Do credit squeezes influence firm survival? – An empirical investigation of China

Abstract

This paper analyses the effect of a "Credit Squeeze" policy that was set by the Chinese government in 2007, increasing the strictness for firm-level bank loans. We adopt the Difference in Difference (DID) model to compare the survival rate change before and after the policy was implemented. We further explore the mechanism behind how the "Credit Squeeze" policy reduced the probability of firms surviving the market from perspectives such as financial constraints and ownership structures. The "Credit Squeeze" policy significantly increased firms' operating costs and lowered firms' productivity. In addition, we find that the zombie firm phenomenon existing in the State Owned Enterprises have large impacts on our estimation. Our results provide practical policy implications regarding the compromise between systematic debt risk and firm survival.

Key Words

Credit Squeeze, Firm Survival, Ownership Structure, Difference-in-Difference Policy measurement

JEL Classification Codes

P21, G38, C54

1. Introduction

The survival of firms in China has a substantial connection with monetary policies and loan markets (Z Song et al., 2011; 10. S Poncet et al., 2010). China's debt buildup and excess liquidity due to expansionary monetary policies in the last decade generated a lot of concerns and risks, contributing to the worries over global inflation that have roiled markets. Between early 2004 and late 2007, Chinese gross debt was between 170 and 180 percent of gross domestic product (GDP)[1], which was higher than in other emerging countries. Because of this, the Chinese government enacted a monetary policy in 2007 to rein in the excessive high-risk lending in order to wean China off its years-long addiction to debt, resulting in a sudden credit crunch to the firms in China[2]. Nevertheless, this risk-cutting policy was not without criticism. Tightening credit policy causes difficulties for firms to obtain sufficient funds to operate and even affects their market survival.

Growing literature has shown that financial constraints have large impacts at the firm level. Lack of sufficient funds impinges on firms' ability to operate normally and efficiently (1. Musso and Schiavo, 2008; 2. Bridges and Guariglia, 2008; 3. Becchetti and Trovato, 2002, 4. F Bellone et al., 2010). There are a number of factors leading to financial constraints; for example, inadequate security and enforcement of property rights, inefficient functioning of financial markets, inefficient regulations and taxation (6. Meghana Ayyagari et al., 2008), and corruption and macroeconomic instability (7. Beck, Thorsten et al., 2005). Moreover, as for acquiring loans, 8. JC Stein (2003) and 9. Hubbard (1997) identify that informational asymmetries and agency problems have negative impacts on the allocation process of financial resources to firms.

Financially constrained firms are influenced in many aspects such as planning deeper cuts in tech spending, employment, and capital spending (5. Campello et al. 2010), restricting international trade and affecting the pattern of multinational activity (11. Kalina et al., 2015), impeding patenting profiles and inefficiently delaying the start of in-house R&D activities (12. Giuseppe Scellato, 2006), resulting in low cash holdings due to persistently low cash flows and costly external financing (14. Denis and Sibilkov, 2009), heavily influencing capital structure choice (15. Korajczyk and Levy, 2003). Meanwhile, a sudden negative shock to borrowing conditions can generate a large and persistent economic recession (16. Khan and Thomas, 2013). 17. Khwaja and Mian (2008) point out that the impacts of sudden credit shocks are always underestimated. Small firms face larger drops in overall borrowing and increased financial distress. Monetary shocks can further combine with financial constraints to deteriorate a firm's performance. 18. Basistha and Kurov (2008) find that firms facing financial constraints are more affected by monetary shocks in tight credit conditions than relatively unconstrained firms.

Capital market imperfections are believed to be very present in China. By law, the largest Chinese banks, which were predominantly state banks, were, until 1998, instructed not to lend to private

[1] The result is from Wind Economic Database.
[2] As shown in the People's Bank of China's Data, the central bank had raised the Required Reserve Ratio ten times in 2007, from 9.0% to 14.5%.

firms (10. S Poncet et al., 2010). Firms, especially small or micro firms, do not have many choices from which to obtain funding. State-owned banks tend to lend money to state-owned enterprises or large firms with sufficient capital. Government connections play an important role in explaining Chinese firms' financing conditions and provide further evidence on the nature of the misallocation of credit by China's dominant state-owned banks (13. Cull, Robert, et al., 2015). 20. Jia, Chunxin (2009) finds that there was a high level of prudence in China's banking sector. Under this circumstance, firms in China face high financial strain. Smaller firms are even hit harder by tightening monetary policies and are unable to increase short-term borrowing in the wake of monetary tightening (21. Koivu, Tuuli (2009). This leads to the cautiousness of the government in tightening monetary policy since they have to balance between facing either high debt risk or a large collapse of firms, especially private and small business.

There is no exact method being most efficient to measure the financial constraint levels of firms. In order to measure the impacts of financial constraints on firms, different papers adopt different standards and methods. 5. Campello et al. (2010) adopt a survey based method to measure the financial constraints of firms based on the pressure of the CFOs. 11. Kalina et al. (2015) use a series of indexes such as external finance dependence, inventories ratio, asset tangibility, and trade credit intensity. 14. Denis and Sibilkov (2009) also use a battery of indicators such as payout ratio, firm size, bond ratings, and paper ratings. 16. Khan and Thomas (2013) model the financial shocks or market imperfections by collateralized borrowing and partial investment irreversibility. Meanwhile, Khwaja and Mian (2008) test a specific event named the 1998 Liquidity Crunch in Pakistan. In those empirical research, OLS is the most common method where the financial constraints are set as the independent variable[3].

In this paper, we investigate whether the credit crunch from 2007 had impacts on firm survival, and if so, how large were the impacts. By using the Difference in Difference (DID) model, we distinguish the change in the survival rate after the implementation of the policy. We find that this policy significantly increased the exit rate of the firms, acting as a role of increasing financial constraints. The year when the policy was enacted saw a 0.3% to 0.5% increment in the exit rate, and this effect would continue to influence firms for the next three years. We find the "Credit Squeeze" policy significantly diminished the TFP and ROA of firms and diminished the coverage ratio and increased the debt cost, which further contributed to the financing constraints.

