A Study on the Determinants of Survivorship of Listed Companies in Korea

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I. Introduction

The capitalistic economy keeps its vitality through a continual process of entry and exit. For creating value added and new job opportunities, the importance of new entry cannot be overemphasized. An exit of a firm reduces the production capacity of the economy and causes a painful problem of unemployment. However, in the perspective of a whole economy, an exit of a firm with no competitive edge seems desirable in the sense that it can transfer the scarce resources from unproductive sectors to the productive ones, thereby, more competitive firms can command more resources for better purposes. Not only entry but also exit is an important process deserving a more thorough scrutiny.

Using the proportional hazard model developed by Cox (1972, 1975), this paper attempts to identify the determinants of survivorship of the listed companies in Korea Stock Exchange. Namely, this paper investigates the questions such as what

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causes the listed company to be delisted and how long it takes from listing to delisting. The standard regression analysis is no longer appropriate for this kind of death process mainly because the data is censored. After listing, a firm will be eventually delisted for several reasons. The ideal situation is that for each firm, we observe both listing and delisting date. However, it is impossible to observe all firms until they are delisted. At fixed point of time, some firms are already delisted but other firms are still being listed. Then, we cannot observe the delisting date of the currently listed companies. Then, censoring occurs. Censoring is an inevitable problem for analyzing a death process like this. Survival analysis or duration analysis has been developed to deal with the censoring problem. This technique has been applied to many economic problems such as the unemployment period, labor strike period and marriage period. For exit problem, Audretsch (1991) found the firm size and R&D as important factors. Audretsch & Mahmood (1995) studied the determinants of the newly entering firms in U.S. manufacturing sectors. They found that the survival probability was higher in rapidly growing industries. Mata, Portugal & Guimaraes (1995) found that independent firms survived longer than the subsidiaries of the existing firms.[1)]

Our dataset comprises of 719 listed firms whose complete

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1) For England case, see McCloughan & Stone (1998). For Portugal case, see Mata & Portugal (1994).

financial statements are provided by Korea Investors Service (KIS), Inc. It covers the period between 1980 and 1998. Applying the proportional hazard model, we obtain the following results. The firm size, R&D investment, the largest shareholder's share and the time between establishment and listing have a favorable effects on the survival probability. The share held by institutional investors has the negative effect. Surprisingly, the financial variables such as capital-asset ratio, operation income ratio and net income ratio turn out to be insignificant. The industry specific variables such as capital-labor ratio and concentration ratio are also insignificant. Market structure does not have any significant effect on the survival probability.

The paper proceeds as follows. In Section II, a brief explanation of duration analysis and the proportional hazard model is provided. Dataset and variables used in the analysis are explained in Section III. The estimation results are given in Section IV. Finally, conclusion follows.

II. Estimation Methodology

II.1. Duration Analysis

Regression analysis is the most frequently used methodology when analyzing the relationship between the dependent

(explained) variable and many independent (explanatory) variables. In dealing with the
data consisting of survival time, however, regression analysis is not an appropriate tool because of censoring. It is said that censoring occurs when the object is still alive at the time that the observation is ended. Our study covers the period from 1980 to 1998. There are lots of firms which remains listed at the end of 1998. Since we do not know when the firms will be delisted, censoring occurs. Any estimation method without paying due consideration to the censoring problem does not provide good estimators. Survival analysis or Duration analysis is the relatively new technique which explicitly takes into account the censoring problem.

In this subsection, we consider some basic concepts of duration analysis provided. In duration analysis, the problem occurs because of censoring. There are three types of censoring, Type Ⅰ, Type Ⅱ, and random censoring.

For Type Ⅰ censoring, some time denoted by t_c, for example, the last period where the data is available, is fixed in advance, and let $X_1, \cdots, X_n$ be the time before something happens. Then,

$X_i = T_i$ if $T_i \le t_c$ and $X_i = t_c$ if $T_i > t_c$.

Namely, if something happens before t_c, we know the exact time when it occurs. If nothing occurs until t_c, we does not know when it eventually occurs but knows only that it does not occur before t_c, i.e., censoring occurs.

For Type Ⅱ censoring, among n objects for observation, we measure the time before only r objects occur and replace the remaining objects with the r-th observation time. Then,

$X_i = T_i$ if $i \le r$ and $X_i = T_r$ if $i < r$.

