NEW SMALL FIRM SURVIVAL IN THE UK

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Abstract

This paper examines the survival of 622 small and micro firms in the UK established between 1990 and 2001. In contrast to the previous research, we consider a wide range of human capital, strategy and industry variables. Our results suggest that founder's education and bank finance impact positively on firm survival. However, we found that firms which compete on price or are financially constrained are much less likely to survive.

Keywords: new firms, human capital, strategy, industry, duration

JEL Classification: L

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1. Introduction

Over the past decades, considerable work has been undertaken on the factors affecting the birth and death of firms and firm growth (e.g., Evans, 1987; Storey and Wynarczyk, 1996; Greene *et al.*, 2004; Yasuda, 2005). However, little attention has been given to the factors associated with firm duration. Econometric duration models have been recently used to analyse firm survival rates focusing particularly on the US economy (e.g., Troske, 1989; Audretsch and Mahmood, 1995; Thompson, 1995). Distinctively, a study by Mata and Portugal (1994) has addressed the same topic for European country. These empirical studies have provided a remarkable contribution to understand firm survival, but the factors that they use to explain it have almost no overlap between them. We argue that probably a narrow or at least incomplete range of explanations are analysed when there is a clear need for multi channel explanations for what is clearly a complex issue.

The current study seeks to enrich our understanding of the determinants influencing the duration of new firms in the UK. It does this in three ways: First, our data allows us to consider a wide range of human capital, strategy and industry variables. Second, we use parametric and semi-parametric procedures to assess the importance of these variables in explaining firms' survival time. To briefly anticipate the results, we show that only 55% of the firms survived in the first four years. We also find evidence that bank finance and founder education are important determinants of firms' duration. Third, we find that liquidity constraints and price competition is another significant factor that influence the length of firm duration.

The reminder of the paper is organised as follows: Section 2 presents the econometric framework. Section 3 describes the data. In Section 4 we discuss the empirical findings. Section 5 concludes the paper.

2. Econometric framework

Straightforward application of OLS is not appropriate to tackle duration analysis. The main reason arises from the fact that at the time of observation, the total length of time between entry and exit from the state is unknown (right-censoring). Given this problem, a binary dependent regression model (logit or probit) may deal with the right-censored observations. However, this strategy is also potentially problematic. For example, it takes no account of differences in time in which is firm is at risk of experiencing the event and so loses information as well as, time-varying explanatory variables cannot be handle easily. Hazard models, however, can surmount the above problems. This is explained below.

The length of a spell for a firm activity is a realization of a continuous random variable T with a cumulative distribution function $F(t)$ and for all points for which $F(t)$ may be differentiated with probability density function $f(t) = F'(t)$, that is:

$$F(t) = \mathrm{P}(T \leq t) = \int_0^t f(u)du \tag{1}$$

The probability than a firm remains in the state ("survives") until time t is given by the survivor function as:

