Are financial constraints an anxiety for firms to survive in the Chinese market?

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Abstract

While financial constraints matter for firm performance, it may expose firms to survival risks. Using a large panel of Chinese firms over the period 1998-2013, which reflects the economic changes reshaping the Chinese manufacturing sector, we analyze the links between firm survival and financial constraints, and how firm performance impacts on these links. We find that financial constraints play an important role in influencing firm to survive. We also find that financial constraints are the mechanism between firm performance and survival issue. More productive and profitable firms can alleviate the financial constraints. Privately-owned and foreign-owned firms with more leverage face more difficulties to survive in the market, however, SOEs with more leverage can ease financial constraints. Finally, we provide evidence that high dependency and high coverage ratio can better help firms to survive in the market through alleviating financial constraints.

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Key Words

firm survival; financial constraints; firm performance; large panel of Chinese firms

JEL Classification Codes

D24; L22; G14; G32

1. Introduction

Firm survival is a crucial component of the growth and evolution of industries in both developed and developing economies (Caves, 1998 (*15*); Tybout, 2000 (*62*); Tsoukas, 2011 (*61*); Fernades and Paunov, 2015 (*32*)). Numerous studies have discussed on the selection mechanism determined by the link between firms' performance and the likelihood survival, such as productivity (Ericson and Pakes, 1995 (*26*); Asplund and Nocke, 2006 (*2*)). Generally, evidence shows that lower productivity firms are more probable to exit due to their poor performance in competition (Eslava et al., 2004 (*27*); Frazer, 2005 (*35*); Foster et al., 2008 (*33*); Liu and Li, 2015 (*54*)). However, the effectiveness of the selection mechanism may be restricted by the imperfectness of market (Liu and Li, 2015 (*54*)). Additionally, whether firm's performance determines firm survival is still unclear.

Previous studies have substantiated that financial constraints influence various aspects of firm performance, such as determining their investment in fixed capital, working capital, productivity, and R&D (see Hubbard, 1997 (*45*); Bloom et al., 2007 (*7*); Chen and Guariglia, 2013 (*17*); Zhang and Liu, 2017 (*64*)). Most studies in this literature have used firm-level data to estimate investment equations augmented with cash flow, and interpreted a high sensitivity of investment to these variables as a proxy for a high degree of financing constraints faced by firms (Investment Cash Flow Sensitivity by FHP, 1988; 2000). Generally, financially constrained firms are difficult to obtain external financing, or suffer from high external financing costs (Pecking Order Theory, Myers (1984) (*56*)), and they invest only if they have sufficient internal financing. In particular, financially constrained firms are willing to invest more when they have adequate cash flow. Furthermore, higher investment cash flow sensitivity is generally found for firms that are a priori more likely to face financing constraints, such as small, young firms, and firms with low-dividend payouts and high levels of indebtedness (Bridges and

Guariglia, 2008 (*12*)). Noticeably, financial constraints are prevalent in the Chinese market, and non-SOEs suffer more than SOEs due to ownership discrimination in external financing market and underdevelopment of financial market (e.g., Chen and Guariglia, 2013 (*17*); Zhang and Liu, 2017 (*64*)).

Nevertheless, the effects of financial constraints on firm survival have been largely neglected in the literature: only a handful of papers have included financial variables in equations to construct survival probabilities models (Zingales, 1998 (*65*); Fotopoulos and Louri, 2000 (*34*); Bunn and Redwood, 2003 (*14*); Bridges and Guariglia, 2008 (*12*)). Particularly, regarding to China's case, studies are rather few (e.g., Liu and Li, 2015 (*54*)).

Does financial constraints matter for firm survival in China? If this selection mechanism works, which kind of role does firm performance play in firm survival through solving the financial constraints problem? Yet, none of these studies exploited firm heterogeneity to better understand this link. This paper seeks to fill this gap. The purpose of this paper is to provide, for the first time, a systematic empirical analysis of the impact of financial constraints on firm survival by looking at the direct effect of financial constraints indicators on firm survival after controlling firm and industry effects in China. We further investigate how financial constraint acts as a mechanism to affect the firm survival issue in China, and how the interactions between financial constraints and firm performance impact on firms' survival.

Firm survival or failure can be affected directly by the financial constraints for a number of reasons. First, informational asymmetries between borrower and lender tend to be more severe for financially constrained firms (e.g., small, young), therefore, leading to higher interest rates or not allowing extending credit to them at all. As a result, financially constrained firms are meeting more difficulties to survive in the market (Clarke et al., 2012 (*19*)). Second, cost of financing can cause financial constraints. Previous studies demonstrate that high financing cost intensifies firms' possibilities of failure in the market (Cowling and Mitchell, 2003 (*21*)).

Un-financially constrained firms with other good lenders (e.g., equity market, bank) can lessen investment risk and the cost of accessing the external market. These channels provide a workable alternative to meet firms' funding requirements. Therefore, gaining access to an alternative source for financing can shield firms against failures (Beck et al., 2001 (*6*); Tsoukas, 2011 (*61*)). Third, financial constraints make firms more vulnerable to suspension in funding or extraneous shocks. Generally, un-financially constrained firms find it easier to expand external financing than constrained than small firms (Beck et al., 2008 (*4*)). Finally, macro factors, such as institutional development or marketization, influence firms' survival significantly. A well-developed institution and market can mitigate informational asymmetries, help to increase external financing for financial constrained firms (Beck et al., 2008 (*4*)).

In this paper, in order to examine the relationship between financial constraints and firm survival, we use a comprehensive and exclusive data set on Chinese manufacturing firms during the period 1998 to 2013. We further illustrate that financial constraints are the selection mechanism of market, focusing on the role of different types of firm performance and on differences in performance payoffs for financial constrained firms. Our paper complements existing studies by researching the relationship between firm survival and firm characteristics, through discussing how firm performance variables and financial constraints mechanisms as ways to influence the industry dynamics models. First, our data set allows constructing objective firm-level time varying variables, based on over 3 million observations during 1998-2013. We measure financial constraints from several dimensions, and raise financial constraints as the selection mechanism to explain Chinese firms' survival. Second, our data set allows constructing objective time varying measures of firm performance in firm level, and based on the interactions between financial constraints and firm performance, we also declare several proxies on firm survival. This is an advantage compared to previous studies which mostly use direct links on firm performance and firm survival, while ignoring the selection mechanism in the process (Bridgesn and Guariglia,

2008 (*12*); Liu and Li, 2015 (*54*)). Third, we further investigate the role of ownership and tell the difference among three types. State owned enterprises (SOEs) survival behaviors are different from other non-SOEs. Fourth, we conduct a more rigorous test of the financial constraints-survival relationship than previous studies by using an improved discrete-time Hazard Model with random effects controlled rather than using the popular Cox Hazard Model.

The remainder of this paper is organized as follows. In Section 2, we present our methodology and baseline specification. Section 3 describes our data, and provides some descriptive statistics. Section 4 presents our main empirical results. Section 5 shows a range of robustness tests. Section 6 concludes.

2. Empirical methodology and baseline specification

Hazard or duration model has long been regarded as an efficient way to measure factors influencing firm survival (Kiefe, 1988 (*49*); Klein and Moeschberger, 2006 (*50*); Fernandes and Paunov, 2015 (*32*)). An obvious advantage of the hazard model is that it can solve the incomplete nature of the duration information existing in the firm survival analysis. A hazard rate is the conditional probability of a firm exiting after survivingl a spell after t periods, given that it has survived for $t-1$ periods (the elapsed duration of the survival spell), and given firm characteristics. Comparatively, conventional methods such as Probit or the OLS (linear probability) are based on unconditional probabilities. In the other words, Hazard models account for the fact that the data contain not only information on firm exit in year t but also additional information that the firm survived until year $t-1$ before it was forced to exit. Thus, hazard models do not require a strong assumption that conditional survival rates are constant over time. Moreover, using hazard models could help to avoid biased estimations that usually occur in Probit or OLS

regressions, where the right-censoring of observations are usually ignored[1]. Furthermore, another shortcoming of the OLS is its prediction outside the [0,1] interval and the corresponding variances being negative values.

