Bank monitoring and stock price crash risk: evidence from China

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Abstract

This paper documents the negative relation between credit line and stock price crash risk in a weak-efficiency and bank dominated environment like China. Using data from china's A-share listed firms, we find a significant negative relationship exists between credit line and stock price crash risk. The underlying mechanism analysis demonstrates that the bank monitoring of management, major shareholder's tunneling activities, and financial constraints are the underlying mechanism. In heterogeneous tests, we find vicious competition among banks and preference for SOEs will weaken the monitoring effect of credit line. Finally, we use the first time credit line issuance as an exogenous shock, the PSM-DID test exhibits the same results.

1.Introduction

In recent years, the phenomenon of stock price crashes has been increasingly emphasized by both the theory and the industry. The crash of stock prices will cause not only the wealth destruction of private sectors, but also the disorder of whole capital markets. An important reason we choose Chinese stock markets as research object is that Chinese stock market is a weak efficiency market. It is characterized with severe information asymmetry, weak corporate governance, and frequent extreme crisis (Pan et al., 2011; Xu et al., 2014). In 2015, an extreme stock market crashes arose, selling of investors was relatively indiscriminate, with about half the index constituents falling by their daily limit and the liquidity of market drying up rapidly. In this context, we believe the Chinese market setting is crucial to the study of stock price crashes in weak information environment and the improvement of policy making.

The definition of stock price crashes refers to the fact that stock return deviates significantly from average. Research in this area stems from a discussion of the risk premium required for extreme event sensitive assets (Barro, 2006; Kelly & Jiang, 2014). Recent studies found that the formation of stock price crash risk is caused by not only the random extreme events, but also the interaction of external and internal factors. External factors refer to investors' heterogeneous beliefs. In a classic heterogeneous belief model, Hong and Stein (2001) proposed that the universal existence of short selling restrictions caused the accumulation of stock's negative information. When the negative information accumulated to a certain extent, it will reflect on the stock price rapidly, causing the stock price to crash. Internal factors refer to the corporate governance of agency problems, especially the bad news hoarding activities. From this perspective, we divide the channels of crash risk into two sources. The first source comes from the management of the firm. Considering their personnel reputation, professional life, salary incentives and so on, management of the firm have the motivation to release good and hide bad news (Kothari et al., 2009). The second source comes from tunneling activities of major shareholders, they control the investment and financing activities

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of the firm, the daily operation and decision making powers. Consequently, they have the motivation and ability to tunnel the company for their own interests, damaging the interests of other stakeholders. Both this two sources of bad news hording activities will lead to the accumulation of negative information, when the problems become so serious that management of major shareholders can no longer conceal it, the bad news will be released rapidly. A huge negative impact on financial performance and investor expectations will lead to the crash of stock prices.

In contrast to numerous prior studies which focused on internal and external corporate governance factors, such as over-investment (Benmelech et al., 2010), executive incentives (Kim et al.,2011b), accounting conservatism (Kim and Zhang, 2016) and political connections (Luo et al., 2016), among others, we argue that bank monitoring can reduce listed firms' bad news hoarding activities.

Traditional financial intermediary theory believes that banks is able to reduce the information asymmetry problems of firms because they have lower costs in obtaining private information (Diamond,1984). Similar to the institutional investors and other important external stakeholders, commercial banks have strong motivation to monitor internal management and to prevent them hiding bad news, thus reducing those firms' crash risk. In terms of supervision capability, banks can survey the company's financial situation, implement informed and uninformed investigation, intervene in corporate governance and exchange private information with other stakeholders. Therefore, the effective and perfective commercial banks' regulation can increase information transparency and reduce crash risks. Apart from curbing management bad news hoarding activities, another potential function of banks is monitoring the big shareholders and reducing tunneling activities. This assumption is especially meaningful under Chinese circumstance. As we know, government at all levels own significant share of commercial banks, and banks also have political connections with government. In other words, China's commercial banking system is directly under control of and often takes concerted action with the government. Therefore, banks especially five major state owned banks may take the responsibility of monitoring big shareholders coordinating with the government. Thus, bank monitoring of large shareholder may reduce the concealment activities.

