The Determinants of Firm Survival in South Africa

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Abstract:

In developing economies the existence of a healthy corporate structure is vital to the pursuit of long term policy objectives of employment and sustainable economic growth. This makes it important to understand what determines firm survival and while there is a growing literature on the topic, there is limited coverage of developing economies because of data limitations. This paper uses a unique dataset on a panel of companies listed in the Johannesburg Stock Exchange (JSE) in South Africa during the period 2000-2010 obtained from the DataStream service to analyse the patterns of survival and investigate the determinants of firm survival. It starts by considering the patterns of growth and survival over the 2000-10 period and specifies some simple logit binary survival models that allow for firm size, age and financial characteristics. These models are improved upon using the non-parametric Kaplan-Meier product limit method and estimating Cox proportional hazard model. Fifty per cent of the companies listed in the JSE survived for the whole period and the determinants of their survival would seem to be consistent with expectations with highly leveraged, highly profitable large firms in primary sector having the highest chance of survival. Surprisingly, Age and the origin of the firm do not seem to be significant factors in determining survival.

Keywords: Firm Survival; Duration models; Financial indicators

JEL classifications: L25; C2; O55

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1. Introduction

In developing economies the existence of a healthy corporate structure is vital to the pursuit of long term policy objectives of sustainable economic growth and employment. Small, medium and large firms can all play important roles in industrial and economic development, through the creation of innovation, competition and employment, while a dynamic population that sees births and deaths (churning) can be important for aggregate productivity growth. At the same time too much churn can reflect firm failures and industrial weakness. This makes it important to understand the dynamics of firm survival and growth and while there is a growing literature on the topic, there is limited coverage of developing economies because of data limitations (Soderbom et al, 2006). This is particularly true in Africa, where few studies exist and those that do use survey data because of the general unavailability of firm panels, eg Frazer (2005), Soderbom et al (2006) and Nkurinziza (2012).

This paper contributes to the literature by creating a panel dataset of companies listed in the Johannesburg Stock Exchange (JSE) in South Africa during the period 2000-2010 and using it to analyse patterns of firm survival and investigate the determinants of firm survival. While this dataset has the disadvantage of not picking up the very smallest firms, it does the consist of companies that produce the majority of South Africa's output and provides a consistent basis upon which to analysis patterns of survival over time. Using this data an analysis of patterns of growth and survival over the period 2000-10 is undertaken and the determinants of their survival investigated.

The next section presents the review of the literature on the determinants of firm survival, both theoretical background and empirical evidence. Section three then discusses the methodology and the data to be used. Section four presents the empirical results and Section five presents some conclusions.

2. Analysing Firm Survival

Empirical work on the survival of firms often takes a rather eclectic approach to specifying the survival equation, drawing on variables that reflect a range of theoretical perspectives. The use of measures of competition arise from the basic neoclassical theory of the firm, where firm produce a homogenous product in a perfectly competitive market, meaning that firms that are unable to make normal profits are driven out of the market. Moving the analysis to the more realistic imperfect competition, an inefficient firm can remain in the market due to factors such as barriers to entry and market power. Indeed, if few players are sharing the market, firms can survive despite being inefficient and smaller firms operating in highly concentrated markets are likely to find it very difficult to sustain the competitive pressures. So the degree of competition in an industry and the size of the firm is linked to firm survival (Lopes-Garcia and Puente, 2006).

Within this general context, a range of models have been developed to explain differences in survival. Jovanovic (1982) developed a passive learning model, in which firms learn survival strategies over time to improve their performance and become competitive, meaning that young

firms are more at risk of failure than the older experienced firms. This was built upon by Pakes and Ericson (1998) to produce an active learning model, with the introduction of human capital, that allows firms with more highly qualified management to be better placed to achieve growth. Industrial evolution theories suggested that it might be the age of the firm rather than its size that important, with older firms being less likely to fail, as they have acquired the necessary experience on the market and its challenges (Geroski, 1995).

Another strand of literature has focussed upon the impact of credit rationing and financial constraints on firm survival (Stiglitz and Weiss, 1981; Myers and Majluf, 1984). Financial constraints are considered as barriers to access to external finance, which may hinder growth and prevent a firm reaching the minimum efficient size, so increasing its probability of failure. Similarly, the financial health of the firm, as reflected by the strength of its balance sheet, might mean it is better placed to handle any negative shocks. Some studies use profitability and tangibility as measure of financial health, others used the amount of credit directly (Bridges and Guariglia, 2008; Spaliara and Tsoukas, 2013), others have used measures of leverage, the ratio of total debt to total assets. Highly leveraged companies are argued to be more likely to survive due to increased monitoring and oversight by the lenders, which limits the degree to which managers can engage in non-productive activities. The empirical evidence is mixed with Audretsch et al (2000) finding no evidence that high leverage reduces the probability of failure in The Netherlands.