Our paper complements existing studies by adopting more detailed firm-level data to explore the mechanism behind the impacts. In order to test what the exact impacts on firms were, we introduce a battery of measurements of financial constraints. We find that the "Credit Squeeze" policy worsened the financial constraint situation for firms. Although firms report many obstacles to growth, not all the obstacles are equally constraining due to factors like size, ownership form, and credit rating and others. (6. Meghana Ayyagari et al., 2008). We firstly consider ownership, which is one of the most important factors impacting firms' operations. The results show that the credit squeeze had no significant influence on State Owned Enterprises (SOEs), while Private Owned Enterprises (POEs) and Foreign Owned Enterprises (FOEs) displayed the contrary. We discover that the sudden credit crunch could lower firms' productivity, profitability, and ability to

[3] Probit model is adopted when patents are the dependent variable (e.g. 12. Giuseppe Scellato, 2006).

repay debt and increase the firms' financial costs. We also find that POEs and FOEs mainly adjusted cash flow and working capital to surmount credit crunch problems. In addition, we consider regional differences, as the "Credit Squeeze" policy enlarged the cost dramatically in the developing regions.

2. Model and specifications

The DID model has long been regarded as an efficient way to test the effects of policies (34. Jonathan and West, 2016; 35. Delgado and Florax, 2015). To make our DID estimation more accurate, we need to answer two questions. One is experiment design, that is, how to design the treated standards. We should identify which kinds of firms were strongly affected by the "Credit Squeeze" policy and then estimate our results. As the "Credit Squeeze" policy aimed at short-term bank loans beginning in 2007, the firms who benefited more from short-term loans before the reformation would be affected more heavily by the policy. The other question is how to accurately identify the "Credit Squeeze" policy, as it is the key analysis in this study. According to Vig (2013) and Campello and Larrain (2015), the 3-year-average or 5-year-average of the key variable before the policy shock is suggested to identify the treated and controlled group. We use the 5-year-average of the before "Credit Squeeze" policy period (2002-2006) to identify the treated effect. First, we calculate each firm's average ratio of short-term bank loans over total assets and then obtain the mean ratio of all the firms in each year. If a firm's average ratio is over the mean ratio, this firm is strongly affected by short-term bank loans and recognized in the treatment group ($Treated_{i,t}$ =1), or else, we recognize the firm into the control group ($Treated_{i,t}$ =0).

In order to identify the casual relationship between the "Credit Squeeze" policy and firm survival behavior, we set our DID model as below:

$$Death\ rate_{i,t+1} = \alpha_0 + \beta_1 * Time_{i,t} + \beta_2 * Treated_{i,t} + \beta_3 * Time_{i,t} * Treated_{i,t} + \beta_4 X_{i,t} + \varepsilon_{i,t}, \quad (1)$$

where $Time_{it}$ measures the "Credit Squeeze" policy's exogenous shock, and a dummy variable that defines before and after the policy shock is used. The law stipulated that when firms take out new loans to repay due loans, the new loans are classified as nonperforming loans for commercial banks. Prior to 2007, loans used to repay due loans were treated as normal debt; therefore, the variable is set as 1 if year is after or equal to 2007; otherwise, it is 0. $Treated_{it}$ is also a dummy variable to account for whether the firm was involved (regulated) in the exogenous "Credit Squeeze" policy shock or not. In addition, X_{it} are control variables that determine firm survival from existed studies, including a firm's sales growth, which is used to capture growth potential and opportunity. Firm size is measured by the logarithm of total real assets. Larger firms are more likely to solve the information asymmetry problem, and the potential market risk is lower to them. The age and square of age are used because firms with an established track record have had financial downturns and withstood previous shocks in the market. Older firms can, therefore, have a higher survival rate. In addition, we also control the potential nonleaker impact of age on the survival rate. The Herfindahl-Hirschman Index (HHI) is used to account for the market power and industry-level characteristics. Year and industry fixed effects are controlled in our estimations.

3. Data and descriptive statistics

3.1 Data

We employ an extensive firm-level dataset on Chinese manufacturing firms spanning the 2002-2011 period, which will be called the NBS database hereafter. We observe annual firm-level data for "above-scale" industrial firms, also known as firms above designated size.

The dataset covers ten years (five years for both before and after the policy). Firms without complete records for our main regression variables were omitted. Due to data restrictions, we discarded observations with negative sales, total negative assets minus total fixed assets, total negative assets minus liquid assets, and negative accumulated depreciation minus current depreciation. To control the potential influence of outliers, we winsorized the variables with a fraction of one percent at each tail of the regressors (23. Guariglia et al., 2011). 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 considered (23. Brandt et al., 2012). After the process, our unbalanced panel covers 300,000 firms, corresponding to over 3,000,000 total observations.

The dataset favors our research in three aspects. First, the NBS database has a large number of samples, including both listed and non-listed enterprises. These firms have different ownership forms including SOE, FOE and POE; therefore, our database is more comprehensive, and large samples can decrease the probability of biased estimations. Second, for any analysis of firm dynamics, it is important to take into account a firm's founding year and size. Our sample contains long period panel data, making our results more reliable and efficient from a dynamic perspective. Third, the samples in our dataset contain broad variables, including a few financial characteristics that we can use to calculate financial constraint levels and capital for daily operations; thus, more mechanisms can be tested, which helps overcome the omitted variables problem.

3.2 Descriptive statistics

Table 1 displays the descriptive statistics of our key variables, where columns 1-5 show the information for the whole sample and columns 6-8 are for firms with different ownership. The average exit rate of Chinese manufacturing firms is approximately 13.4% by year, and Privately-Owned Enterprises (POEs) have the highest exit rate (0.209). Our data also shows that 48.5% of manufacturing sector firms are significantly affected by the "Credit Squeeze" policy, particularly in POEs (0.494). Regarding firm performance variables, the average Total Factor Productivity (TFP) measured by OP is 3.893, where the highest is in POEs (3.958), and the lowest is SOEs (3.091). The average growth rate for our samples was 0.288, and the private group had the highest sales growth (0.307), whereas the SOE group had the lowest (0.170). The profitability measured by ROA was 0.083. SOEs displayed the lowest ROA (0.015), which was only 1/6 of the private firms (0.091). Innovation measured by new products was 0.015, and the average age and size were 10.050 and 1.974, respectively. Regarding financial intermediations, we find POEs had the highest cash flow (0.153). FOEs owned the highest working capital (0.101), and SOEs were

lowest (0.054 and -0.042). Meanwhile, the SOEs had the highest short-term and long-term bank loans (0.507 and 0.104). We use the Coverage Ratio (CR), SA index, Investment Cash Flow Sensitivity (CFSI), and WW index to measure financial constraints, and all the information shows that POEs were suffering heavily from financial constraints, but SOEs suffered the least. Finally, the HHI was highest for SOEs at 0.018. Differences in all the variables between the above sub-samples were statistically significant across all ownerships.