However, some other theories may lead to contradictory conclusion. Fan et al. (2011) argue that political and economic environment of emerging markets differ dramatically from mature market economy. Most intermediary theories are derived under the circumstance of effective markets, thus, direct verification of these theories in emerging market countries sometimes leads to opposite results. Studies like Huang et al. (2012) found that loan announcement of listed firms would lead to a negative reaction of their stock prices, they attributed this anomaly to the political connections between commercial banks and government. Concluded from prior studies, we divide the potential negative relation between bank credit and intensity of monitoring into two reasons.

Firstly, some studies argue that political and ownership problem is essential. Bailey et al. (2011) found that due to the lack of legal regulations and complete law system, Chinese commercial banks don't have complete independence and self-discipline. Numerous banks, especially some small and local banks is attached to the local government. Their loan issuance is mainly invested in state-owned enterprises and lack of further monitoring. Alternatively, because of the implicit government guarantee, commercial banks prefer to issue credit to SOEs. Thus, the effect of bank curbing on "bad news hoarding" activities may be influenced because of ownership difference.

Secondly, bank credit of emerged markets which are mainly syndicated loans, however, the credit line of listed firms in China are mainly individual loan. Contradictory to classical multilateral

agency theory which found complementary effects can mitigate agency problem. We argue that the lack of information sharing among banks will cause the ineffective auditing of credit, and the standard of syndicated loans won't raise compared to individual loan. Besides, firms with credit line from one bank can put pressure on other banks, therefore, the competing effect will drive firms to choose the banks with less demanding and banks to lower their standard. Liu et al. (2015) and some other studies under the circumstance of weak information environment also support the above assumption.

Wang et al. (2019), documenting the relationship between leverage of the firm and crash risk, find that the level of debt financing is negatively associated with a firm's crash risk because of debt creditors' monitoring role of bad news hoarding activities. However, they pay little attention to the economic mechanism beyond the phenomenon, especially the potential negative effect of the banking system, which is the biggest debt creditor in China.

Our paper contributes to the literature from two perspectives, firstly, we focus on the mechanism behind the bank's effect on bad news hoarding activities. we find that bank monitoring can curb bad news hoarding activities through mitigating management agency risk and restricting tunneling activities of big shareholders. Secondly, we propose that the potential conspiracy effect of common loans and heterogeneity of firm's ownership type can influence the crash risk through the channel of bank lending activities. Those findings have practical significance to policy maker, especially in countries like China whose indirect financing is in dominant status.

Finally, the reasons why we focus on the role of credit line rather than traditional bank loan are as follows. First, the history of china's banking system marketization is relatively short, in time before 2008, most banks in china were unlisted, and even some of the big-4 banks were actually still in a state of bankruptcy, causing the long term bank loans in history to lack the relevant supervision. Besides, the credit expansion in financial crisis resulted in an overall decline of loan issuance standards. Thus, some of the long term bank loans in history are not issued under the circumstances of efficiency market, and some are extended from those historical issuance, which leads to impure of some loan data. In contrast, credit line is a relatively new tools in china's banking system. In 2009, only about 20% of listed firms have credit lines. The historical problem is not severe because of its little amount. Another important point is that china's all credit lines are revocable, according to Acharya et al. (2014), revocable items lead to strong monitoring effect. Thus, we believe the relationship between credit line and crash risk can reflect the banks monitoring role of bad news hoarding activities appropriately rather than loans. We also use PSM-DID methods to find the effect of first time credit line issuance to exclude the potential underlying difference in characteristics of stocks.

2. Literature review

The stock price crash risk refers to the potential extreme negative yield of stock prices, which is the result of bad news outbreak. Theoretical studies on this field started from incomplete information theory. Research by Romer (1992) and Cao et al. (2002) note that when the internal traders release the private bad news to the public all at once, the stock price will experience a rapid decline. According to Hutton et al. (2009), when a company has weak information efficiency and non-transparent accounting statements, serious information asymmetry will make it easier for internal traders with information advantage to withhold their private information. The private news hoarding activities is the main cause of severe stock price crash. Later research gradually focused on the

information asymmetry caused by internal management and major shareholders rather than outside investors. Numerous research focused on the deliberately concealing bad news activities of internal management. Jin and Myers (2006) believe that in a market which is weak information efficiency and lack of investors protection, the company's internal management has the motivation to release good news above investor expectations and deliberately concealing bad news which will weigh on stock prices.