Other individual firm characteristics that have been suggested as influencing firm survival are their origin and ownership. Firms from abroad are considered more likely to survive, as they may benefit from local policies designed to encourage foreign investor, have better access to advanced technology and financial resources (Shirefaw, 2009). Above firm level, industries or sectors may have characteristics that make them more risky, such as competitiveness, capital requirement, innovation activity and barriers to entry. To capture this, Audretsch (1995) used innovation requirement, while Lopez-Garcia and Puente (2006) used concentration measures. Tsoukas (2012) and Spaliara and Tsoukas S (2010) introduce financial development indicators such as market capitalisation and size of stock market value traded play an important role is firm survival.

In the limited empirical work on developing countries summarised in Table A2, the main variables posited to determine firm survival are measures of firm size and age. Survival is found to be positively related to size and age by Spaliara and Tsoukas, 2013, Varum and Rocha, 2012, with Harding et al (2004) and Frazer (2005) finding that larger firms are less vulnerable to failure than smaller firms. In contrast, others, such as McPherson (1995), using surveys for Swaziland, Botswana, Malawi and Zimbabwe in the early 1990s, and Nkurunziza (2012), using surveys for Kenya, found firm size to be insignificant. Nkurunziza (2012) and Frazer (2005) reported significant but weak age effects while Soderbom et al (2006) found no significant age effect. Nkurunziza (2012) also considered the effect of credit on firm survival in Kenya and found a significant positive impact.

3. Firm Survival in South Africa

Information on South African companies listed on the Johannesburg Stock Exchange (JSE) was collected for the period 2000-2010 from Datastream. While focusing on listed companies may be open to criticism for over representing the large firms, the range of firms covered is relatively large and there is no other comprehensive dataset of firms across the size groups available in South Africa and as Jenson (2004) argues the JSE listed companies to a large extent represent the characteristics of the corporate sector of the South African economy. In fact the dataset cover the large part of the productive capacity of the South African economy. The data comprises income statements, profit and loss accounts and the balance sheet for each of the companies during the period and additional non-financial data were obtained from various sources including the Profiles Stock Exchange Handbooks, Macgregor Handbooks and online database, Financial Times top companies online and Who Owns Whom online database. Information on mergers and acquisitions was sourced from the website of the Competition Commission of South Africa and Bloomberg database. Firm age is measured as the current year minus the year on which the firm was founded.

The empirical literature has utilised a number of measures of firm size including net sales/revenue, total assets and employment. Smyth et al (1975) and Shalit and Sankar (1977) investigate the interchangeability of the alternative measures and argue that the choice of the suitable one depends on the question being investigated, but is often the result of data availability. In this study, net sales is used as the main measure because it has the least missing values and so provides the largest sample, though in fact the different measures were found to be highly correlated.

Considering the evolution of the number of companies listed in the JSE during the period 1995-2010 in Table 1, the larger number of firms in the earlier period reflects some changes in the JSE over the period. This includes allowing of offshore listing. As Burke (2005) explains, the population of the JSE went from 669 in 1998 to 396 in 2004, while at the same time the capitalisation of the JSE almost doubled. The reason for this seems to have been a tranche of unsuited companies listing on the JSE because of a listing boom, with a lot of fund money going into small capitalisations companies for expected large returns, encouraging listings and driving up prices, until the bottom fell out of the market. To prevent such excesses the JSE tightened up listing requirements. While this change will not affect the analysis of surviving firms, it does impact upon the results in the analysis of non-survivors, which focuses on the reasons why companies did not survive both overall and broken down by size group[1].

[1] It may also affect the results of sample selection models used later, as the full number of firms will be included in the survival equation. This is discussed later.

Table 1: Number of Non-Financial Companies in the JSE in the Period 1995-2010

Year	Number of Non-Financial Companies
1995	158
1996	166
1997	186
1998	413
1999	442
2000	401
2001	350
2002	320
2003	308
2004	307
2005	307
2006	312
2007	325
2008	320
2009	314
2010	304

Dunne and Masenyetse (2014) analyse the changing size distribution of these firms over the period 2000-10 by constructing a transition matrix over a number of years, showing that from the 400 companies that were alive in 2005, 288 (72 per cent) survived to 2010. As expected, the highest survival rate is observed in higher size groups with survival rate of over 90 per cent compared to 54.7 per cent in the lowest size group. The pattern was similar for the period 2000-2005 There were 518 companies alive in 2000 and 294 (56.8 per cent) survived the five years and 139 (47.2 per cent) remained in their size groups. So the earlier period has a larger number of firms, but also a considerably larger proportion of firms failing.

The firms that did not survive were investigated and the reasons for their deaths categorised as takeover, liquidation, delisting and other. The delisting category was introduced to investigate the effects of a listing boom on the JSE identified for the period 1997-98 which then led to a surge of delisting. It includes voluntarily delists suspension and failure to comply with listing requirements[2] (Dunne and Masenyetse, 2014). Takeover refers to the transfer of control of a firm from one group of shareholders to another and can take different forms including mergers and acquisition (M&A), with a merger being the consolidation of two companies in which one survives and the merged one goes out of existence. The acquiring firm assumes the assets and liabilities of the merged company, though sometimes the target company becomes the subsidiary of the parent company and does not disappear from the sample[3]. Changes in scheme of

[2] As those categorised as failing to comply with listing requirements or suspended could be companies in transitory states, that were in the process of being taken over or liquidated, more information was collected to verify the final classification.