$$S(t) = \mathrm{P}(T > t) = 1 - F(t) \tag{2}$$

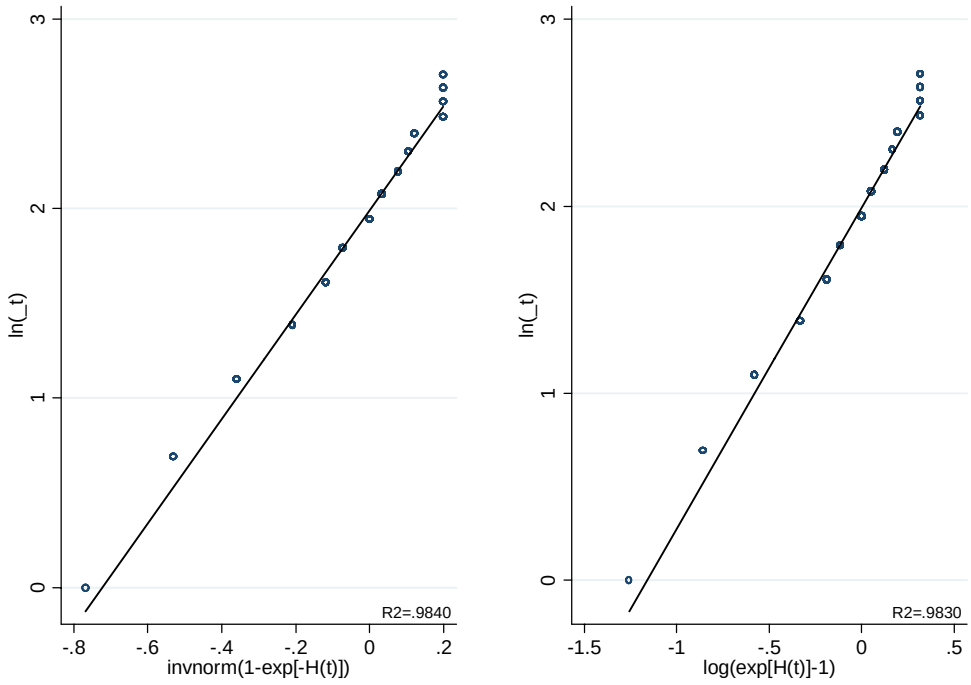
Our sample, however, includes firms that have survived more than some minimum amount of time and therefore firms with short spells are systematically excluded (left-truncation). Rather than estimating the unconditional survival function, we estimate the conditional probability of surviving beyond t, given survival to the entry time t_0, that is:

$$S_{t_0}(t) = \mathrm{P}(T > t \mid T > t_0) = \frac{S(t)}{S(t_0)} \tag{3}$$

The treatment of firms' death is quite complex. A firm may not appear to operate in particular year for a number of reasons, other than its permanent end (e.g., employees were unpaid, changed address or phone number). Following Mata and Portugal (1994) we classify as exit firms that do not appear in our files in two consecutive years. Empirical estimates of the baseline hazard function were computed and the smoothed hazard function curve was plotted (this is available upon request). This showed increasing duration dependence initially followed by decreasing duration dependence. This is in line with previous empirical work suggesting that younger firms are less likely to survive (see Storey and Wynarczyk, 1996).

It is important, however, to explore the effects of certain explanatory variables on the hazard rate by using a multivariate model of the life duration of firms. The smoothed hazard function curve suggests that that the log-logistic or log-normal hazard models may provide an acceptable parametric representation. It should be noticed that a parametric model is preferred if the data can be shown to follow a specific distribution. The log-normal distribution was chosen on the basis of the hazards plots (see Figure 1), which is analogous to probability plotting, but it is designed to handle censored data (see Lee and Wand, 2003). This paper estimates an accelerated failure time (AFT) model assuming a

Figure 1. Hazards Plots



linear relationship between the log of firm survival time $\ln t$ and characteristics X, that is:

$$\ln t = \beta' X + \sigma u \tag{5}$$

where β is a vector of unknown parameters and σ is a scale factor which is related to the shape of hazard function $(\sigma > 0)$ and u is an error term normally distributed. The failure rate is given by:

$$\lambda(t;X) = \frac{f(t \mid x)}{1 - F(t \mid x)} = \frac{(1/t\sigma\sqrt{2\pi})e^{-(1/2\sigma^2)(\ln t - \mu)^2}}{1 - \Phi[\ln(at)/\sigma]} \tag{6}$$

where $\alpha = e^{-\mu}$, $\mu = \beta' X$ and $\Phi(\cdot)$ is the cumulative distribution function of a standard normal distribution.