Table 1. Summary Statistics

Variable	Obs.	Mean	Std.Dev.	Min.	Max.	SOE	POE	FOE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Exit	3,000,151	0.134	0.340	0	1	0.168	0.209***	0.140***
Treated	3,000,151	0.485	0.500	0	1	0.468	0.494***	0.458***
LnTFP	3,000,151	3.893	0.896	2.248	5.570	3.091	3.958***	3.942***
Sales Growth	2,246,980	0.288	0.557	-0.442	1.858	0.170	0.307***	0.248***
ROA	3,000,151	0.083	0.129	-0.057	0.460	0.015	0.091***	0.082***
Firm Size	3,000,151	10.050	1.338	7.932	12.78	10.550	9.959***	10.110***
Firm Age	3,000,151	1.974	0.721	0.693	3.332	2.098	1.906***	1.974***
New Product	1,703,638	0.015	0.053	0	0.228	0.016	0.015***	0.016***
Cash Flow	3,000,151	0.138	0.168	-0.030	0.630	0.053	0.153***	0.106***
Working Capital	3,000,151	0.072	0.276	-0.464	0.579	-0.042	0.068***	0.101***
Long-term Loan	3,000,151	0.042	0.089	0	0.323	0.104	0.040***	0.033***
Short-term Loan	3,000,151	0.501	0.269	0.056	0.947	0.507	0.504***	0.489***
CR	3,000,151	14.070	36.260	-35	136.1	4.399	14.760***	14.800***
SA Index	3,000,151	-3.062	0.210	-3.254	-2.483	-2.977	-3.075***	-3.054***
CFSI	3,000,151	0.007	0.081	-0.179	0.205	0.001	0.011***	0.007***
WW Index	3,000,151	0.443	0.071	0.328	0.588	0.448	0.453***	0.442***
HHI Index	3,000,151	0.013	0.014	0.001	0.054	0.018	0.012***	0.012*

4. Empirical results

4.1 Baseline results

The estimation results of Equation (1) are shown by Table 2. It presents the effect of the "Credit Squeeze" policy on firm exit using the logit with random firm effects. Columns 1-3 show the estimations without control variables, and columns 4-6 present the regression results with control variables. We find the "Credit Squeeze" policy had a positive and significant impact on firms' death rate, whether the year and industry level fixed effects are controlled or not. We focus on the Time*Treated variable because it shows the actual effect of the credit policy shock on firm exit. Keeping all control variables constant and controlling the fixed effects, the coefficient of Time*Treated is 0.010, and the marginal effect of the "Credit Squeeze" policy on firm's exit rate is 0.002 for our samples. In addition, columns 3 and 6 further check the estimations from the "Credit Squeeze" policy year up to three years after regulating the loan supply for the firms. Our results show that the impact lasted for two years after rollover of the policy. With respect to our control variables, we find firm growth can significantly decrease the exit rate, big sized firms slowly exit from the market, and there is a U-shaped relationship between the firm age and exit rate. Finally,

the firms in highly intensive industries were more likely to exit the market.

Table 2. Baseline Results Between the Credit Squeeze Policy and Firm Exit

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Dependent variable Exit (=1: firm die; =0: firm survive)					
Time	0.264***	0.246***	-0.086***	0.837***	0.413***	0.369***
	(0.005)	(0.011)	(0.004)	(0.038)	(0.038)	(0.038)
Treated	0.085***	0.076***	0.031***	0.025***	0.034***	-0.029***
	(0.006)	(0.006)	(0.008)	(0.005)	(0.005)	(0.002)
Time*Treated	0.024***	0.032***	0.056***	0.016***	0.010***	0.014***
	(0.007)	(0.007)	(0.000)	(0.004)	(0.002)	(0.002)
One Year			0.099***			0.076***
			(0.000)			(0.000)
Two Year			0.110***			0.105***
			(0.008)			(0.004)
Three Year			-0.086***			-0.064***
			(0.000)			(0.002)
Sales Growth				-0.693***	-0.630***	-0.678***
				(0.101)	(0.143)	(0.000)
Firm Size				-0.595***	-0.513***	-0.586***
				(0.092)	(0.054)	(0.042)
Firm Age2				0.187***	0.193***	0.239***
				(0.061)	(0.049)	(0.019)
Firm Age				-0.673***	-0.692***	-0.883***
				(0.206)	(0.192)	(0.081)
HHI-Index				6.531***	4.422***	3.718***
				(0.731)	(0.236)	(0.598)
Constant	-2.084***	-1.762***	-2.354***	3.969***	3.293***	4.162***
	(0.004)	(0.020)	(0.004)	(0.695)	(0.329)	(0.491)
Year Dummy	No	Yes	Yes	No	Yes	Yes
Industry Dummy	No	Yes	Yes	No	Yes	Yes
Marginal Effect	0.005	0.005		0.003	0.002	
Log Pseudo-likelihood	-1,177,578	-1,037,681	-276,879	-788,291	-702,378	-233,108
Observations	2,246,980	2,246,980	2,246,980	2,246,980	2,246,980	2,246,980

4.2 Further investigation on the DID test

4.2.1 Financial constraints link

We incorporate financial constraint variables into Equation (1) to test whether the "Credit Squeeze" policy increased firms' exit rate through financial constraints. As discussed in previous studies, several reasons were proven for the causal effect between financial constraints on firm exit behavior. First, informational asymmetries between firms and outside lenders tend to increase the potential risk for financially constrained firms; therefore, these firms were charged a higher interest rate or could not extend credit (Clarke et al., 2012). As a result, the "Credit Squeeze"

policy would further constrained firms financially, making it more difficult to survive. Second, financial constraints make firms more vulnerable to sudden suspensions in funding or outside shocks. Less financially constrained firms are more likely to extend bank loans than highly financially constrained firms (Beck et al., 2008); therefore, the policy shock might increase the exit rate on this point. Our hypothesis is that the "Credit Squeeze" policy increased firms' exit rate through a financial constraints proxy.