Most of the researches on the principal-agent problem affecting the risk of stock price collapse focus on the behavior of insiders' supervision. Some studies of the role of external supervisors are concentrated on institutional investors and analysts. For commercial banks which are external large lenders of listed firms, less prior studies put their attention on this area. This paper is an empirical study of whether commercial banks can effectively supervise listed companies in the credit process, thereby slowing down the bad news hoarding problem and inhibiting the stock price crash risk.

A large number of literatures show that low proportion of financing participation will result in the benefit of individual investors involved in supervision cannot cover the relative cost (Shleifer and Vishny,1986). Correspondingly, banks as "big lenders" have richer financial and business experience, more comprehensive access to information, and lower regulatory costs thus, they should have stronger regulatory capabilities and regulatory motives (Yin et al., 2015). According to the statistics of the sample data in this paper, the ratio of bank loans to the liability of non-financial listed companies is about 47% on average. This is only the proportion of on the balance sheet credit, without considering complex and rapid growth financial innovation in recent years. Diamond (1984) proved through a theoretical model that banks can control the principal-agent problems by easing the adverse selection and moral hazard through supervision of the debtors. In addition, according to the research by Shleifer and Vishny (1988), the banks as large lenders have the motivation to participate in corporate governance and supervision of the operation of the company. Empirical literature also supports the assumption. For example, Hirschey et al. (1990) attempts to find the specific methods for banks to supervise the firms and the market reaction of monitoring effects. Their research finds that commercial banks can monitor firms through passing new loans, loans renewals, renewal ratios, confirmation and usage of credit lines. It also monitors the lender's business activities and financial situation, and the effect of such supervision is reflected in the stock market price and bond price.

Compared with banks that adopt mixed operations, China's commercial banking system cannot directly participate in the business decision-making of enterprises on the basis of law. However, the potential political connection and financial repression make the banking system deeply involve in corporate governance. Consequently, banks supervision effect has controversial results. Sun Liang and Liu Jianhua (2011), Liu Yang et al. (2015) found that excessively relying on indirect financing, ownership differences, existence of implicit redemption, lack of internal control, moral hazard problem and so on, lead to China's commercial bank system are more responsible for corporate financing functions rather than supervision functions. Companies that obtain more loans are not companies with good prospects, but those companies requiring large amounts of loans. In this context, the supervision and management role of commercial banks in issuing loans to enterprises has been greatly weakened. This paper focuses on the supervision role of the credit line provided by banks to enterprises. Unlike bank loans with long maturities and fixed amounts that cannot be recovered once they are lent, credit lines provide a flexible and convenient source of funding, which give banks more opportunities to supervise. Different from others, most of China's bank credits are

revocable credit commitments, enabling banks to supervise the company's subsequent business activities and usage of funds. Some studies have shown that commercial banks' credit grants can more effectively reflect the bank's supervision role on enterprises compared with traditional loans. (Chen, 2013). In summary, this paper assumes that, for enterprises with more credit lines, banks have stronger willingness and ability to supervise the banks, and thus have a stronger inhibitory effect on the stock price crash risk.

3. Identification, data and methodology
3.1 Data
The sample of this paper selects A-share listed companies in Shanghai and Shenzhen from 2010 to 2018. The data of weekly stock return, credit line issuance is obtained from Resset. Other data like company's accounting and corporate governance comes from CSMAR. We then filter the sample by: 1) excluding any firms with less than 26 weekly observations in a given year to avoid inaccurate calculation of stock price crash risk caused by short trading time; 2) ST and PT listed companies' stocks, because the price fluctuates greatly for this type, and the limit of the price is different from ordinary companies; 3) the data of the financial industry is excluded; 4) winsorising the firm-level variables at the 1st and 99th percentiles. The final sample consists of 6287 firm-years.