The parameters of the model (β, σ) are estimated via maximum likelihood taking into account both right-censoring and left truncation. Let define t_i as the total spell length and let t_{0i} be the entry time, and make use of a censoring indicator c_i to distinguish between censored $(c_i = 0)$ and complete spells $(c_i = 1)$. The likelihood function can be written as follows:

$$L = \prod_{i=1}^{n} \left[\frac{f(t_i)}{S(t_{0i})} \right]^{c_i} \left[\frac{S(t_i)}{S(t_{0i})} \right]^{1-c_i} \tag{7}$$

or, equivalently, in terms of the log-likelihood function,

$$\ln L = \sum_{i=1}^{n} [c_i \ln f(t_i) + (1 - c_i) \ln S(t_i) - \ln S(t_{0i})] \tag{8}$$

3. Data

The analysis is based on a firm survey conducted in 2001, which is a rich data source previously used by Greene *et al.* (2004). To identify potential new firms, the dataset was compiled by comparing B.T. telephone directories for 2000 with those for 1995. All businesses, excluding retail outlets, which appeared in 2000, but did not appear in 1995, were identified as 'potentially new'. A population of 'new' firms was derived and an initial 'one-in-three' sample was drawn, selecting every third firm on the list. When the sample list was exhausted, firms were randomly drawn from all remaining sample. The interviewees were located in Buckinghamshire, Shropshire or Tees Valley and were interviewed in person at respondents' normal place of work. The response rate was 73%. To allow an examination of the factors that affect firm survival, we then supplemented

the 2001 survey with follow up postal and telephone surveys for 2002, 2003 and, finally, for 2004.

The 2001 dataset consisted of 622 'new' firms started within the counties between 1990 and 2001, and were wholly independent, non-retail businesses. The distribution across the three counties is uneven, with Tees Valley being home to just over half the sample (51.5%). Buckinghamshire and Shropshire are each home to 24.3% of firms. Table 1 shows the age and the employment size of the firms. All firm ages relate to when the firm started-up originally. Some firms in the sample started up previously on another site; their age is calculated from this initial inception date. About 71% are five years old or less in 2001. The percentage of firms above the small classification was found to be tiny. About 99% of the firms can be classed as small or micro enterprises, while actually 72.51% have no more than four employees. Overall, we can conclude that the firms in the sample are small and young.

Table 1. Age and size of firms*

A) Age (in years)	**Firms** (%)	**Employees** (%)
1-5	70.74	69.31
	(1.82)	(0.75)
6-10	27.81	29.68
	(1.80)	(0.74)
10+	1.45	1.01
	(0.48)	(0.16)
B) Size (No. of Employess 2001)	**Firms** (%)	**Employess** (%)
1-5	72.51	31.57
	(1.79)	(0.76)
6-10	13.99	17.10
	(1.39)	(0.61)
10+	13.50	51.34
	(1.37)	(0.81)
Observations	622	3,773

Note: *Standard errors in parentheses.

3.1 Preliminary analysis

Table 2 provides some summary statistics for the survival-time data. The mean survival time of firm is about 8 years when truncation is not considered. However, when the latter is taken in to account we found that firms last on average for about 3 years and 6 months. In Table 3 we present the lifetable estimates computed by the Kaplan-Meier estimator. The results suggests that the overall survival rate in the first year is about 75%, but only 55% of the firms survive in the first 4 years . The failure rate after year 4, however, follows a much lower pattern. The Table shows that 39.6% of the sample remained alive after $t = 15$. These findings point towards to the view that young firms are less likely to survive than older firms. This is in line with the available literature (e.g., Mata and Portugal,1994).

Turning to the variables to be included in the X vector in eq. (5), we consider a wide range of human capital, strategy and industry variables suggested from the previous literature (e.g., Mata and Portugal, 1994; Stearns *et al.*, 1995, Storey and Wynarczyk, 1996). In Table 4 we present the correlation matrix of the survival time and the variables that are expected to influence the firms' duration. Founder age and firm size are found to be positively and significantly correlated with firm survival time. We also found that the innovation variable is significantly and positively correlated with survival, while the financial constrained variable found to be significantly and negatively correlated with survival time. Finally, we found significant and negative correlation between manufacturing and survival time.