$$Death\ rate_{i,t+1} = \alpha_0 + \beta_1 * Time_{i,t} + \beta_2 * Treated_{i,t} + \beta_3 * Time_{i,t} * Treated_{i,t} + \beta_4 * Time_{i,t} * Treated_{i,t} * FC_{i,t} + X_{i,t} + \varepsilon_{i,t}. \quad (2)$$

Table 3 shows the estimation results of Equation (2). We use several proxies to measure financial constraints, including the ICFS index (FHP, 1988; 2000), WW index (Whited and Wu, 2006), SA index (Hadlock and Pierce, 2010), and liquidity. Columns 1-4 indicate that all the interactors of financial constraint proxies positively and significantly increased the exit rate. Our findings show that when firms were involved in the "Credit Squeeze" policy, they were more likely to be financially constrained, their performance in investment behavior was internally relied on, their financing environment worsened as measured by the financial constraints index, or their liquidity showed a higher constrained level. This resulted in firms having a high exit rate.

Table 3. Financial constraints mechanism check

	(1)	(2)	(3)	(4)
VARIABLES	Dependent variable Exit (=1: firm die; =0: firm survive)			
Time	0.837***	0.938***	0.109**	0.437***
	(0.007)	(0.034)	(0.052)	(0.013)
Treated	0.025***	0.024***	0.017***	0.045***
	(0.007)	(0.001)	(0.000)	(0.007)
Time*Treated	0.014	-0.792	-0.014	-0.016
	(0.009)	(0.485)	(0.009)	(0.010)
Time*Treated*ICFS	0.214***			
	(0.048)			
Time*Treated*WW		1.898*		
		(1.138)		
Time*Treated*SA			0.025***	
			(0.004)	
Time*Treated*Liquidity				0.031***
				(0.008)
Sales Growth	-0.693***	-0.717***	-0.609***	-0.640***
	(0.006)	(0.048)	(0.008)	(0.005)
Firm Size	-0.595***	-0.613***	-0.519***	-0.528***
	(0.002)	(0.062)	(0.021)	(0.002)
Firm Age^2	0.188***	0.194***	0.193***	0.180***
	(0.004)	(0.017)	(0.010)	(0.004)
Firm Age	-0.674***	-0.703***	-0.692***	-0.637***

	(0.017)	(0.062)	(0.041)	(0.018)
HHI-Index	6.532***	5.895***	4.712***	3.127***
	(0.144)	(0.128)	(0.127)	(0.177)
Constant	3.972***	4.180***	3.852***	3.509***
	(0.024)	(0.529)	(0.165)	(0.035)
Year Dummy	Yes	Yes	Yes	Yes
Industry Dummy	Yes	Yes	Yes	Yes
Log Pseudo-likelihood	-788279	-742473	-655544	-696707
Observations	2,246,980	2,246,980	2,246,980	2,246,980

4.2.2 Firm survival mechanisms check-firm performance

How firm performance influences firm survival has been widely discussed in previous studies. Firm performance, including firm productivity and firm profitability, show that high productivity firms can decrease production costs and gain market power compared with potential competitors. They are, thus, more likely to survive in the market. Moreover, high profitability firms are generally associated with more cash flow and have a high tolerance ability to withstand outside shocks; therefore, they can have a high likelihood to survive (Liu and Li, 2015). Additionally, costs of financing can cause financial constraints. Previous studies demonstrate that financing cost plays an essential role in firms exiting from the market (Cowling and Mitchell, 2003). Non-financially constrained firms with good external lenders (e.g., equity market, bank) can face less investment risk and cost of accessing the paper market thereby providing a feasible option to meet firms' external funding requirements. When the banks tighten the supplying of bank loans, the financing environment might be curbed suddenly. Financial constraints restrict the investment activities and decrease the financing needs in the producing and sales process, hurting the firm's payback ability. Thus, low productivity and profitability firms are more likely to exit from the market, and some firms are not able to pay back the debt on time and die. On the other hand, the decreasing of bank loans will increase the financing costs, and firms that cannot afford the high financing cost will also have a high exit rate. We, therefore, propose the hypothesis that the "Credit Squeeze" policy increased the exit rate because of hurting firms' productivity, profitability, and payback ability and increasing the financing cost.

Table 4 shows the estimation results following our hypotheses. We use TFP and ROA to measure firm productivity and profitability and find the "Credit Squeeze" policy decreased the TFP and ROA significantly (columns 1-2). The payback ability and financing costs are measured by coverage ratio and per debt cost. Our results show that the "Credit Squeeze" policy lowered the coverage ratio and increased the debt cost, which further contributed to the financing constraints and making it more difficult for firms to survive.

Table 4. Firm performance mechanisms check

	(1)	(2)	(3)	(4)
VARIABLES	LnTFP^{OP}	ROA	Coverage Ratio	Financing Cost

Time	0.861***	0.095***	20.939***	0.003***
	(0.003)	(0.000)	(0.164)	(0.000)
Treated	0.090***	-0.047***	-6.090***	0.002***
	(0.002)	(0.000)	(0.079)	(0.000)
Time*Treated	-0.056***	-0.022***	-6.114***	0.001***
	(0.002)	(0.000)	(0.112)	(0.000)
Sales Growth	0.382***	0.050***	6.024***	0.002***
	(0.001)	(0.000)	(0.059)	(0.000)
Firm Size	-0.071***	-0.017***	-1.054***	-0.000***
	(0.000)	(0.000)	(0.023)	(0.000)
Firm Age^2	-0.162***	-0.010***	-0.853***	-0.001***
	(0.001)	(0.000)	(0.053)	(0.000)
Firm Age	0.677***	0.036***	2.120***	0.003***
	(0.004)	(0.001)	(0.235)	(0.000)
HHI-Index	0.897***	0.005	-1.755	-0.021***
	(0.044)	(0.006)	(2.264)	(0.001)
Constant	3.175***	0.236***	23.295***	0.016***
	(0.009)	(0.001)	(0.481)	(0.000)
Year Dummy	Yes	Yes	Yes	Yes
Industry Dummy	Yes	Yes	Yes	Yes
Observations	2,246,980	2,246,980	2,246,980	2,246,980
R-squared	0.236	0.193	0.065	0.040