Regarding the specific hazard model to consider, the choice depends on the nature of the data and the identification requirements of our analysis. The continuous-time proportional hazards models proposed by Cox is prominent in firm survival studies. Cox Model, as a proportional shifter of the baseline hazard function, is convenient to estimate the effects of firm characteristics on survival. It makes no assumptions on the distributions of the functions(Agarwal and Audretsch, 2001 (*1*); Chen, 2002 (*16*); Disney et al., 2003 (*25*); Girma et al., 2007 (*36*)). Nevertheless, Cox Model requires firms being ordered exactly regarding their exit time because of the logit function used to link the proportional hazards model and discrete time observations. This put a more demanding requirement on our data, while ordering of firms' failure times is implausible since firm survival times are grouped into discrete one-year intervals. Under this circumstance, the coefficients and standard errors of the Cox model can be biased.

Considering the deficiencies of the Cox model, we have to adopt an alternative extension of the proportional hazards model to discrete time to control for unobserved firm heterogeneity and address the issue of tied failure times[2] (Lancaster, 1992 (*52*)). The most rigorous way of controlling for unobserved firm heterogeneity is through firm random effects, but this requires that those effects be orthogonal to firm characteristics, a condition that may not hold beyond experimental data. Thus, following Fernandes and Paunov (2015) (*32*), hazard models with firm random effects will be our baseline approach, as described further below.

First, we define a firm-survival spell j be complete ($c_j = 1$) or right censored/incomplete

[1]There exists a fact that at the end of the observation period, some of the firms are still in operation. However, we cannot observe enough information to distinguish whether they are exiting or continue to operate

[2]In robustness tests, we will obtain estimates based on continuous-time hazard models with a parametric baseline hazard function that can control for unobserved firm heterogeneity and estimates based on the Cox model correcting the partial likelihood function for ties using the method of Breslow (1974) (*11*) for comparability with previous studies.

($c_j = 0$). We set the discrete time survivor function which is the probability of firm survival at least m years as:

$$S_j(m) = Pr(T_j > m) = \prod_{k=1}^{m}(1 - h_{jk}) \tag{1}$$

where $T_j = min\{T_j^* C_j^*\}$. T_j^* is a latent failure time. C_j^* is a latent censoring time for the firm survival spell, that is exiting, in m years, conditional on survival for $m-1$ years which is defined as:

$$h_j(m) = Pr(m-1 < T_i \leq m / T_i > m-1) = Pr(m-1 < T_i \leq m)/Pr(T_i > m-1) \tag{2}$$

Based on the survivor function above, we consider complementary log-log (cloglog) following Prentice and Gloecker (1978) as the extension to discrete time. For the cloglog model, our estimable equation is given by

$$cloglog[1 - h_m(X/v)] = log(-log[1 - h_m(X/v)]) = X\beta + \lambda_m + \varepsilon \tag{3}$$

Where X is a vector including characteristics of a firm survival spell, which are time varying year-on-year. And λ_m is the baseline hazard rate for all observations, which is estimated non-parametrically by including year fixed effects. Unobserved firm level random effects v are incorporated through the error term $\varepsilon = log(v)$, which obeys the normal distribution. We estimate the probability models by maximum likelihood techniques using a quadrature approximation.

In order to delve into the role of financial constraints, we integrate financial constraints in matrix X_{it}. Previous literature has suggested many possibilities, including investment-cash flow sensitivities (FHP) (Fazzari et al., 1987, 2000 (*30*) (*31*))[3]. Nevertheless, using the investment-cash flow sensitivity as the indicator of financial constraints is not without criticism[4]. Lamont

[3]A few papers have tested whether the investment-cash flow sensitivities in the financial constraint hypothesis holds for Chinese firms' activities. We confirm that Chinese enterprises firms are financially constrained, but SOEs and foreign enterprises tend to be less constrained (Héricourt and Poncet,2009 (*43*); Poncet et al., 2010 (*58*); Chen and Guariglia, 2013 (*17*); Ding et al., 2013 (*24*); Guariglia and Liu, 2014 (*38*); Cull et al., 2015 (*22*)).

[4]Chen and Chen (2013) (*18*) documented that the investment-cash flow sensitivity has declined and disappeared, even during the 2007-2009 credit crunch. Brown et al. (2009) (*13*) show that 1970-2006, the ICF sensitivity is largely disappears for physical investment, but not for R&D.

et al. (2001) create the KZ index[5] because Kaplan and Zingales (1998) (*65*) argued that firms identified as financially constrained in FHP are actually not constrained at all in a depth study of investment-cash flow sensitivity[6].

One of the improvements to the KZ index is the WW index of constraints proposed by Whited and Wu (2006) (*63*)[7]. Another practicable measurement is the SA index introduced by Hadlock and Pierce (2010) (*41*) updated the version of Kaplan and Zingales (1997) (*47*), and their index is derived from the size and age variables of a firm[8].

Based on the consideration above, in this paper, we use WW index to measure financial constraints. Frist, WW index contains rich financial information. Second, as Whited and Wu (2006) argue, WW index avoids serious sample selection, simultaneity, and measurement-error problems via structural estimation with a large data set. Zhang and Liu (2017) (*64*) and Huang et al. (2016) (*44*) find that among domestic firms, the WW index is highest for private firms and lowest for state-owned firms, and this is consistent with the evidence in China (e.g., Chen and Guariglia, 2013 (*17*); Ding et al., 2013 (*24*); Zhang and Liu, 2017 (*64*)). Moreove, the samples do not allow us to calculate KZ index, and SA index is driven by firm size, size square and age, which means a collinear problem may exist in our baseline equation[9]. Zhang and Liu (2017) (*64*) further find that SA index and WW index are consistent in evaluating financial constraints of Chinese non-listed firms' database. Therefore, we utilize ICFS and SA indexes

[5]The KZ index (Lamont et al., 2001 (*51*)) is loaded positively on leverage and Tobin's Q, but negatively on cash flow, cash levels, and dividends.

[6]Lin et al. (2012) (*53*) developed the KZ index for 1999-2008 Chinese listed firms' cases and found that although an average sample firm experiences some degree of financial constraints, the state-owned property does not help reduce a firm's financial constraints on investment.

[7]The WW index is denoted as $-0.091 * CF + 0.021 * TLTD - 0.044 * LNTA + 0.102 * ISG - 0.035 * SG$, where CF is the cash flow divided by the total assets; $TLTD$ is long-term debt-to-total assets; $LNTA$ is the logarithm of total assets; ISG is industry level's sales growth; SG is firm level's sales growth (Whited and Wu, 2006 (*63*); Zhang and Liu, 2017 (*64*)).

[8]SA index (Hadlock et al., 2010 (*41*)) is measured as $(-0.737 * size) + (0.043 * size2) - (0.040 * age)$, where the size equals the logarithm of the inflation-adjusted total assets, and the age is the logarithm of the number between observation year and open year.

[9]In order to overcome the collinear problem, in our robustness test, we use the logarithm of labor's number to measure firm size.

for our robustness tests.

Apart from financial constraints, we have other essential factors to consider as well. To begin with, we use firm-level sales growth ($SalesGrowth_{it}$) as the firm's growth opportunity (Fernandes and Paunov, 2015 (*32*)). Firm's age (Age_{it}) plays an vital role in determining firm failures, meanwhile age^2 is also used in favor of controling nonlinear effects. Furthermore, firm size ($Size_{it}$) represents the size of firm i at time t, measured in terms of the logarithm of its total real assets. We also incorporate its square to allow for non-linearity[10] Herfindahl-Hirschman Index (HHI) of four-digit industries, and industry growth rate is employed to control the industry-level information, which reflects both the capability of competing against rivalries, firms' market power and influences of market structure (Liu and Li, 2015 (*54*)). All data in this paper are deflated by deflators[11]

3. Data and summary statistics

3.1 Data

We adopt an exclusive firm-level data set on Chinese manufacturing firms spanning the 1998-2013 period[12], and we are going to call it NBS database thereafter. This source of information provides a unique window on the economic changes that have reshaped the Chinese manufacturing sector. We observe annual firm-level data for "above-scale" industrial firms, also known

[10]In China, due to the planned economy before 1980s, numerous older firms in China are mainly state-owned. Since 1990s, China has started to promote reforms in the SOEs, and this is an essential part of China's economic transition. During this process, a large number of SOEs has been privatized, merged, or reorganized, resulting in massive exits of older firms. Moreover, as older firms or larger firms may suffer from x-inefficiency, squared terms of size and age are included in our estimations (Liu and Li, 2015 (*54*)).