[3] A consolidation is when the two or more companies form an entirely new entity, so in our panel we will see a birth. It may be an issue whether you treat the new company as a birth or just a combination of the two in dealing with historical data.

arrangement, offers to minorities and offers to shareholders are all considered as takeovers, and may be by other listed companies or by non-listed ones. Liquidations include no dividend liquidation, voluntary winding up and disposal and the other category comprises unbundling of assets and companies that could not be confidently classified with the available information.

As Table 2 shows, the death rate between 2005 and 2010 was lowest in the upper most size groups and highest in the lowest size groups. Takeover was the main cause of death (13.5 per cent) and varied across the size classes, with the highest proportions in the R1-2 billion and R4-5 billion groups, at 25 per cent each. The figures for 2000-2005 were somewhat different in scale, but had a similar pattern. The death rate was considerably higher, 42 per cent compared to 22 per cent and the main cause of death was again found to be takeover. To investigate the listing issue, a delisting category was added to the usual categories, which reduced the number in the 'other' category, but did not alter the takeover and liquidation categories much. This suggests there was no tranche of firms listing and then delisting, but it is likely that a number of the newly listed firms were liquidated or taken over.

Table 2: Sales Size Distribution by Type of death

Panel 1: 2005-2010												
Companies alive in 2005 by Sales Size		Non-Survivors		Type of Death								
				Takeover		Liquidated		Delisting		Other(1)		Missing(2)
Rbn	Number	Number	%	Number	%	Number	%	Number	%	Number	%	Number
<0.1b	128	35	27.3	14	10.9	2	1.6	10	7.8	2	1.6	7
0.1-0.5b	101	29	28.7	18	17.8	5	5.0	1	1.0	0	0.0	5
0.5-1b	33	6	18.2	6	18.2	0	0.0	0	0.0	0	0.0	0
1-2b	24	6	25.0	6	25.0	0	0.0	0	0.0	0	0.0	0
2-3b	16	3	18.8	2	12.5	0	0.0	0	0.0	0	0.0	1
3-4b	17	2	11.8	1	5.9	0	0.0	1	5.9	0	0.0	0
4-5b	16	4	25.0	4	25.0	0	0.0	0	0.0	0	0.0	0
5-10b	24	1	4.2	1	4.2	0	0.0	0	0.0	0	0.0	0
>10b	41	3	7.3	2	4.9	1	2.4	0	0.0	0	0.0	0
Total	400	89	22.3	54	13.5	8	2.0	12.0	3.0	2	0.5	13
Panel 1: 2000-2005												
Companies alive in 2000 by Sales Size		Non-Survivors		Type of Death								
				Takeover		Liquidated		Delisting		Other(1)		Missing(2)
Rbn	Number	Number	%	Number	%	Number	%	Number	%	Number	%	Number
< 0.1b	182	86	47.3	39	21.4	21	11.5	20	11.0	6	3.3	0
0.1-0.5b	146	75	51.4	51	34.9	16	11.0	4	2.7	4	2.7	0
0.5-1b	44	21	47.7	13	29.5	6	13.6	1	2.3	1	2.3	0
1-2b	47	17	36.2	13	27.7	2	4.3	1	2.1	0	0.0	1
2-3b	22	8	36.4	7	31.8	1	4.5	0	0.0	0	0.0	0
3-4b	13	5	38.5	3	23.1	1	7.7	1	7.7	0	0.0	0
4-5b	10	2	20.0	2	20.0	0	0.0	0	0.0	0	0.0	0
5-10b	26	7	26.9	5	19.2	1	3.8	0	0.0	1	3.8	0
>10b	28	3	10.7	3	10.7	0	0.0	0	0.0	0	0.0	0
Total	518	224	43.2	136	26.3	48	9.3	27	5.2	12	2.3	1
1) Includes unbundling of assets and unclassified 2)Includes missing and zero values in the second period												

Table 3 compares these death rates to those found in other studies, though the differences in time periods, duration and coverage of the firms, as shown in column 3 and 4 do make it difficult to draw strong conclusions. It does seem that the death rate for this study is not extreme and close to that reported for the United Kingdom (UK) by Dunne and Hughes (1994) and by Frazer (2005) for Ghana. The overall death rate in Tanzania (40 per cent) and Kenya (40 per cent) seems to be close to that of smaller companies in South Africa, though this may indicate that the surveys undertaken in Kenya and Tanzania pick up a higher proportion of smaller firms than a

panel of listed companies does. In contrast, Ethiopia, Columbia and Morocco reported rather low death rates, but again this may be due to sampling peculiarities.