4.2.3 Firm survival mechanisms check-institution environment

Macro factors, such as institutional development or marketization, influence firms' survival significantly. A well-developed institution and market can mitigate informational asymmetries and increase external financing for financially constrained firms (Beck et al., 2008). Therefore, when the "Credit Squeeze" policy shocked the firms in developing regions, the financially constrained firms might try to access bank loans by obtaining connections and relationships with government and bank officials. Entertainment and Travelling Cost (ETC) is widely used in the literature to measure corruption or rent-seeking because ECT is a mix that includes "grease money" to access government services, "protection money" to lower tax rates, managerial excesses, and normal business expenditures to build relational capital with suppliers (Xu et al., 2017). We use the variable ETC from the 2005 World Bank Survey as the measure of institutional quality in our study. We also employ another variable—the days a firm spent on government assignments and communications to measure the rent-seeking. Moreover, the tax cost is also introduced in our analysis to measure the direct government cost on the firms, to test whether the tax cost in developing regions can affect firms exiting or not. Thus, we propose the hypothesis that firms' exit rate was driven by rent-seeking costs, and this effect was more serious in developing regions.

Table 5 gives the DID estimation results regressed by the OLS model with fixed year and industry

level results. We divide our results into two groups by the NERI index[4] (Fan et al., 2011). We find that the "Credit Squeeze" policy increased costs sharply in the developing regions when firms tried to access outside support to alleviate financial constraints (columns 2, 4 and 6).

Table 5. Firm cost mechanisms check

	(1)	(2)	(3)	(4)	(5)	(6)
	Developed	Developing	Developed	Developing	Developed	Developing
VARIABLES	Communication cost		ECT		Tax cost	
Time	1.048***	0.657***	-0.154***	0.998***	-0.190***	0.015
	(0.010)	(0.009)	(0.016)	(0.009)	(0.015)	(0.019)
Treated	-0.043***	0.073***	0.104***	-0.104***	0.065***	-0.006
	(0.012)	(0.009)	(0.008)	(0.010)	(0.007)	(0.008)
Time*Treated	0.025*	0.054***	0.014	0.117***	0.047***	0.072***
	(0.014)	(0.012)	(0.011)	(0.012)	(0.009)	(0.010)
Sales Growth	-0.637***	-0.772***	-0.527***	-0.819***	-0.516***	-0.775***
	(0.007)	(0.009)	(0.008)	(0.008)	(0.007)	(0.009)
Firm Size	-0.627***	-0.562***	-0.460***	-0.634***	-0.460***	-0.624***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Firm Age^2	0.166***	0.189***	0.218***	0.123***	0.162***	0.181***
	(0.006)	(0.005)	(0.006)	(0.006)	(0.006)	(0.007)
Firm Age	-0.637***	-0.649***	-0.774***	-0.419***	-0.590***	-0.600***
	(0.024)	(0.024)	(0.026)	(0.024)	(0.024)	(0.029)
HHI-Index	6.969***	6.021***	3.985***	5.788***	3.642***	2.916***
	(0.204)	(0.203)	(0.276)	(0.197)	(0.260)	(0.267)
Constant	4.156***	3.688***	3.341***	4.103***	3.288***	4.970***
	(0.035)	(0.034)	(0.050)	(0.034)	(0.047)	(0.057)
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Log Pseudo-likelihood	-399,332	-387,655	-287,876	-437,304	-401,729	-384,126
Observations	2,246,980	2,246,980	2,246,980	2,246,980	2,246,980	2,246,980

4.2.4 Firm survival mechanisms check - working capital management ability

Working capital is generally used as an additional financing source to smooth the external financial shocks and alleviate financial constraints. When firms have limited to access external

[4] The NERI Index captures the following five aspects of the institutional environment in China: (1) government decentralization, (2) development of non-state sectors, (3) development of product markets, (4) production factor markets and (5) market intermediaries and the legal environment. Each of these five sub-indices has at least two sub-items to reflect each of the dimensions better. Each of these sub-indices has a score ranging from 0 to 10, calculated based on the statistics of the government authorities and the authors' surveys. Excluding Hong Kong, Macau and Taiwan, China has 31 provinces, municipalities, and autonomous regions. Therefore, all the manufacturing firms are classified into two groups according to their institutional and marketization development level, measured by the NERI Index. We consider firms with scores above (below) the sample median to be less (more) likely to be in developed regions.

bank loans, they need to rely on cash flow and trade credit to finance their activities. Working capital management is particularly important in the Chinese study. In line with this argument, evidence has proven that effective working capital management has significantly contributed to alleviating the effects of the financial crisis for Chinese firms in 2008 (KPMG China, 2011). Working capital can be used to buffer fixed capital investment (Fazzari and Petersen, 1993), cash flow (Chen and Guariglia, 2013), and R&D investment (Guariglia and Liu, 2014) from temporary changes in the availability of finance. When firms experience the "Credit Squeeze" policy shock, they can use working capital to replenish cash flow and alleviate the financial shock due to its low adjustment costs. Therefore, we try to test the hypothesis that the "Credit Squeeze" policy increased the efficiency of working capital management to help the firm survive.

Following Ding et al. (2013), we introduce four working capital management measurements in our analysis, including the days payable outstanding ratio (DPO), the days sales outstanding ratio (DSO), the inventory turnover ratio (ITO), and the cash conversion cycle (CCC). Specifically, a higher DPO ratio indicates that the company gets better terms from its suppliers, which is beneficial. However, a higher DSO indicates that the working capital management is inefficient, as it takes longer to collect its payments. The ITO indicates how many times the firm can rotate its inventories into sales in a year. A high inventory turnover ratio is a good sign for the firm: it suggests that few products are sitting idle on shelves. CCC combines the cycles of inventories, accounts receivable, and accounts payable. The lower the CCC, the more efficiently the firm can manage its working capital.