Table 2. Summary statistics of the survival-time data

Category:	**Mean**	**Minimum**	**Median**	**Maximum**
Entry time	4.346	0	4	11
Exit time:				
When truncation is not considered:	7.952	1	8	15
When truncation is considered:	3.605	1	4	4
Falures	0.189	0	0	1

Table 3. Kaplan-Meier estimates of Survival Function

Duration (years)	**Beg. Total**	**Fail**	**Lost**	**Enter (2001)**	**Survivor function**	**Standard error**
0	0	0	0	8	1	-
1	8	2	0	52	0.750	0.153
2	58	6	0	79	0.672	0.141
3	131	12	0	91	0.611	0.129
4	210	20	4	66	0.553	0.117
5	252	16	39	78	0.518	0.110
6	275	9	60	79	0.501	0.107
7	285	16	72	27	0.473	0.101
8	224	6	55	21	0.460	0.098
9	184	7	64	20	0.442	0.095
10	133	3	70	10	0.432	0.093
11	70	1	21	9	0.426	0.092
12	57	4	20	0	0.396	0.086
13	33	0	15	0	0.396	0.086
14	18	0	9	0	0.396	0.086
15	9	0	9	0	0.396	0.086

Table 4. Correlation matrix of survival time and covariates

	Survival time	ln(Found. age)	Male	Degree	Profess. Qualif.	Unemployed	Limited company	Manuf.	Constr.	Profess. services	Distrib.	Startup bank/finan. company	Startup public authorities	ln(Size) in 2001	Compet. Advant. low prices	Financ. constr.	Product innovator
Survival time	1																
ln(Founder age)	**0.188**	1															
p-values	0.000																
Male	0.034	0.033	1														
p-values	0.439	0.449															
Degree	0.057	**0.110**	**0.074**	1													
p-values	0.195	0.012	0.090														
Professional qualification	0.004	0.007	**-0.079**	**-0.161**	1												
p-values	0.930	0.883	0.072	0.000													
Unemployed	-0.044	-0.025	0.058	-0.003	**-0.077**	1											
p-values	0.322	0.570	0.191	0.950	0.081												
Limited company	0.053	0.068	**0.215**	**0.155**	-0.031	-0.044	1										
p-values	0.227	0.124	0.000	0.000	0.482	0.316											
Manufacture	**-0.085**	0.032	0.063	0.047	**-0.096**	0.009	0.041	1									
p-values	0.053	0.463	0.154	0.290	0.029	0.835	0.350										
Construction	**0.074**	0.063	**0.098**	-0.031	-0.032	0.061	**0.102**	**-0.141**	1								
p-values	0.092	0.154	0.026	0.483	0.471	0.163	0.020	0.001									
Professional services	0.008	-0.056	0.053	**-0.128**	-0.011	0.005	**-0.160**	**-0.276**	**-0.173**	1							
p-values	0.850	0.201	0.233	0.004	0.809	0.905	0.000	0.000	0.000								
Distribution	0.028	0.054	**0.111**	**0.174**	-0.001	0.040	**0.235**	**-0.281**	**-0.176**	**-0.346**	1						
p-values	0.526	0.219	0.011	0.000	0.988	0.359	0.000	0.000	0.000	0.000							
Startup bank/finan. company	0.040	**-0.133**	0.008	**-0.078**	0.064	0.071	0.035	0.010	**-0.078**	-0.006	-0.024	1					
p-values	0.359	0.002	0.857	0.075	0.143	0.107	0.423	0.820	0.076	0.886	0.581						
Startup public authorities	-0.062	**-0.121**	-0.096	**-0.082**	0.043	0.059	**-0.114**	-0.041	0.026	-0.059	**-0.076**	0.066	1				
p-values	0.162	0.006	0.028	0.062	0.332	0.178	0.009	0.350	0.548	0.180	0.083	0.135					
ln(Firm size) in 2001	**0.090**	0.026	0.063	0.000	0.016	**-0.099**	**0.309**	0.052	0.063	-0.056	0.016	**0.092**	**-0.105**	1			
p-values	0.041	0.554	0.150	0.993	0.724	0.025	0.000	0.235	0.155	0.203	0.718	0.036	0.016				
Competi. advant. low prices	-0.069	-0.068	-0.057	0.005	0.007	**0.101**	-0.020	0.065	-0.050	0.010	-0.011	0.055	-0.001	**-0.086**	1		
p-values	0.119	0.124	0.192	0.915	0.878	0.022	0.655	0.137	0.257	0.828	0.810	0.207	0.975	0.050			
Financially constrained	**-0.079**	-0.030	**0.085**	0.004	0.004	**0.074**	0.070	**0.092**	-0.019	-0.004	-0.041	-0.001	**-0.080**	0.009	-0.007	1	
p-values	0.072	0.489	0.053	0.928	0.927	0.093	0.113	0.037	0.666	0.929	0.347	0.990	0.069	0.837	0.869		
Product innovator	**0.086**	0.011	-0.014	**0.204**	-0.052	-0.018	**0.135**	-0.011	-0.010	**-0.106**	**0.122**	-0.004	-0.023	**0.145**	-0.096	0.129	1
p-values	0.050	0.806	0.753	0.000	0.241	0.690	0.002	0.812	0.830	0.016	0.005	0.937	0.608	0.001	0.029	0.003	