3.2 Stock price crash risk
To measure stock price crash risk, following Kim et al. (2011a), Xu et al. (2012), we use three methodologies: the negative skewness of firm-specific weekly returns NCSKEW, the down-to-up volatility of firm-specific weekly returns DUVOL, and the DOWN based on the number of days plunging down to the limit.
To calculate NCSKEW and DUVOL, we first use the weekly return data of stocks to calculate the residual ε_t^i: through the following regression:

$$R_{i,t} = \alpha_i + \beta_1 R_{m,t-2} + \beta_2 R_{m,t-1} + \beta_3 R_{m,t} + \beta_4 R_{m,t+1} + \beta_5 R_{m,t+2} + \varepsilon_{i,t} \tag{1}$$

where $R_{i,t}$ is the return on an individual stock i in week t, and $R_{m,t}$ is the return on the value-weighted market index in week t. Considering the influence of nonsynchronous transaction, the lead and lag returns are included by two lagging periods and two exceeding periods. And then The logarithm the residual term from the above regression model to calculate firm-specific weekly returns $W_{i,t} = \ln(\varepsilon_{i,t})$.
After obtaining the logarithmic residual $W_{i,t}$, we calculate the negative skewness coefficient $\text{NCSKEW}_{i,t}$:

$$NCSKEW_{i,t} = -[n(n-1)^{\frac{3}{2}}\sum W_{i,t}^3 \ ]/[(n-1)(n-2)\left(\sum W_{i,t}^3\right)^{\frac{3}{2}}] \tag{2}$$

where n is the number of firm-specific weekly returns of firm i in a fiscal year.
$DUVOL$ is then calculated as the natural logarithm of the ratio of the standard deviation of firm-specific weekly returns in down-weeks to that in up-weeks, as follows:

$$DUVOL_{i,t} = log \frac{(n_{up}-1)\sum_{DOWN} W_{i,t}^2}{(n_{down}-1)\sum_{UP} W_{i,t}^2} \tag{3}$$

Where DOWN means less than the average weekly holding return. UP means more than the average weekly holding return. DUVOL reflects the degree of left deviation of stock return. The higher the degree of left deviation, the more trading days of extremely negative return, which means higher risk of stock crash.

3.3 Control variables

Similar to the methods of Kim et al (2011), this paper uses the total asset to represent the size of a company, the leverage to represent the financial risk of company, ROA and market to book ratio to represent profitability, and standard deviation of market model residual to represent the level of risk, the ratio of largest shareholder to represent corporate governance.

3.4 Empirical Model

According to the hypothesis in the previous part, the main regression model in this paper is as follows:

$$CrashRisk = \beta_0 + \beta_1 CreditLine + \beta_2 Controls + \varepsilon \tag{4}$$

The dependent variable of regression model (4) is the risk of stock price crash. We use NCSKEW, DUVOL and DOWN to measure crash risk. Creditline, we use two methods to calculate the variable, the logarithm of the ratio of credit line to the total assets (CL) and the dummy of whether a company get credit line this fiscal year (CL-DUM). Finally, the corresponding control variables are added. The calculation method of the above variables is shown in the preceding section.

4. Empirical results

4.1. Descriptive summary

Table 1 presents the descriptive statistic table of the main variables. It can be seen from the table that the mean value of NCSKEW, DUVOL and DOWN is - 0.289, - 0.447 and 4.837, respectively. The results are similar to those of Xu et al. (2012) and Cao et al. (2015). The average value of CL_DUM, a dummy variable representing bank credit, is 0.447, which means 44.7% of the firm-years data obtained credit line. This result is larger than Luo et al. (2012) and Liu et al. (2015), mainly because of the different data interval. We find that the proportion of listed companies receiving bank credit increases year by year. In addition, this paper also tests the Pearson correlation coefficients of the main variables. The results show that the correlation coefficients of NCSKEW, DUVOL and DOWN, which represent the stock price crash risk, are significantly correlated, indicating that the three variables have a high consistency. In addition, the correlation coefficients between the indicators representing the risk of stock price crash and the indicators of bank credit are positive, and they are significant at the level of 10%. It can be preliminarily proposed that bank supervision can inhibit the risk of stock price crash.