Table 6 shows the regression results on the relationship between the "Credit Squeeze" policy and working capital management. We find working capital management efficiency increased due to the "Credit Squeeze" policy shock. The "Credit Squeeze" policy increased the DPO and ITO (columns 1 and 3), and it decreased the DSO and CCC (columns 2 and 4), which indicates that firms tried to survive and smooth their financing environment through efficiently managing their working capital. They used accounts payable and accounts receivable to extend credit, and inventories and cash conversion cycles were used to liquidate internal finance to overcome the survival risk caused by the "Credit Squeeze" shock.

Table 6. Firms' working capital management efficiency mechanisms check

	(1)	(2)	(3)	(4)
VARIABLES	DPO	DSO	ITO	CCC
Time	-13.243***	-9.751***	11.717***	-13.298***
	(0.190)	(0.088)	(0.124)	(0.136)
Treated	29.281***	14.995***	-13.463***	0.095
	(0.091)	(0.119)	(0.108)	(0.182)
Time*Treated	6.197***	-0.716***	2.798***	-1.413***
	(0.121)	(0.137)	(0.149)	(0.210)
Sales Growth	-15.408***	-17.877***	16.873***	-26.223***
	(0.074)	(0.064)	(0.121)	(0.100)
Firm Size	9.921***	6.856***	-7.690***	9.274***
	(0.033)	(0.029)	(0.043)	(0.045)

Firm Age^2	2.205***	-0.505***	1.345***	1.943***
	(0.080)	(0.072)	(0.145)	(0.114)
Firm Age	-9.161***	8.425***	-9.125***	2.509***
	(0.328)	(0.292)	(0.688)	(0.465)
HHI-Index	50.579***	25.933***	-60.631***	29.032***
	(3.375)	(2.825)	(3.775)	(4.522)
Constant	-53.390***	-30.116***	121.220***	-30.562***
	(0.620)	(0.393)	(0.900)	(0.615)
Year Dummy	Yes	Yes	Yes	Yes
Industry Dummy	Yes	Yes	Yes	Yes
Observations	2,246,980	2,246,980	2,246,980	2,246,980
R-squared	0.173	0.092	0.071	0.072

4.2.3 Ownership heterogeneity and survival mechanisms

In line with previous studies (e.g., Bai et al., 2006; Zhang and Liu, 2017), Chinese firms in different owner sectors perform differently in accessing financial resources. Because of a lacking efficient financial system, the poor protection of private property, and an information asymmetry problem, the private and foreign firms are discriminated against in accessing bank loans in developing and transitional economies, and Chinese POEs also suffer from this trouble (Brandt and Li, 2003; Bai et al., 2006). In addition, state-owned banks continue to supply bank loans to maintain inefficient SOEs, as these firms can help provide social stability; therefore, some SOEs in China are soft budgeted (Bai et al., 2000; Bai et al., 2006). To further understand how the "Credit Squeeze" shock increased the exit rate through financial constraints, we propose the hypothesis that the "Credit Squeeze" policy may not have significantly decreased both short-term and long-term bank loans for SOEs but significantly decreased both the bank loans for POEs and FOEs.

To investigate the bank loans decreasing mechanism across ownerships, we divide our samples into three groups, and we recognize firms as SOEs if state-owned shareholders were over 50%. We use OLS to estimate our results, and table 7 gives the regression results. We find that the "Credit Squeeze" policy significantly restricted the bank credits for POEs and FOEs but not for SOEs, which is consistent with our previous hypothesis. The findings illustrate that the policy curbed the bank loans to the POEs and FOEs and made the financial constraints stronger; thus, firms were more likely to die due to this credit shock effect. However, the coefficients of Time*Treated are insignificant, which means the "Credit Squeeze" policy did not significantly reduce the SOEs' survival rate.

Table 7. Policy shock on bank loans credit across ownerships

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Dependent var.=short-term bank loans			Dependent var.=long-term bank loans		
	State	Private	Foreign	State	Private	Foreign
Time	0.010	0.084***	0.166***	0.019	0.096***	0.086***

	(0.026)	(0.003)	(0.005)	(0.053)	(0.007)	(0.016)
Treated	0.230	-0.223***	0.522***	-0.273*	-0.252***	-0.223***
	(0.062)	(0.002)	(0.002)	(0.039)	(0.005)	(0.011)
Time*Treated	-0.071	-0.022***	-0.632***	0.018	-0.074***	-0.069***
	(0.076)	(0.003)	(0.002)	(0.003)	(0.006)	(0.012)
Sales Growth	0.262	0.271***	0.276***	0.113	0.106***	0.114***
	(0.042)	(0.001)	(0.002)	(0.034)	(0.003)	(0.005)
Firm Size	0.042*	0.065***	0.050***	0.079**	0.094***	0.093***
	(0.004)	(0.000)	(0.001)	(0.005)	(0.001)	(0.002)
Firm Age^2	0.020	0.001	0.012***	0.023	0.006**	0.034***
	(0.013)	(0.001)	(0.002)	(0.009)	(0.003)	(0.005)
Firm Age	-0.181	-0.105***	-0.143***	-0.065	0.012	-0.104***
	(0.085)	(0.005)	(0.008)	(0.076)	(0.012)	(0.021)
HHI-Index	-0.159	-0.371***	-0.446***	0.748	0.197	0.335*
	(0.111)	(0.047)	(0.065)	(0.273)	(0.120)	(0.189)
Constant	-0.035	-0.245***	-0.287***	-0.766	-0.989***	-1.032***
	(0.126)	(0.010)	(0.016)	(0.156)	(0.023)	(0.039)
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	414,474	1,666,016	770,163	414,474	1,666,016	770,163
R-squared	0.075	0.087	0.176	0.040	0.048	0.042

Furthermore, it is important to explore firms' coping strategy and how they survived in the market after the shock of the "Credit Squeeze" policy, particularly for the POEs and FOEs. Previous literature demonstrates that financially constrained firms use internal financing or working capital to alleviate financial constraints to smooth their investment activities, particularly in POEs and FOEs (e.g., Poncet et al., 2010; Chen and Guariglia, 2013; Zhang and Liu, 2017). In addition, Hale and Long (2011) demonstrate that working capital management ability contributes to the spectacular growth characterizing Chinese private firms, as they manage accounts receivable more efficiently than other types of firms. Thus, for firms suffering from financial constraints, the non-SOEs utilize internal financing, cash flow, and working capital, to smooth their fixed assets and R&D investments (Ding et al., 2013; Guariglia and Liu, 2014) and increase firm profitability and TFP to survive in the market (Chen and Guariglia, 2013; Zhang, 2017). However, these financing tunnels are insignificant for SOEs in China; therefore, we try to test the hypothesis that the POEs and FOEs used cash flow and working capital to decrease the "Credit Squeeze" policy shock effect and increase these firms' survival rate.