[11]Appendix 1 defines all the variables used in this paper. Our data have been deflated by the deflators taken from the China Statistical Yearbook (various issues) published by the National Bureau of Statistics of China. We use the provincial capital goods deflator to deflate the capital variables and the gross domestic product (GDP) deflator to deflate other variables.

[12]This data base is officially referred to as the "all state-owned and all above-scale non-state owned industrial enterprise data base". Detailed information of NBS database and matching measurement are well summarized by Brandt et al. (2014) (*10*)

as firms above designated size[13].

There are three crucial features of our data set which could be in favor of our analysis. First, NBS database consists of large number of samples including both listed and non-listed enterprises[14]. Therefore, our database is more comprehensive, and large samples can decrease the probability of biased estimation. Second, our samples contain broad variables, including firm characteristics and financial variables. Thus, we can test more mechanisms of our models and better overcome the omitted variables problem. Third, for any analysis on entry behavior, it is important to take into account a firm's founding year to identify the new entrant. Our samples are a long period panel data making our results be more reliable and efficient from a dynamic perspective.

Due to data restrictions, we have discarded observations with negative sales, negative total assets minus total fixed assets, negative total assets minus liquid assets, and negative accumulated depreciation minus current depreciation. Firms with no complete records on our main regression variables were also omitted. To control the potential influence of outliers, variables are winsorized with a fraction one percent at each tail of the regressors (Guariglia et al., 2011 (*39*)). In addition to the treatment above, we further matched the address, telephone number, and industry code of firms, and observations for firms with less than eight employees are not in our consideration (Brandt et al., 2012 (*9*)). After the process, our unbalance panel covers 118,356 firms, corresponding to 3,298,037 firm-year observations.

3.2 Descriptive statistics

We give a statistical summary of our variables in this part. Table 1 displays the descriptive statistics of our key variables. For the variable of exit, the average yearly exit rate in the Chinese

[13]This data base covers 41 industries and includes all state-owned firms as well as non-state firms with sales exceeding five million Yuan. In 2011, the designated size increased from five million to twenty million Yuan.

[14]For example, it is impossible to know a firm's annual sales until information being collected. This is especially notable in 2004, a census year. The total sales of NBS companies is about 89.5% of total nation's sales in 2014.

manufacturing sector is around 13.7%. The information of all firms are reported in column 1. Columns 2-3 present those firms that failed (column 2) and those that are survivors (column 3). On the basis of firm characteristics, we find that collapsed firms tended to be smaller and younger. This aligns with the previous studies, which show that the probability of exit decrease with firm size and age (e.g., Clementi and Hopenhayn, 2006 (*20*); Tsoukas, 2011 (*61*)). For variables reflecting firm performance, failing firms show lower productivity, profitability, sales growth and more leverage. This is in accordance with the notion proven by numerous studies (e.g. Bunn and Redwood, 2003 (*14*); Farinha and Santos, 2006 (*29*); Liu and Li, 2015 (*54*)).

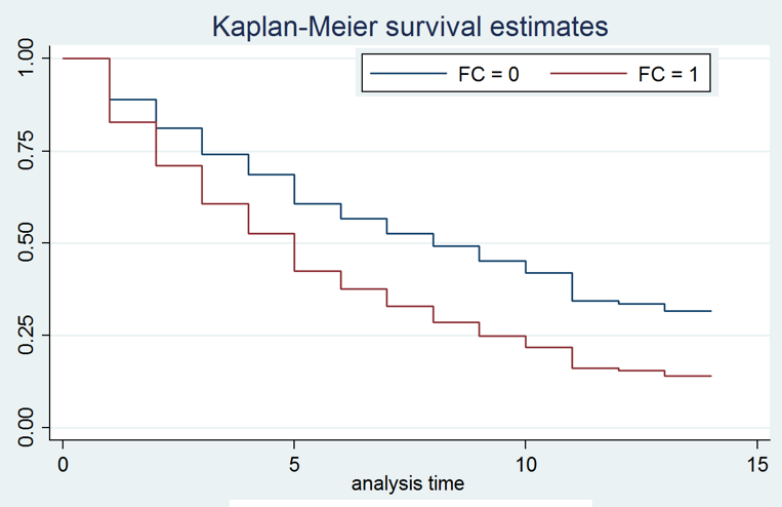
Regarding to the ownership (SOEs, private and foreign groups are reported in columns 4-6, separately), the highest exit rate could be seen at SOEs (20%) and the lowest is for foreign firms (11.6%). With respect to firm performance, for the variable of productivity, the foreign group has the highest TFP (3.909), whereas the SOE group has the lowest (2.578). As for the profitability (ROA), the private group is the highest (0.106) and that of SOEs is as low as 0.001. This sheds light on a fact that in China, SOEs generally have lower efficiencies and profitability compared to firms with other types of ownership. For the variable of total leverage, the average value for firms with different ownership types generally fluctuates around 0.568. The highest leverage is for SOEs (0.686) and the lowest is for foreign firms (0.516). This is consistent with the financial constraint levels measured by the WW index, Investment-Cash Flow Sensitivity (ICFS), and SA index, in which the SOE group has the weakest financial constraints (-0.458/-0.005/-3.008) while the private group has the strongest (-0.439/0.015/-3.070). In addition, foreign group has the highest coverage ratio (2.029), and SOEs have the lowest coverage ratio (0.241). Moreover, private group relies on banks most heavily (0.932), but SOEs rely on banks least (0.809), and this is consistent with the facts that SOEs are least financially constrained. A number of previous studies also support these findings (e.g. Chen and Guariglia, 2013 (*17*); Zhang and Liu, 2017 (*64*)).

	All Firms	Exit=1	Exit=0	State	Private	Foreign
	(1)	(2)	(3)	(4)	(5)	(6)
Exit	0.137	1.000	0.000***	0.200	0.144***	0.116***
	(0.344)	(0.000)	(0.000)	(0.400)	(0.351)	(0.320)
Sales Growth	0.342	0.169	0.368***	0.184	0.398***	0.270***
	(0.920)	(0.963)	(0.910)	(0.881)	(0.955)	(0.835)
Log(Assets)	9.986	9.303	10.095***	10.163	9.917***	10.429***
	(1.480)	(1.316)	(1.475)	(1.844)	(1.405)	(1.507)
Log(Worker)	4.885	4.227	4.986***	5.059	4.819***	5.107***
	(1.150)	(1.100)	(1.123)	(1.511)	(1.068)	(1.220)
Age	2.027	2.059	2.022***	2.802	1.886***	1.936***
	(0.846)	(0.832)	(0.848)	(0.938)	(0.793)	(0.680)
TFP	3.727	3.597	3.747***	2.578	3.777***	3.909***
	(1.088)	(1.230)	(1.064)	(1.278)	(0.974)	(0.979)
ROA	0.077	0.012	0.088***	0.001	0.106***	0.002***
	(1.602)	(4.263)	(0.578)	(0.253)	(2.488)	(4.009)
Leverage	0.568	0.595	0.564***	0.686	0.557***	0.516***
	(0.292)	(0.325)	(0.286)	(0.335)	(0.280)	(0.286)
WW Index	-0.441	-0.410	-0.446***	-0.458	-0.439***	-0.440***
	(0.082)	(0.077)	(0.081)	(0.082)	(0.080)	(0.095)
ICFS	0.005	0.005	0.001***	-0.005	0.015***	0.005***
	(0.156)	(0.154)	(0.156)	(0.179)	(0.161)	(0.150)
SA Index	-3.057	-3.138	-3.044***	-3.008	-3.070***	-2.988***
	(0.259)	(0.181)	(0.267)	(0.337)	(0.238)	(0.298)
Coverage Ratio	1.392	1.457	1.384***	0.241	1.457***	2.029***
	(2.226)	(2.253)	(2.223)	(2.608)	(2.132)	(2.246)
Bank Dependency	0.900	0.902	0.900***	0.809	0.932***	0.909***
	(0.204)	(2.207)	(0.204)	(0.251)	(0.198)	(0.177)
Herfindahl Index	0.016	0.017	0.016***	0.022	0.015***	0.016***
	(0.023)	(0.023)	(0.022)	(0.027)	(0.021)	(0.023)
Industry Sales Growth	0.235	0.153	0.248***	0.179	0.249***	0.231***
	(0.315)	(0.279)	(0.318)	(0.237)	(0.323)	(0.335)
Observations	3,298,037	428,5599	2,869,478	357,458	2,392,275	548,304

This table reports the summary statistics for the sample firms during 1998-2013 and tests comparing SOEs and private firms, private and foreign firms. The significance of test statistic for the equality of variables' mean are shown by ***, ** and *. ***, ** and *.represents statistical significance at the 1%, 5% and 10% percent level respectively. The regressors are defined in Table A1.