Table1 Summary statistics

Panel A: Descriptive Statistics						
Variable	Number	Means	Median	Std Dev	Mim	Max
NCSKEW	12936	-0.239	-0.225	0.826	-2.769	1.588
DUVOL	12936	-0.347	-0.338	0.917	-3.153	1.826
DOWN	12936	4.837	2.000	5.538	0.000	37.000
CL	12936	0.179	0.000	0.240	0.000	1.684
CL_DUM	12936	0.447	0.000	0.484	0.000	1.000
Size	12936	23.553	22.389	1.181	19.864	25.173
Lev	12936	0.449	0.475	0.317	0.057	1.317
ROA	12936	0.034	0.033	0.068	-0.286	0.237
MB	12936	2.477	2.097	1.781	0.380	4.279
Return	12936	0.003	0.002	0.015	-0.031	0.038
Sigma	12936	0.081	0.077	0.027	0.012	0.064
TopHold	12936	0.377	0.362	0.166	0.092	0.750

Panel B: Correlation Matrix					
	NCSKEW	DUVOL	DOWN	CL	CL_DUM
NCSKEW					
DUVOL	0.927^{***}				
DOWN	0.818^{***}	0.803^{***}			
CL	-0.045^{*}	-0.051^{*}	-0.027^{*}		
CL_DUM	-0.055^{**}	-0.059^{*}	-0.032^{**}	0.545^{**}	

Notes: Panel A presents the descriptive statistics and Panel B presents the Pearson correlation coefficients between any two key variables (***p<0.01，**p<0.05，*p<0.1)

4.2 Main results

Table 2 presents the OLS regression results of crash risk on credit line. According to the assumption, if the bank credit line has an inhibitory effect on the risk of stock price crash, the bank credit line variable is expected to be significantly negative.

We use NCSKEW, DUVOL and DOWN as dependent variable in columns (1) to (6), respectively. The independent variable of Panel A is the credit line of a firm divided by its total assets CL. Columns (1) to (3) are simple linear regression without the control variable and the last three columns are the multiple regression models with the control variables. Regression (1) shows that when NCSKEW is selected as the index of stock price crash risk, CL, the bank credit variable, is significantly negative at the level of 5%, which indicates that the crash risk of enterprises with more bank credit is significantly lower than that of enterprises with less bank credit. This result supports the main hypothesis. When DUVOL and DOWN are used on column (2) and (3), similar results can be obtained by regression (2) (3). In addition, the multiple regression model (4) (5) (6) doesn't change the main results. The control variables, Ret are positively correlated with the risk of stock price crash, while Size, ROA, Lev and major shareholder ownership are negative. This result is basically consistent with the classical literature (Kim et al, 2011a). The independent variable of Panel B is the Credit line dummy variable (CL_DUM). We find that the relationship between the dummy variable of bank credit line and crash risk is significant from column (1) to (6). In other words, whether to obtain bank credit has a significant impact on the crash risk.

Table 2: Baseline regression

Panel A CL and Crash Risk

	(1)	(2)	(3)	(4)	(5)	(6)
	NCSKEW	DUVOL	DOWN	NCSKEW	DUVOL	DOWN
CL	-0.049**	-0.025*	-1.904*	-0.063**	-0.040*	-1.529
	（0.022）	（0.095）	(0.073)	(0.035)	(0.077)	(0.189)
Size				-0.083**	-0.183**	-0.535
				(0.028)	(0.012)	(0.133)
Lev				-0.314***	-0.308**	-0.510**
				(0.008)	(0.022)	(0.019)
ROA				-0.587***	-0.392**	-0.699***
				(0.005)	(0.013)	(0.003)
MB				0.017	0.021	0.488
				(0.821)	(0.849)	(0.868)
Return				1.621*	1.855**	2.916
				(0.073)	(0.030)	(0.168)
Sigma				0.877	0.999**	1.516
				(0.103)	(0.043)	(0.171)
TopHold				-0.351***	-0.232***	-0.547***
				(0.002)	(0.002)	(0.007)
Constant	-0.362	-0.399	3.370*	-0.595	-0.667	1.299
	(0.194)	(0.253)	(0.082)	(0.292)	(0.317)	(0.384)
Industry	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
N	12936	12936	12936	12936	12936	12936
Adj-R2	0.028	0.025	0.017	0.044	0.059	0.026