Table 3: Comparison of Firm Death Rates

Study	Country	Target Industry	Period	Length (Years)	Death Rate
Dunne and Hughes(1994)	UK	All Industries	1980-85	5	20.5%
Dunne et al(1988)	US	Manufacturing	1977-82	5	50.0%
Roberts and Tybout (1996)	Chile	Manufacturing	1984-85	1	7.1 %
Soderbom et al (2006)	Tanzania	Manufacturing	1992-99	7	44%
Soderbom et al (2006)	Ghana	Manufacturing	1992-99	7	20%
Soderbom et al (2006)	Kenya	Manufacturing	1992-99	7	40%
Shiferaw (2009)	Ethiopia	All industries	1996-02	6	16%
Roberts and Tybout (1996)	Colombia	Manufacturing	1984-85	1	14.9%
Roberts and Tybout (1996)	Morocco	Manufacturing	1984-89	5	6%
Klapper and Richmond(2011)	Cote D Ivoire	All Industries	1978-97	--	24%

4. Determinants of Firm Survival in South Africa

To determine the factors that influence firm survival a simple discrete choice model is often used, with a dependent binary variable (y) taking the value 1 if the firm did not survive throughout the entire period and 0 otherwise. This is observable but the underlying continuous unobservable variable (y^*) satisfies

$$y^* = x'\beta + u \qquad 4$$

With $y = 1$ if $y^* < 0$ (the firm dies) and zero otherwise. A latent variable model, this can be estimated using a probit model if u is standard normally distributed and logit if it is logistic (Soderbom et al ,2006); Nkurinziza , 2012).

A number of the variables that the literature suggests are important are available in the dataset, namely firm size, age, leverage, profitability, ownership and sector.

- Firm size ($SIZE_i$) measured by net sales and three size classes are defined to distinguish small, medium and large companies. A small company is defined as the one with net sales of less than R0.1 billion. Medium size companies are the ones with net sales of R0.1 - 5billion, while large firms are above R5 billion.
- Firm age (AGE_i) is measured by the difference between the current year and the year of establishment. Firms are classified into three age classes' young, middle aged and mature firms. A young firm is the one with age of less than 5 years while the middle aged firm is the one with ages between 5 and 10 years. The last category, mature firm is the one with age greater than 10 years.
- Firm leverage ($LEVERAGE_i$) is measured as the ratio of total debt to total assets. It captures firm's access to external finance such as debt and equity. Two leverage groups are identified,

low leveraged firms are defined as those with leverage below the median while high leverage are those with leverage above the median.

- Firm profitability *(PROFITABILITY$_i$)* is measured as the ratio of profits before interest and taxes to total assets. Profitability is also disaggregated into two groups, low profitability firms are defined as those with profitability below the median while high profitability firms are those above.
- Firm Origin (*ORIGIN$_i$*) captures the original country of the firm. The variable is a binary variable equal to one if the firm is of South African origin and zero otherwise. Our dataset does not have the foreign ownership variable so the origin dummy is expected to mimic foreign ownership.
- Firm sector (*SECTOR$_i$*). While the data has nine International Classification Benchmark (ICB) industries basic material, consumer goods, consumer services, health care, industrials, oil and gas, technology, telecommunications financials and utilities, some of these industries have small numbers of companies, and so sector dummies for primary, secondary and tertiary sectors are used instead.

Table 5 presents estimates of the survival model, with dependent variable for the logistic model is a binary variable equal to unity if a firm died during the period 2000-10 and zero if it is found alive at the end of the period. In general, the signs and significance in all the explanatory variables are as expected. The probability of survival for larger and medium firms is higher than the probability of survival for small firms, the base category, though the coefficient for medium sized firms is insignificant. This result suggests that firm size matters, with larger firms are better placed to effectively handle negative shocks compared with small firms and provide support for the empirical literature from other countries **(**Soderbom, 2006**).** Looking at the sectors, the probability of survival is lower for firms in the secondary and tertiary sectors compared with those in the primary sector which is the base category. The result seems intuitive in the case of South Africa, since the primary sector is mainly dominated by mining companies which tend to survive for a long time. The lifespan of a mine can exceed 30 years.

Older firms seem to have a higher probability of not surviving than smaller firms, conditional on the other variables. The middle aged and old firms dummies are both positive and statistically significant at 1 per cent and 5 per cent respectively. This result is contrary to the theoretical predictions that age increases survival probability, through increasing firm resilience, but may be due to the nature of this panel. Nkurunziza (2012) did reject the importance of age on firm survival.

Looking at the financial indicators, the coefficient of high profitability is negative and statistically significant at 5 per cent level indicating that the probability of survival is higher high profitability firms compared with the low profitability ones which is the base category. A similar result is observed in leverage. The coefficient of high leverage is negative and statistically significant suggesting that the probability of survival for high leverage firms is higher than those with lower leverage. Firms that are profitable have access to external financial resources, such as credit facilities, that assist them to better manage negative shocks (Nkurunziza, 2012; Lopez-Garcia and Puente, 2006). Finally, the coefficient for the dummy for domestic origin is positive as expected, but insignificant. This may be due to the small number of foreign firms in the panel.