Table 1: Descriptive Statistics

Figure 1 shows Kaplan-Meier survival rates for financially constrained firms vis-à-vis un-financially constrained firms as preliminary evidence on the univariate relationship between financial constraints and firm survival. Un-financially constrained firms have higher survival rate: after five years, 70% survive, while only 50% of financially constrained firms survive.



4. Empirical results

4.1 Baseline results

Our baseline results and test statistics are presented in Table2. It presents the effect of financial constraints on firm exit using the discrete time hazard model cloglog, Probit, and Logit (columns 1-4; columns 5-8; columns 9-12 respectively) with firm random effects controlled. Each groups show results for whole firms and subsamples of different ownership structures, separately. The significance of the estimated effects is assessed using heteroscedasticity robust standard errors.

	Hazard Models for Firms Exit with Random Effects											
	Cloglog				Probit				Logit			
	All Firms	State	Private	Foreign	All Firms	State	Private	Foreign	All Firms	State	Private	Foreign
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Financial Constraints	5.462***	4.423***	7.043***	7.968***	2.987***	2.616***	3.545***	4.957***	5.097***	7.479***	9.366***	6.026***
	(0.090)	(0.122)	(0.106)	(0.137)	(0.049)	(0.081)	(0.059)	(0.090)	(0.148)	(0.118)	(0.167)	(0.100)
Sales Growth	-0.037***	-0.003	-0.061***	-0.127***	-0.008***	-0.005	-0.042***	-0.095***	-0.013*	-0.079***	-0.173***	-0.014***
	(0.005)	(0.006)	(0.005)	(0.007)	(0.002)	(0.004)	(0.003)	(0.004)	(0.007)	(0.006)	(0.008)	(0.005)
Size	-0.164***	-0.421***	-0.252***	-0.152***	-0.391***	-0.149***	-0.435***	-0.662***	-0.111***	-0.500***	-0.734***	-0.400***
	(0.014)	(0.021)	(0.018)	(0.025)	(0.008)	(0.013)	(0.010)	(0.016)	(0.024)	(0.020)	(0.029)	(0.016)
$Size^2$	0.000	0.032***	0.007***	0.003**	0.014***	0.000	0.017***	0.025***	0.017***	0.018***	0.025***	0.011***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Age	-0.023**	-0.148***	-0.077***	-0.394***	-0.006	-0.081***	0.057***	-0.257***	-0.150***	-0.057***	-0.505***	-0.008
	(0.010)	(0.015)	(0.013)	(0.017)	(0.006)	(0.010)	(0.008)	(0.012)	(0.018)	(0.014)	(0.021)	(0.012)
Age^2	0.002	0.058***	0.004	0.130***	0.007***	0.034***	0.002	0.088***	0.060***	0.009***	0.163***	0.007***
	(0.002)	(0.003)	(0.003)	(0.004)	(0.001)	(0.002)	(0.002)	(0.003)	(0.004)	(0.003)	(0.005)	(0.003)
Herfindahl Index	0.480***	0.995***	0.446***	-0.054	0.565***	0.467***	0.591***	0.152*	0.983***	0.766***	0.034	0.736***
	(0.076)	(0.115)	(0.094)	(0.130)	(0.046)	(0.077)	(0.059)	(0.089)	(0.136)	(0.105)	(0.153)	(0.085)
Industry Sales Growth	-2.055***	-2.216***	-2.695***	-3.114***	-0.978***	-1.156***	-1.272***	-1.695***	-2.555***	-2.931***	-3.706***	-2.211***
	(0.013)	(0.019)	(0.016)	(0.021)	(0.007)	(0.012)	(0.008)	(0.013)	(0.024)	(0.018)	(0.026)	(0.015)
Constant	2.326***	-0.185**	3.255***	4.315***	2.783***	2.035***	3.199***	5.722***	1.971***	4.902***	8.221***	3.897***
	(0.067)	(0.094)	(0.085)	(0.118)	(0.040)	(0.061)	(0.052)	(0.079)	(0.114)	(0.096)	(0.145)	(0.076)
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Region Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	2,613,481	251,291	1,555,595	394,705	2,613,481	251,291	1,555,595	394,705	2,613,481	251,291	1,555,595	394,705
Log-Likelihood	-895,539	-376,469	-656,246	-354,927	-899,936	-379,573	-662,026	-358,592	-896,555	-377,468	-657,551	-355,491

Robust standard errors in parentheses. Significant at *10%, **5%, ***1% confidence levels. The specifications have a binary dependent variable that is equal to 1 in the year of exit for markets that exit and 0 otherwise. The table shows marginal effects. For dummy variables, the marginal effect is the change in the probability of exit associated with a change in the variable from 0 to 1, and for continuous variables, the marginal effect is the marginal change in the probability of exit associated with a change in the variable evaluated at the means of other variables. The regressors are defined in Table A1.

Table 2: Baseline Results on Financial Constraints and Firm Death

Column 1 shows that financial constraints significantly increase the exit probability for Chinese firms, and financial constraints is a selection mechanism of market has been proven. Moreover, the coefficients of financial constraints in columns 2-4 point out that financial constraints

play a weightier role in firms exiting for privately-owned and foreign-owned firms. Keeping all other variables constant, the marginal effect in SOEs implies that a firm's financial constraint level would increase its death probability by 4 times, however, it would increase the privately-owned and foreign-owned firms' death probability by 7 and 8 times. These findings are highly associated with the previous evidence that non-SOEs suffer more from financial constraints than SOEs in China.

With respect to our firm-specific controls, firms with higher sales growth and firms in higher sales growth industries have a lower exit probability (Fernandes and Paunov, 2015 (*32*)). However, higher intensive industry firms are more probable to exit. The coefficients on $Size$ and $Size^2$ enter with the expected signs, and both show significant levels. The coefficients on firm Age exert a negative and significant impact on failure and this finding is in line with previous theoretical and empirical evidence, which shows that failure rates decrease with the firm's track record (e.g. Jovanovic, 1982 (*46*); Clementi and Hopenhayn, 2006 (*20*)). Finally, the coefficients on Age^2 are positive and significant suggesting significant non-linearities (Tsoukas, 2011 (*61*); Liu and Li, 2015 (*54*)). Columns 5-12 also show the similar findings by Probit and Logit models with firm random effects, and the log-likelihood values in Table 2 suggest that the cloglog model provides the best fit to the data (Fernandes and Paunov, 2015 (*32*)).

4.2 Firm performance-financial constraints-survival links

Firm-specific performance, such as financial indicators, or productivity, have plausible impacts on firms' performance. In particular, firms with high levels of leverage face higher probabilities of failure compared to those with low leverage consistent with previous reported empirical evidence (Zingales, 1998 (*65*); Farinha and Santos, 2006 (*29*); Bridges and Guariglia, 2008 (*12*); Görg and Spaliara, 2009 (*37*)). High levels of debt would increase moral hazard and adverse selection problems, and would lead to a higher probability of failure (Tsoukas, 2011 (*61*)). Firm

profitability enters with the expected negative sign implying that an increase in profitability ratio lowers the hazard of failure. Bunn and Redwood (2003) (*14*), Bridges and Guariglia (2008) (*12*) and Görg and Spaliara (2009) (*37*) find that more profitable firms are less likely to fail. Moreover, low level productivity firms are more probable to exit (Ericson and Pakes, 1995 (*26*); Asplund and Nocke, 2006 (*2*)). Because lower productivity firms are more prone to exit due to their poor performance in competition (Eslava et al., 2004 (*27*); Frazer, 2005 (*35*); Foster et al., 2008 (*33*); Liu and Li, 2015 (*54*)).