4. Empirical results

Based on our discussion in section 2, we estimated a parametric survival model with lognormal distribution to examine the effect of the specific covariates on the hazard rate. Table 5 shows the results of three different specifications of the model. In general, our results are robust across the specifications. Among the human capital variables only the degree variable was found to be positive and statistically significant. This may suggest that founders with a degree were more likely to have a business that survived, which would seem to relate to human capital and entrepreneurial ability. Our results also show that an industry such as manufacturing has negative and statistically significant effect on survival. However, other sector-specific variables do not appear to play significant role on firm survival. This is also true of legal form.

Furthermore, there is clear evidence that bank start-up finance has a positive impact on the survival of firms. This may suggest that banks have a valuable role in enhancing the survivability of new firms. The effect of product innovation on firm survival was found to carry the expected sign, but it is insignificant. Our results, however, provide strong evidence that firms that are able to maintain business on the basis of non-price competitive factors are more likely to survive. This is in line with Stearns *et al.* (1995) who also found that price competitor strategy is associated with significantly lower chances of survival.

Table 5. Regression results from the log normal model

	Specification		
Variable	**I**	**II**	**III**
ln(Founder age)	0.130	0.230	0.311
	(0.620)	(0.611)	(0.594)
Male	-0.194	-0.009	0.025
	(0.352)	(0.356)	(0.344)
Degree	0.747*	0.710*	0.570
	(0.440)	(0.432)	(0.417)
Professional Qualification	0.586	0.478	0.416
	(0.503)	(0.496)	(0.478)
Unemployed	-0.355	-0.270	-0.175
	(0.354)	(0.349)	(0.341)
Limited company	0.340	0.438	0.481
	(0.338)	(0.355)	(0.351)
Manufacture	-	-0.830*	-0.838*
	-	(0.492)	(0.491)
Construction	-	-1.018	-1.010
	-	(0.698)	(0.680)
Professional services	-	-0.709	-0.732
	-	(0.454)	(0.447)
Distribution	-	-0.639	-0.555
	-	(0.480)	(0.463)
Startup bank/finanance company	0.682*	0.662*	0.584*
	(0.361)	(0.354)	(0.345)
Startup public authorities	0.063	-0.017	-0.026
	(0.406)	(0.407)	(0.391)
ln(Size) in 2001	0.211	0.209	0.208
	(0.181)	(0.178)	(0.172)
Competetitive Advantage low prices	-0.618*	-0.589*	-0.483
	(0.318)	(0.312)	(0.302)
Financially constrained	-0.611*	-0.613*	-
	(0.330)	(0.331)	-
Financially constrained (serious problem)	-	-	-0.661*
	-	-	(0.392)
Financially constrained (not serious problem)	-	-	-0.295
	-	-	(0.460)
Product innovator	0.044	0.075	0.081
	(0.310)	(0.305)	(0.295)
Intercept	2.046	2.088	1.711
	(2.382)	(2.349)	(2.281)
Log likelihood	-215.437	-213.292	-207.333
χ2 (degrees of freedom)	23.270(12)	27.560(16)	24.98(17)
AIC	458.874	462.584	452.665
Observations	519	519	512

Notes:
*Significant at the 10% level. ** Significant at the 5% level.