For random censoring, let C_i be the censoring time associated with failure time T_i . Then, observations $(X_1, d_1), \cdots, (X_n, d_n)$ are given as follows;

$X_i = \min(T_i, C_i)$, $d_i = 1$ if $T_i \le C_i$ (T_i is not censored.) and $d_i = 0$ if $T_i > C_i$ (T_i is censored.).

Type Ⅰ censoring is considered only in this paper because we cannot wait until all the firms will eventually delisted. Due to the data availability, t_c is set to 1998. We do not know the exact survival time of the firms which have been listed at the end of 1998.

Let T be the time before a firm is delisted. $F(t)$ and $f(t)$ are cumulative distribution function and probability density function, respectively. Obviously, $F(t) = \Pr[T \le t] = \int_0^t f(u)\,du$.

$F(t)$ measures the probability that a firm will be delisted before t. For duration analysis, it is more convenient to deal with survival function, S(t) which measures the probability that a firm will survive at least t, i.e.,

$$S(t) = \Pr[T > t] = 1 - F(t) = \int_t^{\infty} f(u)\,du .$$

Hazard rate function, h(t) is the conditional probability that given that the firm survives by t, it will immediately be delisted. Formally, h(t) is given as follows;

$$h(t)=\lim_{dt\to 0}\Pr[\,t\le T\le t+dt|\ T>t] \qquad =\frac{f(t)}{S(t)} \quad =\frac{f(t)}{(1-F(t))} \qquad ---(1)$$

From h(t), F(t) and f(t) can be recovered as follows. Note that $\frac{f(t)}{(1-F(t))}=-\frac{d}{dt}\ln(1-F(t))$. Hence, $-h(t)=\frac{d}{dt}\log(1-F(t))$ holds. By integrating both sides, we get $-\int_0^t h(s)ds=\log(1-F(t))$.

Therefore, the following relations are obtained;

$$1-F(t)=\exp[-\int_0^t h(s)ds] \quad \text{and} \quad f(t)=\frac{dF(t)}{dt}=h(t)\cdot\exp[-\int_0^t h(s)ds]$$

--(2)

If f(t) and F(t) are given, h(t) can be obtained by (1). Conversely, once h(t) is given, both F(t) and f(t) can be recovered by (2). Namely, the hazard function has exactly the same information as F(t) or f(t) has.

II.2. Proportional Hazard model and Partial Likelihood Function

The estimation method for survival function can be divided into parametric and non-parametric ones. The parametric method assumes a prespecified distribution such as exponential, Weibull distribution, log-normal and Gamma distributions. Life-table method and Kaplan-Meier method belong to the non-parametric one. Proportional hazard model proposed by Cox (1972, 1975) lies in semi-parametric method.

Both life-table and Kaplan-Meier methods construct the empirical survival function by dividing the whole interval into several subintervals and calculating the survival probability for each subinterval. Since the empirical survival function provides some useful insight, usually both methods are used before applying formal analysis.

Both life-table and Kaplan-Meier method consider whether an event occurs or not. The proportional hazard model by Cox considers explicitly the variables which affects the survival time. The proportional model considers the relationship between the survival time and several variables. Cox proposed the following form of survival and hazard function;

$$h(t;x) = h_0(t)\exp(x\beta) \quad ---(3)$$

$$S(t;x) = \exp\left\{-\int_0^t h_0(s)\,ds\right\}^{x\beta} = S_0(t)\,e^{x\beta} \quad ---(4)$$

where $h(t;x)$ is the hazard function at t and x, $h_0(t)$ is the baseline hazard rate at t, $x=(x_1,....,x_n)$ is covariate vector at t and $\beta=(\beta_1,...\beta_n)$ is the coefficient vector.

The proportional hazard model consists of two multiplicative terms. The first term, $h_0(t)$ is called the baseline hazard function which measures the hazard rate when the covariates are set to 0. This represents the general or overall hazard rate applicable to all observations. Cox does not impose any specific functional form on the baseline hazard function. The second term, $\exp(x\beta)$ measures the effect of covariates on the survival time. By estimating β, how the changes in the covariate affects the hazard rate can be analyzed.