Table 4: Survival Estimation Results

	Logistic Estimation
Medium firms	-0.09
	(0.19)
Large firms	-1.78***
	(0.39)
Secondary sector	0.28
	(0.25)
Tertiary sector	0.89***
	(0.24)
Middle aged firms	0.71**
	(0.31)
Old firms	0.65***
	(0.20)
High profitability	-0.39**
	(0.17)
High leverage	-0.39**
	(0.17)
Domestic origin	0.15
	(0.22)
Constant	-0.57*
	(0.30)
Log likelihood	-390.29
LR chi2(9)	57.83(0.00)
Observations	605
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1	
Dependent variable is equal to unity if a firm died during the period and zero if it is found alive at the end of the period 2000?? -2010	

As discussed, using a simple 0 or 1 discrete survival variable has been criticised as being too simple as it does not reflect the amount of time the firm has survived within the sample period. More recent work uses techniques based on transition or time to event data, which are able to account for the evolution of the exit risk, by controlling for the occurrence and timing of the exit event. Furthermore, they are able to account for right censoring, which occurs since firms that survived up to 2010 are censored (Varum and Rocha, 2012)

One popular method is to compute the product limit estimate of duration of survival:

$$\hat{s}(t) = \prod_{j|t_j \le t} \frac{r_j - d_j}{r_j} \qquad 1$$

where d_j is the number of firms that end at time t_j and r_j is the number of firms that are still in the database and at risk at the time just before time t_j. The resultant survivor function is a decreasing step function with jump at each failure time. A hazard rate can also be computed that measures the rate at which the risk is being accumulated while the hazard function is the instantaneous probability of leaving a state conditional on survival to time t. The hazard function *h(t)* is defined as,

$$h(t) = \lim_{\Delta t \to 0} \frac{pr\left[t \leq T < t + \Delta t | T \geq t\right]}{\Delta t} \qquad 2$$

$$h(t) = \frac{f(t)}{S(t)} \qquad 3$$

Where T is the firm's life duration, *f(t)* is the probability density function and *S(t)* is the survival function.

Estimating the survival rates using the Kaplan-Meier product limit estimate procedure gave the results presented in Figure 1. The vertical axis represents the estimated probability of survival while the horizontal axis is the number of years. About 50 per cent of the firms listed in the JSE survive for 10 years while about 75 per cent of the firms survive less than 3 years.