Panel B CL_DUM and Crash Risk

CL_DUM	-0.318***	-0.347***	-0.843**	-0.277***	-0.302**	-0.898*
	（0.003）	（0.009）	（0.037）	（0.007）	（0.014）	（0.074）
controls	Y	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
N	12936	12936	12936	12936	12936	12936
Adj-R2	0.037	0.042	0.020	0.047	0.065	0.028

*Notes: This table presents regression results for credit line and stock price crash risk with A-listed firms from 2010 to 2018. Independent variable of Panel A is the logarithm ratio of credit line to total assets, and that of Panel B is a dummy. T-statistics reported in parentheses are based on robust standard errors. *, ** and *** stand for significance at 10%, 5% and 1% levels, respectively.*

4.3 **Endogenous problems**

The OLS regression of 4.2 assumes that the credit line is exogenous, however, we are concerned that credit line issuance may be endogenous with the crash risk, and we also can't neglect the potential influence of selection bias and relevant variables omission. For example, the issuance of credit line may be connected with the stock price. To address this concern, we employ natural experiment method of PSM-DID to carry out the robust test. We compare firms that obtained credit line the first time (treatment group) with the firms that never obtained credit line before (control group). We then examine the effect of the first time credit line issuance. Therefore, we can exclude alternative explanations if no other change, independent of the credit line issuance, occurred simultaneously in the firm.

Specifically, we retreat the data to build the treatment group and control group. 1) we exclude those sample with missing data 2 years before and after the first credit line issuance. 2) we sort out treatment group, we find 289, 106, 114, 160, 172 firms got credit line the first time from 2012 to 2016 respectively.3) matched control group was selected among the enterprises that had never obtained the credit line before the control group using propensity score matching methods. The logit model consists of size, ROA, SOE, Industry and proportion of largest shareholder which is consistent with the control variable of main model. The matching method is using nearest neighbor algorithm with caliper 0.01. Finally, we identify the final sample consists of 841 treatment firms and the same control firms and there is no significant difference between two groups. Our DID regression model is:

$$CrashRisk = \beta_0 + \beta_1 Post + \beta_2 Treat + \beta_3 Post * Treat + Controls + \varepsilon \qquad (5)$$

Where Post is the indicator, after the first credit line issuance, the value is 1 and otherwise 0. The Treat is the indicator of treatment group. The sample of the treatment group is 1 and 0 otherwise. We also include controls and industry fixed effect and year fixed effect. Table3 presents the results of PSM-DID model, we find that no matter we use NSCKEW or DUVOL as dependent variable, the coefficient of Post*Treat is significantly negative. The results indicate that the first time credit line issuance is capable of reducing crash risk.

Table 3: The endogenous tests using PSM-DID

	(1)	(2)	(3)	(4)	(5)	(6)
	NCSKEW	DUVOL	DOWN	NCSKEW	DUVOL	DOWN
Post	-0.148***	-0.214***	-0.892**	-0.203***	-0.257***	-1.395**
	(0.001)	(0.000)	(0.018)	(0.003)	(0.000)	(0.015)
Treat	-0.074**	-0.115**	-0.367	-0.053**	-0.048**	-0.279*
	(0.037)	(0.014)	(0.177)	(0.026)	(0.018)	(0.089)
Post*Treat	-0.059**	-0.146***	-0.228*	-0.073**	-0.108***	-0.299
	(0.030)	(0.008)	(0.072)	(0.045)	(0.003)	(0.182)
Size				-0.157**	-0.331**	-0.325***
				(0.014)	(0.037)	(0.004)
Lev				-0.273***	-0.016***	-0.556**
				(0.006)	(0.000)	(0.014)
ROA				-0.377**	-0.578**	-0.563***
				(0.027)	(0.011)	(0.009)
MB				0.026	0.016	0.561
				(0.986)	(0.389)	(0.421)

Return				1.571	1.280	1.358*
				(0.155)	(0.385)	(0.095)
Sigma				0.740	0.321	1.223
				(0.115)	(0.158)	(0.333)
TopHold				-0.543**	-0.460***	-0.735**
				(0.022)	(0.004)	(0.059)
Constant	-0.362	-0.399	3.370*	-0.321	-0.615	2.562
	(0.194)	(0.253)	(0.082)	(0.214)	(0.383)	(0.134)
Industry	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
N	1702	1702	1702	1702	1702	1702
Adj-R2	0.123	0.171	0.064	0.166	0.203	0.075

*Notes: This table represents the results of endogenous tests. The treatment group is firms got credit line the first time, the control group is selected using PSM methods. T-statistics reported in parentheses are based on robust standard errors. *, ** and *** stand for significance at 10%, 5% and 1% levels, respectively.*

In other words, the results of endogenous tests using PSM-DID methods correspond to the main tests. Consequently, we argue that the significant negative relation between crash risk and credit line is not caused by endogenous problems or omission of important variable.