If a particular form of the baseline hazard function is assumed, parameters can be estimated, say, by maximizing the likelihood function. But, misspecification may give bad estimates.[1] Cox did not assume any specific form of baseline hazard function, but avoided the problem by defining so-called partial likelihood function. By grouped the data into categories, one with completed spell, $t_i,\ i=1,2,\cdots,n$ and the other with censored duration $t_i,\ i=n+1,n+2,\cdots,N$. censored duration, Cox defined the likelihood function as follows;

$$L=\prod_{i=1}^{n}\exp(\beta' x_i)h(t_i)\exp[-\exp(\beta' x_i)H(t_i)] \qquad \prod_{i=n+1}^{N}\exp[-\exp(\beta' x_i)H(t_i)] ,$$

where $H(t)=\int_0^t h(s)ds$.

Combining the exponential functions that appear in both terms

1) For this, see Heckman & Singer(1984)

and rewriting the combined terms further, we obtain

$$L = \prod_{i=1}^{n} \exp(\beta' x_i) h(t_i) \cdot \exp[-\sum_{i=1}^{N} \exp(\beta' x_i) \int_0^{t_i} h(z) dz]$$

$$= \prod_{i=1}^{n} \exp(\beta' x_i) h(t_i) \cdot \exp\left\{ -\int_0^{\infty} [\sum_{h \in R(t)} \exp(\beta' x_h)] h(t) dt \right\} ,$$

where $R(t) = \{ i \mid t_i \geq t \}$

The likelihood function is a product of two terms, $L = L_1 L_2$, where

$$L_1 = \prod_{i=1}^{n} \frac{\exp(\beta' x_i)}{\sum_{j \in R(t_i)} \exp(\beta' x_h)} \quad \text{and}$$

$$L_2 = \prod_{i=1}^{n} [\sum_{j \in R(t_i)} \exp(\beta' x_j) h(t_i)] \ \exp\left\{ -\int_0^{\infty} [\sum_j \in R(t) \exp(\beta' x_j)] h(t) dt \right\} .$$

Cox recognized that L_1 did not depend upon $h(t)$ and called it partial likelihood function. Cox's partial maximum likelihood estimator is obtained by maximizing the partial likelihood function. Tsiatis (1981) showed that asymptotically, the partial likelihood function inherits the same property such as normality which the whole likelihood functions has. It also does not depend upon the baseline hazard function.

The proportional hazard model is a very flexible semi-parametric model. By taking log of both sides of Equation (3) and setting $\alpha(t) = \log h_0(t)$, we obtain

$$\log h(t) = \alpha(t) + \beta_1 x_1 + \cdots + \beta_k x_k .$$

If $\alpha(t)$ is set to a constant α_0, it reduces to the exponential distribution. With $\alpha(t)=\alpha_0+\alpha t$, it is the Gompertz distribution. With $\alpha(t)=\alpha_0+\alpha\log t$, it becomes the Weibull distribution.

For the proportional hazard model with time-independent covariates, the hazard ratio between i and j observations is given by $\frac{h_i(t)}{h_j(t)}=\exp\{\beta_1(x_{i1}-x_{j1})+\cdots+\beta_k(x_{ik}-x_{jk})\}$, which is independent of time.

III. Data and Covariates

In duration analysis, we have to examine the time period of a firm between birth and death. This requires the whole history of firms. Unfortunately, such a dataset is not available. Due to the data availability, our study is restricted to analyzing the period from listing to delisting. There are many ways in which a firm is delisted. It may be bankrupt and liquidated or merged into a new firm. We cannot distinguish them. Simply death means delisting.

The dataset comprises of 719 firms whose complete financial statements are provided by Korea Investors Service (KIS), Inc.[2)] If the financial statement about a firm is not provided by KIS in

2) KIS provides the financial statements about 811 firms. Among them, 92 firms with incomplete financial statements are omitted.

two consecutive years, that firm is considered delisted.

Table 1 summarizes the number of listed firms between 1955 to 1999. In Table 1, 92 firms are included which are omitted in the analysis because of incomplete financial statements. Table 1 shows that it is between 1986년 and 1989 that the most firms, 277 firms were listed. Figure 1 shows more detailed pictures, year by year.