Figure 1: Kaplan-Meier Survival Estimates

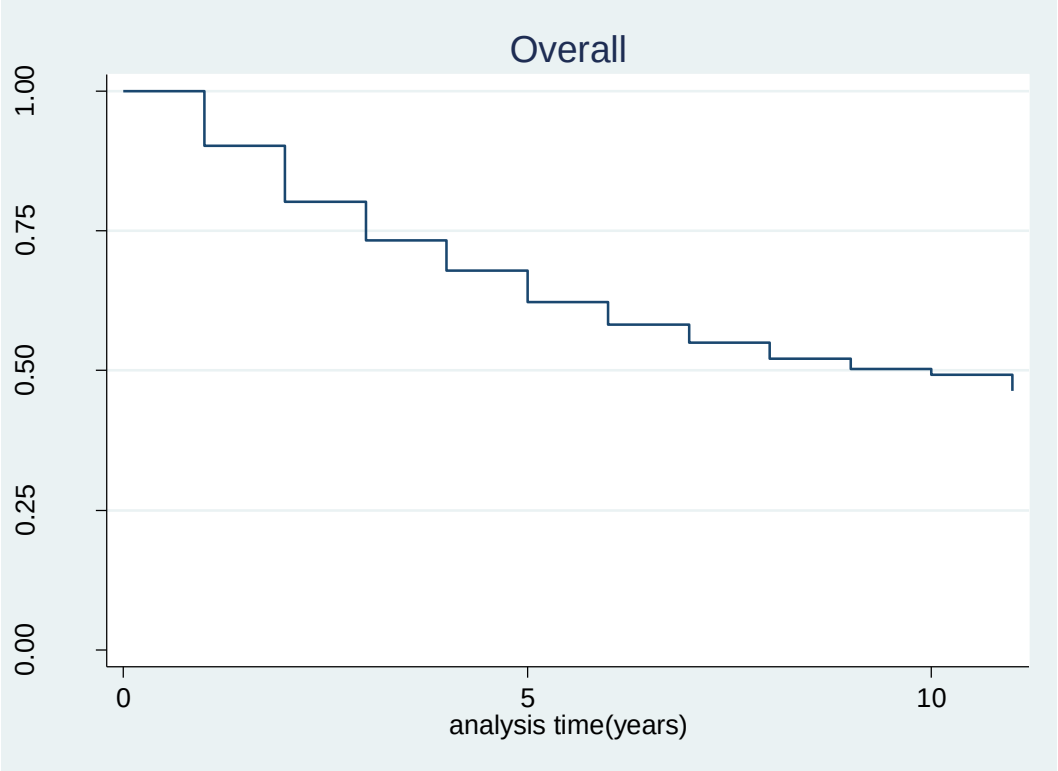
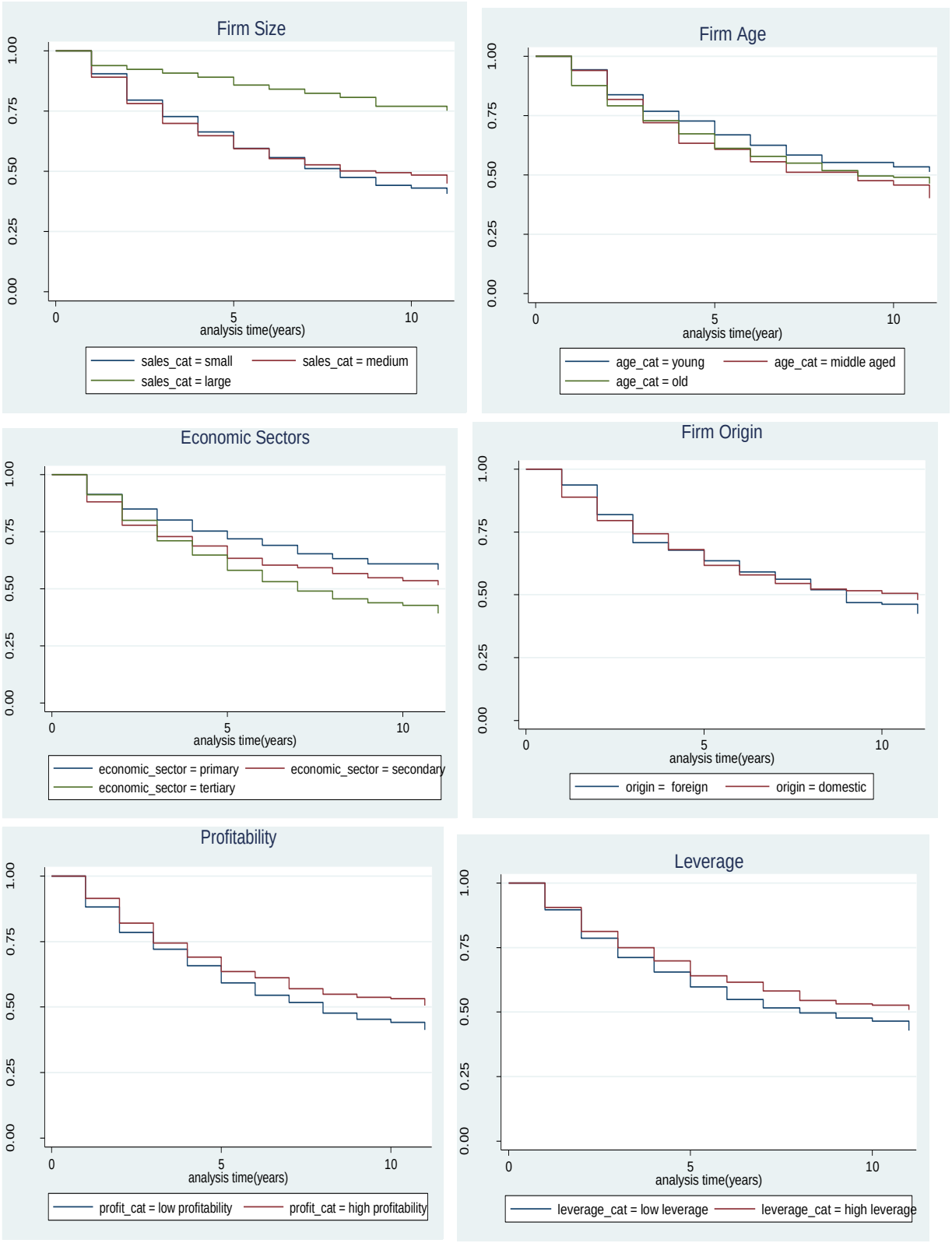


Figure 2: Kaplan-Meier Survival Estimates



(-) indicates that the survival function does not reach median value

To investigate the effects of the explanatory variables on firm survival, the non-parametric log rank tests of equality is used to compare the distributions of sub-samples in the data. The sample is divided into sub-samples according to the covariates. Assuming two groups, the log-rank test is calculate as the sum of observed (O_1 and O_2) minus the expected number of events in each group (E_1 and E_2) over all failure times for one of the two groups.

$$\log - rankstatistic = \frac{(O_2 - E_2)^2}{Var(O_2 - E_2)}$$

Table 4 below presents the results; with C column 2 giving the log rank test results with p values in brackets and column 3 the groups of firms classified by the explanatory variables. The last column gives the median survival time in years. There are clearly significant differences between the survival functions across the groups within the explanatory variables in all variables except age and origin of the firm. The null hypothesis of no difference for the size categories is rejected suggesting that large firms have higher survival chances compared to small and medium firms, as might be expected, with just above 75 per cent of large firm surviving longer than 10 years compared with less than 50 per cent for small and medium firms. Small and large firms seem to have similar patterns of survival for up to seven years, while the medium firms survival function declines slowly thereby increasing the distance. Firms in the primary sector survive longer, while those in the tertiary sector about 50 per cent of them survive for 7 years. The difference between the primary and the secondary is smaller than the distance between the primary and the tertiary sectors. As regards the financial indicators, highly profitable and highly leveraged firms have better survival chances, while for age and origin the null hypothesis is not rejected. These results are confirmed by the survival functions for the explanatory variables presented in Figure 2.