Furthermore, we found that financial constrained firms in the 1 year of their operation have less chances of survival. In specification (III) we use more detailed information on the financial constrained variable by using a set of dummies indicating whether the firm considered having a serious financial problem or not very serious financial problem in the first year. The results suggest that only firms with serious financial problems are less likely to survive. Figure 2 compares the survival curves for firms that compete primarily on price and firms that adopt other strategies. Similarly we compare the survival curves for firms with and without financial constrained in the first year. Clearly from Figure 2, survival time are much lower for firms who compete on prices and firms were financial constrained in the first year. The estimated hazard function is plotted in Figure 3.

Figure 2. Survival functions

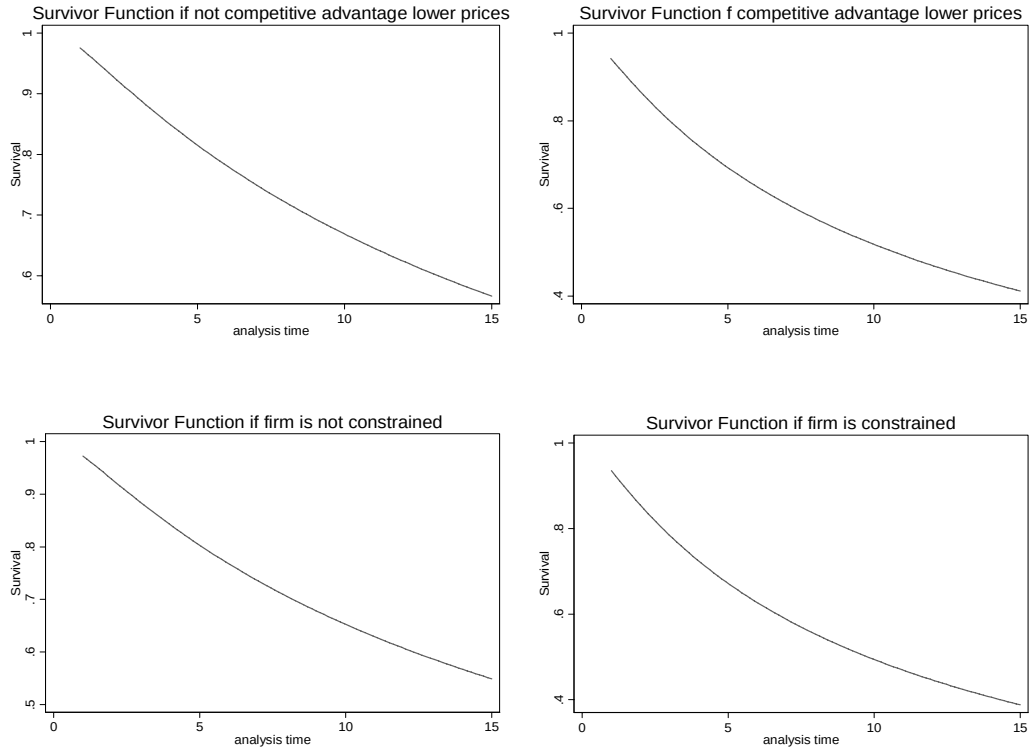
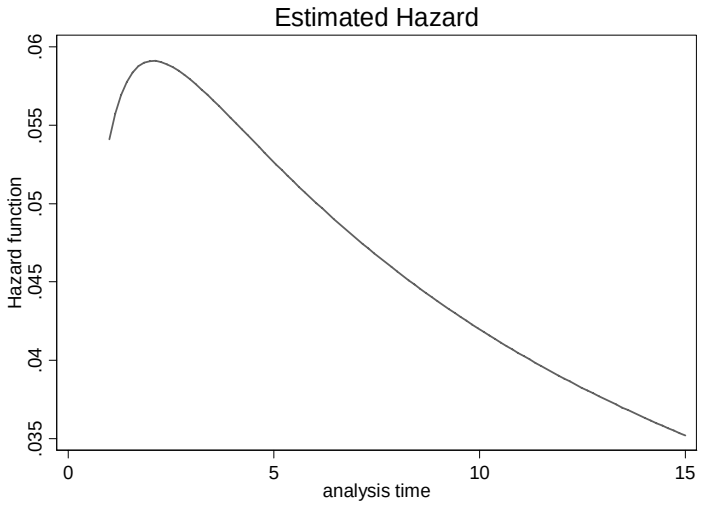