Time period	Number of listed firms	Cumulative Sum
1955-1959	9	9
1960-1964	5	23
1965-1969	18	
1970-1975	132	277
1976-1979	145	
1980-1985	46	323
1986-1989	277	
1990-1995	93	179
1996-1999	86	
Total	811	

Table 1; Number of listed firms between 1955 to 1999

Figure 1 shows that the number of listed firms tended to increase since 1982. Table 1 and Figure 1 summarize the number of listed firms. Figure 2 shows the number of delisted firms since 1991 to 1999. It is 1994, 1996 and 1998 that many firms were delisted. As aforementioned, a firm is delisted because it is merged, liquidated or simply it does not meet the criterion for listing. These are the years that Korean economy suffered from slump.

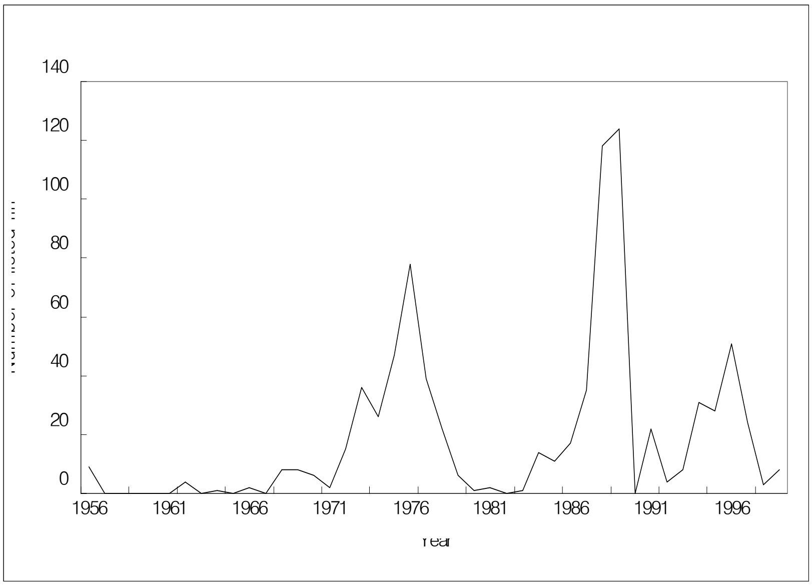

Figure 1; Number of listed firms between 1991 and 1999

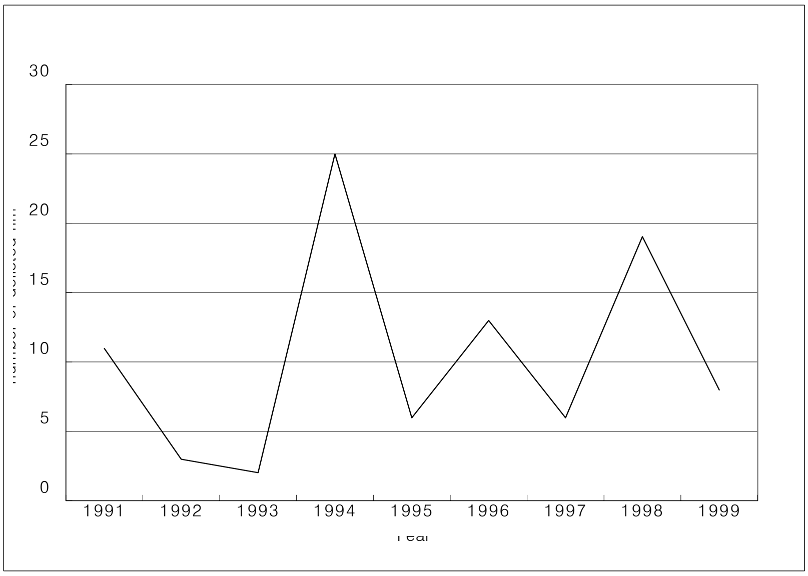

Figure 2; Number of delisted firms between 1991 and 1999

Since our dataset covers the period between 1980 and 1998, if a firm was listed after 1980, the left censoring problem does not arise. For firms listed before 1980, since our dataset begins in 1980, the left censoring problem is inevitable for these firms. The left censoring problem cannot be handled properly in the proportional hazard model mainly because the partial likelihood function does not contain it. For this reason, the left censoring problem is simply ignored. Since our dataset ends in 1998, if a firm is found listed in 1998, the right censoring occurs.