Table 5: Log-Rank Test for Equality of Survivor Functions and Median Survival Times

Explanatory Variable	Log-Rank test (pvalue)	Groups of Firms classified by Explanatory variables	Median Survival Times in years
Size	19.69 (0.00)	Small	8
		Medium	9
		Large	-
Age	2.53 (0.28)	Young	-
		Middle	9
		Old	9
Economic Sector	12.11 (0.00)	Primary	-
		Secondary	-
		Tertiary	7
Profitability	4.17 (0.04)	Low Profitability	8
		High Profitability	-
Leverage	3.14 (0.07)	Low Leverage	8
		High Leverage	-
Origin	0.37 (0.54)	Foreign	9
		Domestic	11

*pvalues in parenthesis
(-)indicates that the survival function does not reach the median value

The proportional hazard model is specified as follows (Cox, 1972),

$$h(t, X) = h_0(t)\phi(X, \beta) \qquad 10$$

Where $h_0(t)$ is the baseline hazard and is a function of time, X is the set of explanatory variables and beta is the vector of parameters. The proportional hazard model implies that the hazard faced by each firm is multiplicatively proportional to the baseline hazard and is the same for each firm. The proportionality assumption is tested using the Covariate rho-test proposed by Grambsch and Therneau (1994).

Table 6 presents the results for the test of proportional hazard assumption. The null hypothesis is that the covariate has the same proportional impact on the hazard everywhere along the hazard function. The test for all explanatory variables fails to reject the null hypothesis that the hazard ratio is constant over time, as do the tests for the covariates medium sized firms, large firms, secondary sector, tertiary sector, middle aged firms, old firms, high profitable firms, high leverage firms and domestic origin. The result indicates that the Cox hazard models can be estimated.

Table 6: Test of the proportional hazards assumption

	rho	chi2	prob>chi2
Medium firms	-0.03	0.36	0.54
Large firms	-0.06	1.15	0.28
Secondary sector	-0.00	0.02	0.88
Tertiary sector	0.05	0.89	0.34
Middle aged firms	0.04	0.52	0.46
Old firms	-0.01	0.1	0.75
High profitability	-0.01	0.07	0.78
High leverage	-0.05	0.94	0.33
Domestic origin	-0.02	0.16	0.68
Global test		8.24	0.50

Estimating the survival model, with unspecified baseline hazard, gives the semi-parametric Cox Proportional Hazard Model, the results of which are reported in the first two columns of Table 7. The hazard ratio has the base category as one, so a value below one means that the variable has a lower hazard ratio than the base category and a value above one indicates that it has a higher hazard ratio.

Correctly specifying the functional form of the baseline hazard may lead to consistent parameter estimates. As such it is important to check whether the results will change when the functional form of the baseline hazard is assumed to follow particular distributions. In line with Perez and Castillejo (2006), the baseline is assumed follow exponential and Weibull distributions. The exponential assumes that the log of survival function is linearly related to time, while the Weibull implies that the log of hazard increases or decreases with the log of time (Nkurunziza, 2012). These are the most commonly used distributions.

Interestingly, the results are consistent across the specifications, in terms of direction of the hazard ratio and significance. They also provide a more limited set of significant covariates than the logistic survival equation with the results indicating that large firms have higher survival chances and those in the tertiary sector lower, using 5per cent significance. Higher profitability have higher survival chance at just above 5% significance, and so do higher leveraged firms, at around 7 per cent significance. Comparing the three models performance using Akaike Information Criterion (AIC), it seems the exponential is a better model as it is the one that minimizes AIC.

Table 7: Cox Proportional Hazard Model

	Unspecified Baseline Hazard		**Weibull Baseline Hazard**		**Exponential Baseline Hazard**	
	Hazard Ratio	**Pvalue**	**Hazard Ratio**	**Pvalue**	**Hazard Ratio**	**Pvalue**
Medium firms	0.921	0.535	.901	0.429	.904	0.443
Large firms	**0.253**	**0.000**	**.230**	**0.000**	**.233**	**0.000**
Secondary sector	1.273	0.209	1.298	0.175	1.293	0.181
Tertiary sector	**1.737**	**0.002**	**1.791**	**0.001**	**1.781**	**0.001**
Middle aged firms	1.376	0.127	1.371	0.132	1.372	0.131
Old firms	1.315	0.059	1.261	0.110	1.269	0.100
High profitability	0.789	0.054	**.783**	**0.048**	**.785**	**0.050**
High leverage	0.808	0.073	.803	0.065	.804	0.066
Domestic origin	1.149	0.345	1.183	0.250	1.178	0.264
Constant			**.047**	**0.000**	**.054**	**0.000**
Log likelihood LR chi2(9) AIC	-1772.5374 44.66(0.00) 3563.075		-707.3413 49.96(0.00) 1436.683		-708.0857 49.14(0.00) 1436.172	
Observations	605		605		605	

Conclusions

Understanding the factors underlying the survival of firms is critical for industrial development as it informs the type of intervention necessary for improving the medium term performance of the firms and the overall economy. The paper investigated the duration and determinants of firm survival among the JSE listed companies during the period 2000-10. Constructing a transition matrix for the period showed the largest firms had the highest chance of surviving and that the major cause of non-survival was takeovers, which varied by size class and was highest in medium sized classes.