4.2.1 Productivity-financial constraints-survival mechanism

Previous literature demonstrates that market enhances productivity by eradicating low efficient firms and reallocating resources from low productivity firms to high productivity firms (Frazer, 2005 (*35*); Farinas and Ruano, 2005 (*28*); Foster et al., 2008 (*33*)). Furthermore, high productivity firms are more likely to survive in the market, because high productivity firms have good performance in competition. On the contrary, low productivity firms are more anticipated to exit (Ericson and Pakes, 1995 (*26*); Asplund and Nocke, 2006 (*2*)). In addition, Zhang and Liu (2017) (*64*) demonstrate that financially constrained Chinese firms are more likely to use TFP as a signal to access external financing, as TFP is neutral and a more appropriate indicator for firm performance in China. Therefore, we propose the following hypotheses:

More productive firms are more likely to survival through easing financial constraints.

	Hazard Models for Firms Exit with Random Effects			
	All Firms	State	Private	Foreign
	(1)	(2)	(3)	(4)
Financial Constraints	8.076***	2.529***	9.224***	9.835***
	(0.096)	(0.626)	(0.114)	(0.147)
TFP	-0.057***	-0.000	-0.068***	-0.061***
	(0.001)	(0.019)	(0.001)	(0.001)
WW*TFP	-0.130***	0.019	-0.151***	-0.134***
	(0.002)	(0.043)	(0.002)	(0.003)
Sales Growth	-0.007	-0.358***	-0.049***	-0.136***
	(0.005)	(0.024)	(0.005)	(0.007)
Size	-0.389***	-0.304***	-0.558***	-0.206***
	(0.015)	(0.113)	(0.019)	(0.025)
$Size^2$	0.014***	-0.002	0.022***	0.001
	(0.001)	(0.005)	(0.001)	(0.001)
Age	-0.217***	-0.165***	-0.218***	-0.403***
	(0.011)	(0.041)	(0.013)	(0.018)
Age^2	0.066***	0.053***	0.069***	0.132***
	(0.002)	(0.019)	(0.003)	(0.004)
Herfindahl Index	1.870***	0.724***	2.068***	-0.082
	(0.078)	(0.197)	(0.097)	(0.132)
Industry Sales Growth	-0.691***	-0.089***	-0.784***	-3.298***
	(0.013)	(0.020)	(0.015)	(0.021)
Constant	4.150***	2.667***	5.565***	5.303***
	(0.070)	(1.016)	(0.090)	(0.121)
Year Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
Region Dummies	YES	YES	YES	YES
Observations	2,613,481	251,291	1,555,595	394,705
Log-Likelihood	-782,242	-370,655	-561,750	-349,830

Robust standard errors in parentheses. Significant at *10%, **5%, ***1% confidence levels. The specifications have a binary dependent variable that is equal to 1 in the year of exit for markets that exit and 0 otherwise. The table shows marginal effects. For dummy variables, the marginal effect is the change in the probability of exit associated with a change in the variable from 0 to 1, and for continuous variables, the marginal effect is the marginal change in the probability of exit associated with a change in the variable evaluated at the means of other variables. The regressors are defined in Table A1.

Table 3: Results on Financial Constraints and Firm Death Considering Productivity

Results from Table 3 substantiates our assumption that high TFP significantly eliminates the hazard rate, and the interaction term of hazard rate with respect to TFP and financial constraints is also significantly positive for all three structures of ownership. This implies that on average high TFP firms are more probable to survive, because firms with higher TFP can relieve financial constraints confronted through competing successfully and sending a signal to external lenders. With respect to ownerships, this mechanism has more impacts on privately-owned and foreign-owned firms than on SOEs. The coefficients of TFP and the interaction term of TFP

and financial constraints on SOEs are insignificant. TFP is not sensitive to financial constraints due to SOEs' soft budget constrained (Zhang and Liu, 2017) (*64*), and on the other approach, the reformation and exit of SOEs are strongly administrated, thus this productivity-financial constraints mechanism is not effective for SOEs (Liu and Li, 2015 (*54*)).

We conclude that productivity can alleviate financial constraints and benefits firms in survival.

4.2.2 Profitability-financial constraints-survival mechanism

Literature demonstrates that financially constrained firms may create internal financing markets, and these markets can effectively allocate scarce financing resources within the firm itself, and the internal financing markets are able to substitute the external financing markets in the provision of managerial incentives (e.g., Harris and Raviv, 1996 (*42*); Stein, 1997 (*60*); Matsusaka and Nanda, 2002 (*55*); De Motta, 2003 (*23*)). Furthermore, from the pecking-order theory of financial services, Myers and Majluf (1984) (*56*) demonstrate that internal financing is less costly than external financing. Evidence also supports the notion of a pecking order between internal financing and external financing, and finds that the cost of financing increases the probabilities of firms' failure (Beck et al., 2005 (*5*); Beck et al., 2001 (*6*); Ayyagari et al., 2003 (*3*); Beck et al., 2008 (*4*)). Relaxing financial constraints therefore has a greater effect on sales growth for small firms than for others (Beck et al., 2005 (*5*)). Thus, we raise our hypotheses:

More profitability firms can avoid the possibilities to exit through alleviating financial constraints.

	Hazard Models for Firms Exit with Random Effects			
	All Firms	State	Private	Foreign
	(1)	(2)	(3)	(4)
Financial Constraints	1.470***	0.361*	2.793***	2.741***
	(0.139)	(0.210)	(0.174)	(0.239)
ROA	-4.078***	-3.611***	-4.543***	-5.059***
	(0.057)	(0.087)	(0.067)	(0.087)
WW*ROA	-7.002***	-5.341***	-8.218***	-8.773***
	(0.124)	(0.179)	(0.144)	(0.179)
Sales Growth	-0.220***	-0.183***	-0.152***	-0.130***
	(0.006)	(0.008)	(0.007)	(0.009)
Size	-0.729***	-0.412***	-0.859***	-0.718***
	(0.015)	(0.023)	(0.019)	(0.026)
$Size^2$	0.018***	0.002**	0.025***	0.014***
	(0.001)	(0.001)	(0.001)	(0.001)
Age	-0.213***	-0.148***	-0.212***	-0.263***
	(0.011)	(0.015)	(0.013)	(0.018)
Age^2	0.065***	0.046***	0.069***	0.092***
	(0.002)	(0.003)	(0.003)	(0.004)
Herfindahl Index	1.795***	0.514***	1.996***	0.900***
	(0.077)	(0.115)	(0.097)	(0.129)
Industry Sales Growth	-0.067***	-0.058**	-0.179***	-0.183***
	(0.016)	(0.024)	(0.019)	(0.027)
Constant	4.307***	3.141***	5.506***	5.207***
	(0.069)	(0.108)	(0.090)	(0.118)
Year Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
Region Dummies	YES	YES	YES	YES
Observations	2,613,481	251,291	1,555,595	394,705
Log-Likelihood	-800,505	-342,919	-573,402	-315,980

Robust standard errors in parentheses. Significant at *10%, **5%, ***1% confidence levels. The specifications have a binary dependent variable that is equal to 1 in the year of exit for markets that exit and 0 otherwise. The table shows marginal effects. For dummy variables, the marginal effect is the change in the probability of exit associated with a change in the variable from 0 to 1, and for continuous variables, the marginal effect is the marginal change in the probability of exit associated with a change in the variable evaluated at the means of other variables. The regressors are defined in Table A1.

Table 4: Results on Financial Constraints and Firm Death Considering Profitability

Table 4 reports the estimation of coefficients of ROA on the interacted financial constraints as well as other control variables. The results show that firms with a higher ROA rate are more probable to survive, and ROA can weaken financial constraints. In particular, this effect is more efficient for non-SOEs (columns 3-4) than SOEs (column 2). Because ROA can be recognized as a proxy of internal financing that can ease the external financial constraints (Chen and Guariglia, 2013 (*17*); Zhang and Liu, 2017 (*64*)). Moreover, non-SOEs suffer from financial constraints more than SOEs, thus the coefficients of non-SOEs are higher than that of SOEs.

4.2.3 Leverage-financial constraints-survival mechanism

Generally, firms with higher levels of leverage are often associated with a poorer balance sheet, and higher levels of leverage means the firm faces more difficulties to access financing from the market (Zingales, 1998 (*65*); Bougheas et al., 2006 (*8*)). Moreover, high levels of leverage would increase moral hazard and adverse selection problems, and would lead to a higher probability of failure (Tsoukas, 2011 (*61*)). Firms with high leverage face higher probabilities of failure compared to those with low leverage confirming previous reported empirical evidence (Farinha and Santos, 2006 (*29*); Bridges and Guariglia, 2008 (*12*); Görg and Spaliara, 2009 (*37*)). Thus, higher leverage makes firms suffer from financial constraints more severely, which expands the financial constraints' selection mechanism on firms exit. Therefore, we construct our hypotheses:

More leveraged firms can suffer higher probability of exit due to magnifying financial constraints.