Table 8 shows the regression results of firms' survival mechanisms across different types of ownership. Columns 1-3 demonstrate the cash flow as a proxy to alleviate the financial shock and increase the survival rate for POEs and FOEs, but it did not work on SOEs. Moreover, we find POEs and FOEs also used working capital to manage financial resources and helped firms to overcome the financial shock, decreasing the exit rate. Our results align with the previous findings that cash flow and working capital were used as the alternative financial intermediations to finance firms for POEs and FOEs. Our estimations also reveal that SOEs did not use these financial

intermediations to ease the financial shock and help the firms survive (Chen and Guariglia, 2013; Ding et al., 2013; Zhang, 2017). This indicates that, actually, the survival of SOEs during the credit crunch was a reflection of SOEs in a long term being endorsed by the government, regardless of their own efficiency in operation. This is a typical zombie firm phenomenon, which has been substantiated in more than one study (e.g. 36. Tan et al., 2016; 37. Huang et al., 2017)

Table 8. Firm survive mechanisms across ownerships

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	State	Private	Foreign	State	Private	Foreign
Time	0.295***	0.069***	0.572***	0.218***	0.527***	0.212***
	(0.032)	(0.010)	(0.039)	(0.081)	(0.017)	(0.032)
Treated	0.181***	-0.077***	0.214***	0.057***	-0.057***	0.047***
	(0.001)	(0.009)	(0.021)	(0.021)	(0.010)	(0.008)
Time*Treated	0.041	0.194***	0.010	0.007	0.078***	0.022**
	(0.111)	(0.015)	(0.036)	(0.012)	(0.011)	(0.009)
Time*Treated*Cash Flow	-1.214	-0.922***	-1.313***			
	(0.745)	(0.052)	(0.214)			
Time*Treated*Working Capital				-0.267	-0.231***	-0.261***
				(0.176)	(0.018)	(0.021)
Sales Growth	-0.644***	-0.647***	-1.067***	-0.546***	-0.605***	-0.583***
	(0.011)	(0.010)	(0.031)	(0.024)	(0.006)	(0.007)
Firm Size	-0.447***	-0.443***	-0.597***	-0.648***	-0.553***	-0.684***
	(0.004)	(0.003)	(0.008)	(0.035)	(0.002)	(0.003)
Firm Age^2	0.020***	0.129***	0.290***	0.144***	0.142***	0.168***
	(0.006)	(0.006)	(0.021)	(0.008)	(0.005)	(0.007)
Firm Age	-0.042	-0.526***	-0.980***	-0.493***	-0.522***	-0.564***
	(0.027)	(0.027)	(0.087)	(0.020)	(0.020)	(0.029)
HHI-Index	0.333	8.761***	4.494***	0.711***	3.049***	1.448***
	(0.475)	(0.225)	(0.615)	(0.194)	(0.202)	(0.279)
Constant	2.448***	2.406***	4.466***	5.226***	3.594***	5.260***
	(0.069)	(0.040)	(0.184)	(0.268)	(0.040)	(0.060)
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Log pseudolikelihood	414,474	1,666,016	770,163	-288,563	-552,666	-301,497
Observations	414,474	1,666,016	770,163	414,474	1,666,016	770,163

5. Robustness test

In this section, we employ survival models to check the impacts of the “Credit Squeeze” policy in view of the hazard rate. Based on the proportional hazards model, we extend the survival function to discrete time. We then proceed with the model in terms of the conditional probability. The first one is based on a logit model, which was put forward by 30. Cox (1972). The hazard rate is conditional, which is represented by a series of covariate values. Another alternative extension of the proportional hazard model regarding discrete time is through the complementary log-log

(cloglog) method, which fits the discrete survival data by generating pseudo-observations as before and fitting a generalized linear model with a binomial error structure and complementary log-log link (31. Fernandes and Paunov, 2015). We provide the general Probit model and Weibull Distribution Model as references. Table 9 presents all four regression results.

Table 9. Hazard risk model checks

	(1)	(2)	(3)	(4)
VARIABLES	Probit	Weibull	Cox	clog-log
Time	0.433***	-0.395***	2.486***	0.359***
	(0.003)	(0.008)	(0.000)	(0.011)
Treated	0.015***	0.030***	0.009**	0.031***
	(0.004)	(0.007)	(0.004)	(0.007)
Time*Treated	0.009*	0.029***	0.031***	0.014*
	(0.005)	(0.008)	(0.006)	(0.008)
Sales Growth	-0.333***	-0.555***	-0.452***	-0.573***
	(0.003)	(0.004)	(0.004)	(0.005)
Firm Size	-0.307***	-0.598***	-0.387***	-0.467***
	(0.001)	(0.002)	(0.002)	(0.002)
Firm Age^2	0.105***	0.147***	0.138***	0.163***
	(0.002)	(0.003)	(0.004)	(0.004)
Firm Age	-0.382***	-0.518***	-0.489***	-0.576***
	(0.009)	(0.015)	(0.015)	(0.015)
HHI-Index	3.647***	5.973***	3.371***	3.604***
	(0.079)	(0.130)	(0.137)	(0.133)
Constant	1.946***	6.320***		2.705***
	(0.013)	(0.003)		(0.023)
Log likelihood	-695,555	1,373,327	-3,566,274	-699,709
Observations	2,246,980	2,246,980	2,246,980	2,246,980

The dependent variables in the four regressions above stand for the hazard rate for a firm to survive. In other words, they represent the risk of firms exiting the market. The interaction terms all show significant positive levels. This indicates that the hazard rate of firms exiting the market was significantly intensified by the "Credit Squeeze" policy. Obviously, the higher hazard rate could lead to the higher rate of firms exiting the market; thus, from the perspective of hazard rate, we substantiate our conclusion about the role of the credit squeeze policy again.