We now examine the covariates which are considered to affect the survival probability. In the literature, the firm size denoted by size is considered as one of important factors. Many studies shows that the firm size affects the survivorship significantly. Mata & Portugal (1994) mention as one of stylized facts that entry and exit occur in the group of firms with small size. The firm size seems negatively related to the hazard rate. In general, the larger the firm size is, the more the firm invests. The exit means to give up the investment made so far, which is too costly. Hence, it is hard for a large size firm to exit. Another argument for the negative relationship between the firm size and the hazard rate is concerned with the innovation ability. The larger size firm can afford a huge amount of resource for innovation which enhances the possibility of survivorship. The firm size can be measured in many different ways such as revenue or the number of employment. In the literature, the firm size is measured as the number of employment. Hence we use it as a proxy variable for the firm size.

R&D investment may be either negatively or positively related to the survival probability. It is usually argued that R&D leads to a higher probability for survival. On the contrary, however, R&D investment may impose a financial burden on the new firms which should compete the incumbent firms. If it is too much burdensome, it is positively related to the hazard rate. For R&D investment, it is very hard to obtain the accurate information because R&D is a very sensitive part of a firm's strategy. So it is treated as a dummy variable denoted by R&D dummy in our study.

In the balanced sheet, assets consists of capital and debt. The larger the debt portion is, the smaller the financial cost is. With other things being equal, the firm with less financial burden is more financially sound, thereby, will last longer. Capital-asset ratio denoted by K/A ratio is expected to be negatively related to the hazard rate.

For the variables concerning the corporate governance, we use two variables. The first one is the largest shareholder's share denoted by largest share. This variable is included in order to test the agency theory. According the agency theory developed by Jensen and Meckling (1976), when the largest shareholder's share increases, his interested is aligned with that of firm, thereby, the cost from the principal-agent problem decreases. This will have a positive effect on the survivorship. On the contrary, as indicated one of the serious problems associated the large conglomerates called 'chaebol', as the largest shareholder's share increases, (s)he can mismanage the firm without any check. The adverse effects may overwhelm the benefit from reducing agency cost. The second one is the sum of shares held by so-called institutional investors such as banks, security company and trust company. In principle, the institutional investors can play a role of watch dog for the bad behavior by the incumbent management. If they can monitor the management's behavior effectively, it will have a favorable effects on the survivorship. This variable is denoted by **monitoring share** which is expected negatively related to the hazard rate if the institutional investors can sever as a effective monitoring device.

For the variables concerning the financial status of the firm, first of all, operating income is considered which is defined as revenue minus production cost including sales cost and administration cost. Operation income divided by revenue denoted by **OI ratio** reflects the firm's production related activity. Net income defined as the operating income plus net financial income reflects the non-production related activity such as investment in real estate or financial asset. Net income divided by revenue is denoted by **NI ratio.** The sign of this variables tells us whether firms mainly interested in financial activity last longer or not.

Liquidation ratio is obtained by dividing liquid asset by liquid debt. This represent the firm's ability to pay back the short-term debt. If this ratio is high, the firm can confront the unexpected liquidity crisis successfully. Hence, it is expected negatively related to the hazard rate.

Age variable is included which measures the time between establishment and listing. This variable tells whether history matters for survivor.

Finally, in order to include the industry specific environment, two variables are added. **Capital-Labor ratio** denoted by **K/L ratio** is included in order to test whether there is a significant difference in survivor probability between labor intensive industry and capital intensive industry. **Concentration ratio** is also added. It shows under which environments firm can survive more easily, either in concentrated industry or rather competitive industry.

IV. Estimation Results.

First, we perform the Likelihood Ratio (LR) test in order to check whether adding covariates is meaningful. For this, we calculate the log likelihood function with and without restriction. It is well known that asymptotically,

$$LR=2(\log L(\theta)-\log L(\overline{\theta})) \sim \chi^2(k)$$, where

k : degree of freedom equal to the number of restrictions,

$\log L(\theta)$: value of log likelihood function without restriction, namely without covariates,

$\log L(\bar{\theta})$: value of log likelihood function with restriction, namely with covariates.

The result of LR test is summarized in Table 2.

Classification \ Statistic	Log Likelihood	LR test
Without restriction	734.497	58.526 (.0000)
With restriction	675.971	

Table 2; LR TEST (p-value in the parenthesis)

As Table 2 shows, LR ratio is 58.526 which turns out to be significant with 1% significant level. This result shows that adding covariates is meaningful.