	Hazard Models for Firms Exit with Random Effects			
	All Firms	State	Private	Foreign
	(1)	(2)	(3)	(4)
Financial Constraints	5.667***	6.800***	6.308***	8.886***
	(0.103)	(0.140)	(0.123)	(0.154)
Leverage	0.203***	0.133***	0.487***	0.322***
	(0.031)	(0.040)	(0.042)	(0.051)
WW* Leverage	0.042	-0.234**	1.010***	0.600***
	(0.077)	(0.097)	(0.100)	(0.122)
Sales Growth	-0.057***	-0.058***	-0.021***	-0.135***
	(0.005)	(0.006)	(0.005)	(0.006)
Size	-0.498***	-0.067***	-0.591***	-0.308***
	(0.015)	(0.021)	(0.018)	(0.024)
$Size^2$	0.017***	0.005***	0.022***	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)
Age	-0.219***	-0.142***	-0.215***	-0.252***
	(0.011)	(0.015)	(0.013)	(0.017)
Age^2	0.067***	0.045***	0.070***	0.090***
	(0.002)	(0.003)	(0.003)	(0.004)
Herfindahl Index	1.900***	0.585***	2.107***	0.945***
	(0.077)	(0.115)	(0.097)	(0.129)
Industry Sales Growth	-0.528***	-0.614***	-0.656***	-0.920***
	(0.013)	(0.018)	(0.015)	(0.019)
Constant	3.851***	2.579***	4.645***	4.268***
	(0.071)	(0.109)	(0.092)	(0.122)
Year Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
Region Dummies	YES	YES	YES	YES
Observations	2,613,481	251,291	1,555,595	394,705
Log-Likelihood	-808,805	-344,227	-580,639	-317,905

Robust standard errors in parentheses. Significant at *10%, **5%, ***1% confidence levels. The specifications have a binary dependent variable that is equal to 1 in the year of exit for markets that exit and 0 otherwise. The table shows marginal effects. For dummy variables, the marginal effect is the change in the probability of exit associated with a change in the variable from 0 to 1, and for continuous variables, the marginal effect is the marginal change in the probability of exit associated with a change in the variable evaluated at the means of other variables. The regressors are defined in Table A1.

Table 5: Results on Financial Constraints and Firm Death Considering Leverage

Table 5 focuses on the results that whether firms with more leverage face higher death probability. Column 1 shows that there is a positive and significant relationship between leverage and exit, and leverage can further intensify the financial constraints' selection mechanism. However, with respect to ownerships, there is a significant difference between SOEs and non-SOEs. Columns 3-4 show that more leveraged firms are in worse condition to access external financing, and see stronger financial constraints, thus they are more likely to exit. However, column 2 shows that leverage can alleviate financial constraints and eliminate the death rate for SOEs,

which is contrary to our hypotheses. There are mainly two approaches to explain this phenomenon. First, in China, most of "zombie" firms appertain to SOEs. Second reason is related to political connections, where soft-budget cannot be ignored.

4.3 Other findings

Apart from the firm performance we discussed above, we further check whether other firm behaviors or external shocks have impacts on the relationship between financial constraints and firm survival.

4.3.1 Bank dependency and firm survival

Firm's dependency on banks also show uncertain effects. Bank dependency is measured by the ratio of short term debt to total debt[15] (Kashyap et al., 1992 (*48*)). In ther other words, it reflects the accessibility to market financing versus bank loan, where the majority of short-term debt is in the form of bank loan. We attempt to measure to which extent a firm has to finance itself short-termly rather than in a long term. The higher the mix, the more bank-dependent a firm is. It is generally accepted that firms with higher levels of bank dependency are more likely to be financially constrained (Spaliara, 2009 (*59*); Tsoukas, 2011 (*61*)).

[15]Oliner and Rudebusch (1996) (*57*) use short-term debt/total short-term debt in their test for the presence of a bank lending channel of transmission of monetary policy which has subsequently been used by Guariglia and Mateut (2006) (*40*).

	Hazard Models for Firms Exit with Random Effects			
	All Firms	State	Private	Foreign
	(1)	(2)	(3)	(4)
Financial Constraints	4.788***	5.043***	5.282***	6.596***
	(0.133)	(0.179)	(0.165)	(0.215)
Bank Dependency	0.629***	1.184***	0.711***	1.263***
	(0.048)	(0.065)	(0.062)	(0.085)
WW* Bank Dependency	1.931***	2.973***	2.043***	3.250***
	(0.112)	(0.149)	(0.143)	(0.190)
Sales Growth	-0.030***	-0.090***	-0.028***	-0.143***
	(0.005)	(0.006)	(0.005)	(0.006)
Size	-0.407***	-0.056***	-0.531***	-0.244***
	(0.015)	(0.021)	(0.018)	(0.024)
$Size^2$	0.014***	0.009***	0.019***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Age	-0.213***	-0.132***	-0.205***	-0.235***
	(0.011)	(0.015)	(0.013)	(0.018)
Age^2	0.066***	0.044***	0.068***	0.087***
	(0.002)	(0.003)	(0.003)	(0.004)
Herfindahl Index	1.909***	0.581***	2.110***	0.963***
	(0.077)	(0.115)	(0.097)	(0.129)
Industry Sales Growth	-0.625***	-0.734***	-0.687***	-0.969***
	(0.012)	(0.018)	(0.015)	(0.019)
Constant	3.162***	1.220***	4.049***	3.068***
	(0.085)	(0.128)	(0.112)	(0.149)
Year Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
Region Dummies	YES	YES	YES	YES
Observations	2,613,481	251,291	1,555,595	394,705
Log-Likelihood	-808,769	-344,381	-580,242	-317,728

Robust standard errors in parentheses. Significant at *10%, **5%, ***1% confidence levels. The specifications have a binary dependent variable that is equal to 1 in the year of exit for markets that exit and 0 otherwise. The table shows marginal effects. For dummy variables, the marginal effect is the change in the probability of exit associated with a change in the variable from 0 to 1, and for continuous variables, the marginal effect is the marginal change in the probability of exit associated with a change in the variable evaluated at the means of other variables. The regressors are defined in Table A1.

Table 6: Results on Financial Constraints and Firm Death Considering Bank Dependency

As presented in Table 6, a firm highly indebted is in high expense to obtain external finance. Thus, the higher the debt burden, the higher is the cost of external finance (Spaliara, 2009).

4.3.2 Coverage ratio and firm survival

Ding et al. (2013) (*24*) use coverage ratio (defined as the ratio of net income over total interest payments) to measure the liquidity of Chinese firms. Coverage ratio is one of the financial health indicators, in the form of cash flow shocks. High ratio indicates that a firm is more likely to be able to get access to external finance and therefore adjust working capital into cash flow.

This could help to alleviate financial constraints (Chen and Guariglia, 2013 (*17*)). In the other words, firms with high coverage ratio are less likely to exit.