Next, we consider another possible existing selection bias problem relevant to the policy and firm characteristics. Even though we found in a previous analysis that the "Credit Squeeze" policy significantly increased the exit rate of firms, we did not distinguish different firm characteristics among our observations. DID regressions based on firms with different characteristics could bias the results (32. Silva, Armando, 2011). Following the method put forward by 33. Heckman et al. (1997), we combine the DID model with matching and use the DID Propensity Score Matching (DID-PSM) model. The DID-PSM model allows us to construct a new group of firms with similar

characteristics[5]. We thus rescale our sample data and show the results in table 10.

Table 10. PSM-DID regression checks

	(1)	(2)	(3)	(4)
VARIABLES	Dependent variable Exit (=1: firm die; =0: firm survive)			
Time	0.249***	0.035**	0.378***	0.463***
	(0.021)	(0.014)	(0.021)	(0.019)
Treated	-0.002	0.035***	-0.007	-0.006
	(0.023)	(0.010)	(0.023)	(0.007)
Time*Treated	0.102***	0.058***	0.092***	0.022***
	(0.030)	(0.000)	(0.030)	(0.001)
One Year		0.100***		0.081***
		(0.001)		(0.000)
Two Year		0.108***		0.099***
		(0.011)		(0.009)
Three Year		0.017*		0.021***
		(0.009)		(0.005)
Sales Growth			-0.890***	-0.696***
			(0.029)	(0.009)
Firm Size			-0.462***	-0.606***
			(0.007)	(0.040)
Firm Age^2			0.173***	0.190***
			(0.019)	(0.008)
Firm Age			-0.504***	-0.677***
			(0.091)	(0.039)
HHI-Index			6.163***	3.135***
			(0.574)	(0.200)
Constant	2.379***	-2.131***	-2.369***	4.196***
	(0.150)	(0.031)	(0.016)	(0.458)
Year Dummy	Yes	Yes	Yes	Yes
Industry Dummy	Yes	Yes	Yes	Yes
	-359,665	-330,986	-340,652	-275,029
Observations	1,110,417	1,110,417	1,110,417	1,110,417

Our new sample, which consists of firms with similar characteristics, has more than 1,000,000 observations in total. The results based on the DID-PSM have the same significance level as our baseline regression results (table 2). Nevertheless, we can see even larger coefficients on our new regressions; thus, the DID regression among similar firms still show that the "Credit Squeeze" policy lowered the chance for firms to survive in the market.

6. Conclusions

[5] The procedure we use to select data based on the estimated propensity score is shown in the Appendix.

This paper explores how large the impacts of the credit crunch that happened in 2007 were on firms' survival in China. We investigate the causal effect of the "Credit Squeeze" policy on the Chinese manufacturing firms' exit rate by adopting a large panel dataset over the period of 2002–2013. We use the DID model to identify the causal effect of the "Credit Squeeze" policy shock and discuss whether ownership structures have an influence on the probability of firms surviving in the market and the ways they alleviated the sharp rise in financial constraints caused by the policy.

We find the "Credit Squeeze" policy had a positive and significant impact on firms' death rate in this "Credit Squeeze" duration, and it acted in the role of increasing financial constraints. We further find the "Credit Squeeze" policy diminished the TFP and ROA of firms significantly, fastened the coverage ratio, and increased the debt cost, which further contributed to the financing constraints making it more difficult for firms to survive. In addition, the "Credit Squeeze" policy dramatically enlarged the costs in the developing regions where firms tried to get access to some outside support to alleviate the financial constraints. Moreover, in order to survive in the market, firms' working capital management efficiency increased after the "Credit Squeeze" shock. Regarding the heterogeneity across different types of ownership, our findings demonstrate that SOEs short-term and long-term bank loans were not significantly reduced by the shock, whereas POEs and FOEs' bank loans were significantly constrained by the "Credit Squeeze" policy. Furthermore, POEs and FOEs utilized the internal financing cash flow and working capital to alleviate financial constraints, which helped to mitigate their exit rate in the market.

A few policy implications can be drawn regarding our findings in this paper. The "Credit Squeeze" policy increased the exit rate of Chinese firms from the market. This exogenous credit shock provides a natural experiment to test which kinds of firms are less able to survive the market. As shown in the analysis, low productivity, low profitability, and high financing cost firms face more difficulties in these situations. Second, this paper provides a suggestion to help firms manage their bank loans efficiently by increasing their working capital or internal financing resources management efficiency. Finally, further financial regulation policies should focus more on the heterogeneities across different types of ownership to increase the policy efficiency.

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Appendix

Appendix. PSM procedure check

			(1)	(2)	(3)	(4)	(5)
VARIABLES	Treated or not		Mean			t-test	
			Treated	Matched	Bias (%)	t-statistics	p.value
Sales Growth	0.112***	Before	0.205	0.187	4.4	23.30	0.000
	(0.005)	After	0.205	0.204	0.3	1.700	0.090
Tangibility	0.199***	Before	0.888	0.884	2.5	12.92	0.000
	(0.014)	After	0.888	0.888	-0.2	-1.180	0.238
Firm Size	-0.026***	Before	9.858	9.935	-5.9	-30.83	0.000
	(0.002)	After	9.858	9.845	0.1	0.690	0.314
Firm Age	0.092***	Before	2.106	2.099	1.0	5.230	0.000
	(0.003)	After	2.106	2.108	-0.4	-1.930	0.053
HHI-Index	-0.287**	Before	0.014	0.015	-1.0	-5.150	0.000
	(0.129)	After	0.014	0.014	0.1	0.640	0.520
TFP	0.019***	Before	6.330	5.617	63.55	63.55	0.000
	(0.000)	After	6.330	6.133	12.1	1.13	0.101
State Dummy	0.307***	Before	0.702	0.637	13.8	72.34	0.000
	(0.005)	After	0.702	0.713	-0.8	-12.30	0.010
Nonstate Dummy	0.083***	Before	0.091	0.105	-4.5	-23.85	0.000
	(0.007)	After	0.091	0.091	0.2	0.900	0.366
Constant	-0.436***						

	(0.023)
Year Dummy	Yes
Industry Dummy	Yes
	-760,965
Observations	1,110,417