To further analyse the survival of firms a logistic survival equation was estimated, which provided a range of significant covariates, showing higher size, profitability and high leverage to increase survival probability and being in the tertiary sector and higher age to reduce it. In such models the discrete dependent variable only reflects whether the firm exits before the end of the period or not and does not consider the period the firms survive before they exit. Other non-parametric and parametric methods were used to deal with this.

Using the Kaplan-Meier method to compute the survival patterns, showed significant differences between the survival functions across the explanatory variables, except for age and origin of the firm. Specifying a Cox proportional hazard model showed that large, high profitability and high leverage firms operating in the primary sector are expected to have higher survival chances among the JSE listed companies, with age and origin of the firm found not to be significant factors. The validity of the constant proportional hazard assumption was tested using a covariate rho-test and not rejected, but the semi parametric model does not specify the functional form of the baseline hazard and this may lead to inconsistent parameter estimates. To address this problem exponential and Weibull distributions were used for comparison. The results were generally robust to specifying the distribution of the baseline hazard.

Overall, the results are useful in providing an understanding of the dynamics and determinants of firm survival. If a healthy size distribution of firms is to be maintained some efforts might need to be made to support smaller companies, particularly in the tertiary sector, and a better understanding of the causes and implications of takeovers, the major cause of firm exit is necessary. The results also indicate that financial factors can play an important role, with both leverage and profitability showing some significance. Policies such as improved access to financial support for smaller firms may be useful in reducing the failure rate. It is, however, important to recognize that this study was based on JSE listed companies and so smaller companies are underrepresented. Expanding the analysis to cover non-listed firms is an important task in further improving our understanding of the determinants of firm survival in South Africa.

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Appendix A1: Descriptive Statistics

Variable	N	Mean	Median	sd	variance	skewness	kurtosis	min	max
Survival Dummy	716	0.49	0	0.500	0.25	0.03	1.00	0	1
Size	697	1.69	2	0.631	0.39	0.33	2.32	1	3
Age	703	2.27	3	0.898	0.80	-0.57	1.48	1	3
Profitability	661	1.49	1	0.50	0.25	0.00	1.00	1	2
Leverage	655	1.49	1	0.50	0.25	0.00	1.00	1	2
Economic Sectors	716	2.33	3	0.759	0.57	-0.63	1.99	1	3
Origin	716	0.71	1	0.454	0.20	-0.93	1.86	0	1

Appendix A2: Summary of Selected Empirical Studies in Developing Countries

Study	Country Data Period	Focus Industry	Method	Main Explanatory Variables
Sub Saharan Africa				
McPherson(1995)	Botswana, Swaziland, Zimbabwe and Malawi Surveys	All industries	Discrete time duration model	Annual growth rate, size, age, location, gender, credit, industrial dummies.
Harding et al(2004)	Ghana, Kenya and Tanzania Survey1993/94-1998/99	Manufacturing	Probit model	Productivity, firm size, age, ownership
Frazer(2005)	Ghana Survey 1991-1997	Manufacturing	Probit model	Productivity, firm size, age, size of capital stock, dummy for exporting, share of unionisation, foreign ownership, state ownership
Soderbom et al (2006)	Ghana, Kenya and Tanzania Survey 1993/94-1998/99	Manufacturing	Probit model	Productivity, firm size, age, factor intensity, ownership
Shiferaw(2009)	Ethiopia Annual census 1996-2002	All Industries	Discrete time duration model	Productivity, firm size, age, factor intensity, ownership, location, herfindahl index
Klapper and Richmond (2011)	Cote d Ivoire 1976-1997	All Industries	Discrete time duration model	GDP growth, location, sector, ownership, firm size, reforms dummies
Nkurunziza (2012)	Kenya Survey 1992-1999	All industries	Probit and Discrete time duration model	Size, age, origin, industry dummies, overdraft use, loan use
Buyinza F (2011)	Uganda Survey 2006	Manufacturing	Discrete time duration model	Age, size, ownership, export status, value added per worker
Latin America				
Malerba and Molina(nd)	Brazil Innovation survey 2001-08	Industrial companies	Discrete time duration model	Research and development, technology, age, investments, innovation, sector, domestic
Asia				
Tsoukas, S. (2011)	Indonesia, Korea, Malaysia, Singapore and Thailand Stock market 1995-2007	All industries	Discrete time duration model	Leverage, profitability, size, age , minimum efficient size, bond issuance, exchange rate, private sector credit, market value traded, market capitalisation
Spaliara M, Tsoukas S (2010)	Indonesia, Korea, Malaysia, Singapore and Thailand Stock market data 1997-98	All industries	Probit model	Leverage, profitability, size, age , minimum efficient size, bond issuance, exchange rate,