	Hazard Models for Firms Exit with Random Effects			
	All Firms	State	Private	Foreign
	(1)	(2)	(3)	(4)
Financial Constraints	3.772***	5.151***	5.357***	7.341***
	(0.146)	(0.217)	(0.170)	(0.235)
Coverage Ratio	-0.026***	-0.009	-0.066***	-0.175***
	(0.008)	(0.011)	(0.009)	(0.012)
WW* Coverage Ratio	-0.129***	-0.094***	-0.243***	-0.387***
	(0.018)	(0.024)	(0.021)	(0.027)
Sales Growth	-0.003	-0.080***	-0.067***	-0.143***
	(0.007)	(0.009)	(0.007)	(0.010)
Size	-0.122***	-0.129***	-0.049**	-0.437***
	(0.027)	(0.024)	(0.019)	(0.026)
$Size^2$	-0.002	0.054***	0.001	0.129***
	(0.004)	(0.005)	(0.004)	(0.006)
Age	-0.579***	-0.149***	-0.601***	-0.455***
	(0.022)	(0.033)	(0.026)	(0.037)
Age^2	0.016***	0.004**	0.019***	0.009***
	(0.001)	(0.002)	(0.001)	(0.002)
Herfindahl Index	0.508***	1.068***	0.331**	-0.316
	(0.121)	(0.197)	(0.144)	(0.210)
Industry Sales Growth	-1.879***	-2.497***	-2.381***	-2.994***
	(0.020)	(0.032)	(0.023)	(0.033)
Constant	3.874***	2.823***	4.457***	5.864***
	(0.107)	(0.158)	(0.129)	(0.184)
Year Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
Region Dummies	YES	YES	YES	YES
Observations	2,613,481	251,291	1,555,595	394,705
Log-Likelihood	-407,764	-158,580	-321,747	-153,998

Robust standard errors in parentheses. Significant at *10%, **5%, ***1% confidence levels. The specifications have a binary dependent variable that is equal to 1 in the year of exit for markets that exit and 0 otherwise. The table shows marginal effects. For dummy variables, the marginal effect is the change in the probability of exit associated with a change in the variable from 0 to 1, and for continuous variables, the marginal effect is the marginal change in the probability of exit associated with a change in the variable evaluated at the means of other variables. The regressors are defined in Table A1.

Table 7: Results on Financial Constraints and Firm Death Considering Coverage Ratio

Table 7 presents the regression results on the analyzing of the coverage ratio mechanism, which is the link between financial constraints and firm survival. High coverage ratio can free firms from financial constraints and help firms to survive in the market. Nevertheless, this mechanism shows no significant level in SOEs (column 2).

4.3.3 Financial crisis

After identifying the links between financial constraints and firm survival, we now explore how this linkage develops over time. Chinese firms experienced huge loss in the financial crisis in 2008, and Chinese firms succumb to financial constraints more severely in the world. Financially constrained firms are more vulnerable to suspension in funding, while un-financially constrained firms find it easier to acquire external financing (Beck et al., 2008 (*4*)). It is accordingly of our primary interest to investigate whether the financial constraints-firm survival selection mechanism was more significantly influenced due to the 2008 financial crisis. We would anticipate that the positive effect of financial constraints on firm exit would strengthen its relevance over time. In order to test this hypothesis, we set an interaction term of financial constraints with a time dummy (Before/After the crisis).

	Hazard Models for Firms Exit with Random Effects			
	All Firms	State	Private	Foreign
	(1)	(2)	(3)	(4)
WW *Before Crisis	4.118***	4.370***	5.288***	7.598***
	(0.091)	(0.122)	(0.107)	(0.134)
WW* After Crisis	5.849***	5.783***	7.157***	9.806***
	(0.091)	(0.144)	(0.107)	(0.140)
Sales Growth	-0.089***	-0.005	-0.010*	0.109***
	(0.005)	(0.006)	(0.005)	(0.007)
Size	-0.073***	-0.145***	-0.097***	-0.372***
	(0.011)	(0.015)	(0.013)	(0.017)
$Size^2$	0.011***	0.057***	0.004	0.123***
	(0.002)	(0.003)	(0.003)	(0.004)
Age	-0.303***	-0.374***	-0.361***	-0.224***
	(0.014)	(0.021)	(0.018)	(0.024)
Age^2	0.007***	0.029***	0.011***	0.002
	(0.001)	(0.001)	(0.001)	(0.001)
Herfindahl Index	0.016	1.000***	0.017	0.242*
	(0.077)	(0.115)	(0.094)	(0.128)
Industry Sales Growth	-1.920***	-2.206***	-2.510***	-3.027***
	(0.013)	(0.019)	(0.016)	(0.021)
Constant	2.513***	0.012	3.197***	4.436***
	(0.067)	(0.095)	(0.083)	(0.114)
Year Dummies	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES
Region Dummies	YES	YES	YES	YES
Test of Equality (*P-value*):Crisis	0.000	0.000	0.000	0.000
Observations	2,613,481	251,291	1,555,595	394,705
Log-Likelihood	-888,910	-376,265	-650,000	-353,080

Robust standard errors in parentheses. Significant at *10%, **5%, ***1% confidence levels. The specifications have a binary dependent variable that is equal to 1 in the year of exit for markets that exit and 0 otherwise. The table shows marginal effects. For dummy variables, the marginal effect is the change in the probability of exit associated with a change in the variable from 0 to 1, and for continuous variables, the marginal effect is the marginal change in the probability of exit associated with a change in the variable evaluated at the means of other variables. The p-value shown in each column tests the null hypothesis that the difference in the marginal effects of the before and after financial crisis on financial constraints proxies included in the column is statistically insignificant. The regressors are defined in Table A1.

Table 8: Results on Financial Constraints and Firm Death Considering Financial Crisis

Results for the evolution of financial constraints over time are reported in Table 8. We observe that the coefficients on financial constraints are larger and highly significant for the later period (after the financial crisis). This suggests that financial constraints worsened firms' situation after the financial crisis. The coefficients of the financial constraints after the crisis for privately-owned and foreign-owned firms (3-4) are higher than that of SOEs (column 2), indicating that compared to SOEs, the financial crisis expanded the financial constraints' influence on privately-owned and foreign-owned firms.

5. Robustness tests

In this section we set a battery of robustness tests to strengthen our conclusions. The additional checks in this section involve estimation of our empirical models with a few common random-effects models such as Probit, Logit, Cox, and OLS. In addition, other financial constraint indicators, such as ICFS, SA Index, are adopted to substitute WW Index.

5.1 Alternative estimation methods

Notwithstanding all the methods we have used so far include firm-specific covariates, it is still unlikely that they can account for all observation-specific effects. Not taking proper account of unobserved heterogeneity may bias the results and lead to misleading inferences. Therefore, we consider a more flexible approach to account for unobserved heterogeneity: a linear exit probability model with firm fixed effects. Moreover, we will estimate a OLS specification for survival up to a fixed number of years, which also allows controlling for firm fixed effects (columns 1-4).

Apart from that, we will also test the Cox continuous-time proportional hazards model. Based on the characteristics of our observations, we obtain estimates based on continuous-time hazard models with a parametric baseline hazard function that can control for unobserved firm heterogeneity and estimates based on the Cox model correcting the partial likelihood function for ties using the method of Breslow (1974) (*11*) for comparability with previous studies. Columns 5-8 of Table 9 present the results.

Columns 9-12 present the estimates from a continuous-time parametric survival model where the distribution of the baseline hazard function is assumed to be a Weibull and the model allows for random firm effects to account for unobserved heterogeneity under the assumption that these are uncorrelated with other explanatory variables.

In Table 9, we verify the robustness of our main findings following the discussion above.

The positive and significant impact of financial constraints on firm exit maintains across all these models.