Estimation result is summarized in Table 3 where for each covariate x_i, estimate of the coefficient, β_i, Wald statistic, and e^{β_i} represented by EXP(B). EXP(B) measures the marginal effect of the covariate on the hazard rate when other covariates are fixed. For example, for monitoring share, it is 1.029. This means that with other covariates fixed, increase in the monitoring share by 1 unit increases the hazard rate relative to the baseline hazard rate by approximately 3%. For largest share, it is 0.977. With other things being equal, when the largest shareholder's share increases by one unit, the relative hazard decreases by roughly 2%.

As Table 3 shows, the firm size, R&D investment, the largest shareholder's share, share held by institutional investors and the time between establishment and listing turn out to be significant.

covariates	estimates	Wald Statistic	EXP(B)
Size	-.280*	5.121	.755
R&D dummy	-1.025**	8.541	.358
K/A ratio	-.138	1.205	.870
Largest share	-.022*	5.293	.977
Monitoring share	.028**	5.725	1.029
OI ratio	-.336	.309	.714
NI ratio	.208	.7624	1.231
Liquidation ratio	-.191	1.982	.825
Age	-.069**	19.327	.932
K/L ratio	-5.39E-07	.952	1.00
Concentration ratio	-.314	.0633	.729

Table 3; Estimation Results

Note; Wald statistic $\left\{\frac{\beta}{s.e.(\beta)}\right\}^2 \sim \chi^2(1)$

*; significant with 5%, **; significant with 1%

Except the monitoring share, all the variables have negative sign which means when these variables increase, the hazard decreases.

Firms with larger size, larger largest shareholder's share, R&D investment and longer history outlast.

That the firm size is negatively related to the hazard rate is a well-established stylized fact in the literature. Our results show that it holds in Korea, too. The largest shareholder's share is also negatively related to the hazard rate. This can be interpreted as that when the largest shareholder increases, it will have a positive effect on the survivorship by reducing the agency cost as predicted by agency theory. The monitoring share is significant, but positively related to the hazard rate. This means, with other things being equal, increases in the shares held by the institutional investors increases the hazard rate. It can be interpreted as indicative of the fact that the institutional investors do not effectively perform the role as outside monitor for the bad behavior of the management. It may related to the fact that still the financial sector is not fully developed in Korea. For R&D investment, it may impose a financial burden on the brand new firms, which leads to increases in hazard rate. It turns out that R&D has a favorable effect on the survivorship. Age variables also turns out significantly negatively related to the hazard rate. Once established, it will last longer.

Surprisingly, all the financial variables turn out to be insignificant. For K/A ratio, OI ratio and Liquidation ratio, the sign is correct although not significant. Interestingly, the sign of NI ratio is opposite to the expectation. Note that our dataset consists of manufacturing sectors only. NI ratio reflects the non-manufacturing activities of the firm. With caution, it can be interpreted that the manufacturing firms which concentrates on the non-manufacturing activities such as investment in real estate or financial assets has lower probability for survival.

Finally for the industry specific variables, both K/L ratio and concentration ratio are also insignificant. It seems that there is no significant difference between capital intensive and labor intensive industries and that market structure does not affect the survival probability of the firm.

V. Conclusion

In this paper, using the proportional hazard model proposed by Cox (1972, 1975), we study the determinants which affects the survivorship of the listed companies between 1980 to 1998. The dataset consists of 719 listed companies with complete financial statements provided by KIS, Inc. Our results show that the firm size, R&D investment, the largest shareholder's share and the time between establishment and listing have a favorable effects on the survival probability. The share held by institutional investors is positively related to the hazard rate. This shows that the larger size firms with highly concentrated decision making process and not being monitored by outside investors survive longer.

Surprisingly, the variables concerning the financial status of the firms turn out to be insignificant. Also industry environment represented by capital-labor ratio and concentration ratio is insignificant. Market structure does not have any significant effect on the survival probability.

Since there are very few works in this area, our study contributes in identifying the firm specific factors which significantly affect the survivorship of the firms. We would like to mention two limitations of the current research which are due to the data availability. For analyzing survivorship, in principle, we have to measure the time between birth and death. Since entire history of a firm is very hard to obtain, we restrict our focus on the listed companies and use the time between listing and delisting as a proxy variable. Second, our dataset is restricted to listed companies only. There are huge number of companies which have not yet been listed. Extending the analysis to this case remains as a future research agenda.

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