Figure 2. Estimated hazard function



We also considered a generalisation of the model I-III in Table 5 to allow for unobserved heterogeneity. We estimated different frailty models and test whether unobserved heterogeneity is relevant using likelihood ratio tests based on the restricted and unrestricted models. The estimated likelihood ratio tests suggest that unobserved heterogeneity is not relevant in our sample (these results are available upon request). The robustness of the results presented in Table 5 is also confirmed by using different model specifications. Table 6 present these results. In column (I) we present estimates using the log-logistic distribution. In Column (II) we provide estimates of the determinants of firm survival using the Cox proportional hazard model. This model makes no assumption about the duration dependence, unlike parametric approaches. Finally column (III) presents the regression results using an ordered probit model. As the dependent variable is now the number of years that a firms remains in the survey. All these specification suggest similar conclusion reported for Table 5.

Table 6: Regression results for different model specifications

Variable	Log logistic	Cox PH	Ordered Probit
ln(Founder age)	0.162	0.114	0.071
	(0.606)	(0.449)	(0.278)
Male	-0.003	0.104	-0.077
	(0.347)	(0.254)	(0.160)
Degree	0.752*	-0.534	0.422**
	(0.425)	(0.327)	(0.191)
Professional Qualification	0.450	-0.357	0.241
	(0.480)	(0.381)	(0.227)
Unemployed	-0.265	0.137	-0.103
	(0.340)	(0.232)	(0.149)
Limited company	0.495	-0.412	0.174
	(0.344)	(0.253)	(0.153)
Manufacture	-0.764	0.486	-0.374*
	(0.480)	(0.357)	(0.214)
Construction	-1.012	0.651	-0.348
	(0.722)	(0.444)	(0.274)
Professional services	-0.653	0.566*	-0.269
	(0.434)	(0.326)	(0.197)
Distribution	-0.667	0.549	-0.291
	(0.464)	(0.349)	(0.210)
Startup bank/finanance company	0.653*	-0.413**	0.324**
	(0.344)	(0.253)	(0.152)
Startup public authorities	-0.030	0.028	-0.029
	(0.399)	(0.284)	(0.178)
ln(Size) in 2001	0.166	-0.103	0.097
	(0.172)	(0.129)	(0.077)
Competetitive Advantage low prices	-0.609**	0.431**	-0.273**
	(0.302)	(0.208)	(0.1288)
Financially constrained	-0.664**	0.383*	-0.258*
	(0.328)	(0.216)	(0.137)
Product innovator	0.096	0.009	0.024
	(0.295)	(0.214)	(0.135)
Intercept	2.322	-	-
	(2.351)	-	-
Log likelihood	-213.133	-500.239	-345.246
χ2 (degrees of freedom)	28.370(16)	24.94(16)	29.87(16)
AIC	462.267	-	-
Observations	519	519	519

Notes:
*Significant at the 10% level. ** Significant at the 5% level.

5. Conclusions

This paper provides a detailed analysis of the factors that influence the new firm duration in UK using a unique data set of 622 firms. In contrast to previous studies, we consider a wide range of human capita, strategy and industry variables. By implementing parametric methodology using the log-normal distribution we found that founder's education and bank finance impact positively on firm survival. In contrast, we found that firms which compete on price are much less likely to survive than firms which follow different competitive strategy. This is line with previous research by Stearns *et al.* (1995). Furthermore, financial constraints in the first year found to have a negative and significant effect on firm duration. The results are robust when estimated using different distribution assumptions and model specifications.

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