	Alternative Models for Firms Exit or Survival											
	OLS with Fixed Effects				Cox				Weibull with Unobserved Heterogeneity			
	All Firms	State	Private	Foreign	All Firms	State	Private	Foreign	All Firms	State	Private	Foreign
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Financial Constraints	0.796***	0.820***	0.864***	1.436***	5.066***	3.563***	5.114***	5.338***	7.568***	8.429***	8.529***	7.751***
	(0.010)	(0.165)	(0.070)	(0.021)	(0.092)	(0.239)	(0.125)	(0.231)	(0.091)	(0.122)	(0.102)	(0.127)
Sales Growth	-0.007***	0.004	-0.014***	-0.028***	-0.027***	0.006	-0.047***	-0.070***	-0.076***	-0.175***	-0.144***	-0.156***
	(0.000)	(0.006)	(0.002)	(0.001)	(0.005)	(0.011)	(0.007)	(0.011)	(0.005)	(0.006)	(0.005)	(0.006)
Size	-0.026***	-0.180***	-0.187***	-0.030***	-0.206***	0.209***	-0.585***	0.022	-0.167***	-0.119***	-0.237***	-0.368***
	(0.001)	(0.025)	(0.011)	(0.003)	(0.009)	(0.029)	(0.018)	(0.037)	(0.015)	(0.020)	(0.018)	(0.024)
$Size^2$	0.008***	0.007***	0.008***	0.011***	0.063***	0.016***	0.023***	0.013***	0.002***	0.008***	0.007***	0.028***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Age	-0.187***	-0.019***	-0.018***	-0.331***	-0.285***	-0.074***	-0.199***	-0.529***	-0.255***	-0.369***	-0.211***	-0.359***
	(0.002)	(0.007)	(0.004)	(0.003)	(0.013)	(0.020)	(0.013)	(0.023)	(0.011)	(0.014)	(0.012)	(0.017)
Age^2	0.009***	0.009***	0.001	0.015***	0.008***	0.004	0.058***	0.161***	0.084***	0.119***	0.072***	0.102***
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.004)	(0.003)	(0.005)	(0.002)	(0.003)	(0.003)	(0.004)
Herfindahl Index	0.172***	-0.139	0.041	0.124***	1.704***	0.168	2.228***	1.666***	2.955***	2.430***	3.118***	2.091***
	(0.010)	(0.103)	(0.079)	(0.020)	(0.066)	(0.149)	(0.094)	(0.170)	(0.077)	(0.110)	(0.090)	(0.122)
Industry Sales Growth	-0.087***	-0.289***	-0.235***	-0.157***	-0.476***	-0.325***	-0.465***	-0.554***	-1.906***	-1.702***	-2.213***	-1.896***
	(0.001)	(0.030)	(0.017)	(0.003)	(0.012)	(0.034)	(0.016)	(0.031)	(0.013)	(0.018)	(0.014)	(0.019)
Constant	1.447***	1.736***	1.586***	2.559***					5.454***	6.120***	5.627***	6.506***
	(0.009)	(0.170)	(0.069)	(0.018)					(0.005)	(0.005)	(0.005)	(0.005)
Firm Fixed Effects	YES	YES	YES	YES								
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Region Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	2,613,481	251,291	1,555,595	394,705	2,613,481	251,291	1,555,595	394,705	2,613,481	251,291	1,555,595	394,705
R^2	0.142	0.094	0.168	0.225								
Log-Pseudo-Likelihood					-4,039,077	-495,041	-2,181,169	-547,750	-1,545,875	-997,078	-1,260,872.	-911,284

Robust standard errors in parentheses. Significant at *10%, **5%, ***1% confidence levels. The specifications have a binary dependent variable that is equal to 1 in the year of exit for markets that exit and 0 otherwise. The table shows marginal effects. For dummy variables, the marginal effect is the change in the probability of exit associated with a change in the variable from 0 to 1, and for continuous variables, the marginal effect is the marginal change in the probability of exit associated with a change in the variable evaluated at the means of other variables. The regressors are defined in Table A1.

Table 9: Results on Financial Constraints and Firm Death Adopting Alternative Regression Methods

5.2 Alternative measurement of financial constraint indexes

The measurement of financial constraints is always full of controversies. In order to test whether our regression results are misled by the financial constraints index-WW index, ICFS and SA index are employed to measure financial constraints to check robustness of our previous results.

We re-estimate the models in Table 2 with those two different proxies of the financial constraints and report the results in Table 10. We find that the influence of the financial constraints on firm exit is consistent with that in Table 2, indicating that our results are unlikely to be misguided by a particular measurement of financial constraints.

	Hazard Models for Firms Exit with Random Effects							
	Financial Constraints=ICSF				Financial Constraints=SA Index			
	All Firms	State	Private	Foreign	All Firms	State	Private	Foreign
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Financial Constraints	0.025**	0.308***	0.094***	0.338***	-1.029***	-1.680***	-1.178***	-1.854***
	(0.010)	(0.016)	(0.013)	(0.018)	(0.013)	(0.019)	(0.017)	(0.021)
Sales Growth	-0.267***	-0.221***	-0.230***	-0.243***	-0.276***	-0.201***	-0.251***	-0.199***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)	(0.004)
Size	-0.472***	-0.380***	-0.610***	-0.659***	-0.751***	-0.773***	-0.807***	-0.559***
	(0.014)	(0.020)	(0.017)	(0.023)	(0.009)	(0.011)	(0.013)	(0.015)
$Size^2$	0.003***	0.003***	0.009***	0.007***	0.033***	0.046***	0.033***	0.003*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Age	-0.015	-0.141***	-0.068***	-0.281***	-0.380***	-0.296***	-0.373***	-0.663***
	(0.010)	(0.015)	(0.013)	(0.017)	(0.011)	(0.015)	(0.013)	(0.017)
Age^2	0.015***	0.047***	0.011***	0.100***	0.108***	0.072***	0.110***	0.183***
	(0.002)	(0.003)	(0.003)	(0.004)	(0.002)	(0.003)	(0.003)	(0.004)
Herfindahl Index	0.945***	0.585***	1.000***	1.009***	0.963***	0.178	1.172***	1.349***
	(0.075)	(0.115)	(0.094)	(0.128)	(0.080)	(0.117)	(0.103)	(0.132)
Industry Sales Growth	-1.352***	-0.044***	-1.773***	0.018	-0.007	-0.033***	-0.004	-2.119***
	(0.008)	(0.012)	(0.010)	(0.013)	(0.008)	(0.012)	(0.010)	(0.013)
Constant	2.605***	2.658***	3.383***	4.045***	-2.086***	-3.926***	-2.295***	-3.947***
	(0.066)	(0.102)	(0.085)	(0.116)	(0.043)	(0.070)	(0.055)	(0.071)
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES
Industry Dummies	YES	YES	YES	YES	YES	YES	YES	YES
Region Dummies	YES	YES	YES	YES	YES	YES	YES	YES
Observations	2,613,481	251,291	1,555,595	394,705	2,613,481	251,291	1,555,595	394,705
Log-Likelihood	-940,809	-347,287	-614,057	-322,502	-813,389	-344,917	-586,802	-349,807

Robust standard errors in parentheses. Significant at *10%, **5%, ***1% confidence levels. The specifications have a binary dependent variable that is equal to 1 in the year of exit for markets that exit and 0 otherwise. The table shows marginal effects. For dummy variables, the marginal effect is the change in the probability of exit associated with a change in the variable from 0 to 1, and for continuous variables, the marginal effect is the marginal change in the probability of exit associated with a change in the variable evaluated at the means of other variables. The regressors are defined in Table A1.

Table 10: Results on Financial Constraints and Firm Death Adopting Alternative Indexes

6. Conclusion

Using a large panel data set of Chinese firms, we find that firm-level financial constraints are a key factor influencing firm survival. When the level of financial constraints increases, chances for firms to survive dwindle. In other words, moving towards a lower level of financial constraints is likely to reduce the incidence of firm failures. We argue that financial constraints are the selection mechanism in the market and therefore could impede firms' survival prospects. Furthermore, this mechanism has stronger effect on privately-owned and foreign-owned firms than SOEs.

We further investigate how other indicators of firm performance affect the financial constraint mechanism. These linkages between firm performance and financial constraints play different roles in firm's survival. Particularly, each linkage shows different impacts among three types of ownership structure. The findings show that privately-owned and foreign-owned firms with higher TFP can relieve financial constraints and are more likely to avoid exit, but not for SOEs. Higher TFP firms can compete in the market and reallocate financing resources more efficiently. High ROA rate can alleviate financial constraints to help firm to survive, and this influence is more helpful for non-SOEs. High leverage aggravates the financial constraints and makes firms more probable to exit, especially for higher leveraged non-SOEs. Exceptionally, for SOEs, leverage can alleviate financial constraints and decrease the death rate. As SOEs are soft-budgeted, and more administrated, extra leverage is favorable and fills the demand of financing.

Finally, we delve into whether the linkage between financial constraints and survival has changed over time. We find that the harmful effects of financial constraints are enlarged after the financial crisis, and the financial constraints selection mechanism has strengthened over time.

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Appendix: Variable Name Definition

Exit	Variable equals 1 if the firm is in the sample in year t but not in year t+1, and 0 otherwise.
TFP	TFP is constructed using the Olley and Pakes (1996) method.
Sales growth	Sales in period t and t-1 over sales in period t-1.
ROA	Share of firms' net profit over total sales.
Firm Size	Natural logarithm of total assets
Firm Age	Natural logarithm of the number of years since the open year
Industry sales growth	Industry sales in period t and t-1 over sales in period t-1, industry sales are constructed by all N firms in the 3-digit CIC industry and year.
Herfindahl index	The Herfindahl index is computed as the sum of the squares of the markets shares of all N firms in the 3-digit CIC industry and year.
Financial constraints	Financial constraints are constructed using the Whited and Wu (2006) method.