancy of New Firms', in G. Mussati, A. Fumagalli and M. Vivarelli (eds.), *Births and Start-Up of Small Firms*, Dordrecht: Kluwer Academic Publishers.

Penrose, E., 1959, *The Theory of the Growth of the Firm*, Oxford: Basil Blackwell.

Phillips, B. and B. Kirchhoff, 1989, 'Formation, Growth and Survival: Small Firm Dynamics in the U.S. Economy', *Small Business Economics* **1**(1), 65—74.

Prais, S., 1974, 'A New Look at the Growth of Industrial Concentration', *Oxford Economic Papers* **26**(2), 273—288.

Hymer, S. and P. Pashighian, 1962, 'Firms Size and Rate of Growth', *Journal of Political Economy* **70**(6), 556—569.

Segal, U. and A. Spivak, 1989, 'Firm Size and Optimal Growth Rates', *European Economic Review* **33**(1), 159—168.

Singh, A. and G. Wittington, 1975, 'The Size and Growth of Firms', *Review of Economic Studies* **42**(1), 15—26.

Storey, D. et al., 1987, *The Performance of Small Firms: Profits, Jobs and Failures*, London: Routledge.

Wagner, J., 1992, 'Firm Size, Firm Growth, and Persistence of Chance: Testing Gibrat's Law with Establishment Data From Lower Saxony, 1978—1989', *Small Business Economics* **4**(3), 125—131.

White, H., 1980, 'A Heteroskedastic-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity', *Econometrica* **48**, 817—838.

White, H., 1982, 'Maximum Likelihood Estimation of Misspecified Models', *Econometrica* **50**(1), 1—25.