4.4 Economic mechanism
4.4.1 The effect of supervising management
Previous studies show that managerial bad news hoarding activities is one of important reasons of stock price crash. (Hutton et al., 2009). We investigate whether the negative relationship between credit line and crash risk is caused by banks' supervision of management bad news hoarding activities. In a weak information environment like China, banks as main providers of financial resources have strong influence to the management decision. Banks also have incentive to monitor the management during and after the credit line issuance in order to protect the safety of their assets. Therefore, we expect that banks may reduce crash risk through supervision of management.

Empirically, we divide our sample into high and low group according to the following two principles: firstly, the proportion of management stock ownership, When the management holds more stock or options of the company, the management will consider protecting the value of their own stock assets. Therefore, the interests of the management and the shareholders are relatively consistent, the management will trade off the benefit and hurt of their bad news hoarding activities. Secondly, the internal control quality, the ability of management manipulating the content of information is influenced by the strength of internal supervision, for firms with effective internal control, managers is difficult to hide information, thus the supervision effect of banks should be week and insignificant, otherwise strong and significant.

The results of this part are in Table 4, we find that the negative effect of credit line is more significant for firms with less managerial ownership and weak internal control. And the coefficient of low management stock ownership and weak internal control type is less than the other group. The results provide empirical evidence to the fact that bank can monitor management through credit line issuance.

Table 4 Subsample analyses: management supervision

	NCSKEW	DUVOL	DOWN	NCSKEW	DUVOL	DOWN
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Management stock ownership						
	Low			High		
CL	-0.374***	-0.404***	-1.658**	-0.227*	-0.249*	-0.695
	（0.004）	（0.008）	（0.045）	（0.076）	（0.073）	（0.120）
Controls	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
N	6468	6468	6468	6468	6468	6468
Adj-R2	0.075	0.064	0.029	0.069	0.090	0.047
Panel B: Internal control						
	Low			High		
CL	-0.259***	-0.366**	-1.974*	-0.126**	-0.152	-1.004*
	（0.001）	（0.030）	（0.087）	（0.018）	（0.119）	（0.120）
Controls	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
N	6468	6468	6468	6468	6468	6468
Adj-R2	0.069	0.068	0.034	0.072	0.084	0.057

Notes: This table represents the results of subsample tests. We divide the sample into two part based on the management power, panel A is the stock ownership of management, which is the ratio of management share to the total. Panel B is the internal control, the data comes from the DIB internal control and risk management database. T-statistics reported in parentheses are based on robust standard errors. *, ** and *** stand for significance at 10%, 5% and 1% levels, respectively.

4.4.2 The effect of financial constraints

In this subsection, we investigate another potential mechanism behind the phenomenon that credit line can reduce the crash risk. He and Ren (2017) propose that the higher financial constraints will motivate managers to hoard the bad news, leading to high crash risk correspondingly. We assume that one function of credit line is reducing company's financial constraints by providing liquidity to the firm, especially when the firm is in severe liquidity crisis.

Empirically, we divide the sample into two parts based the following two measurement of financial constraints. Firstly, the simple leverage ratio of firms, the financial constraint of high leverage group is severe while the low group is light. Secondly, the cash- cash flow sensitivity, if there are financing constraints, the firm will hold a certain amount of cash in anticipation of the future needs of operation and investment, representing a strong cash flow sensitivity. Specifically, we use the coefficient α of formula 5 as the indicator of financial constraints.

$$\Delta crash = \alpha * CF + controls + \epsilon \tag{5}$$

Where CF is the cash flow, controls include size, expense of investment, growth rate and the change of leverage.

The results are in table 5, panels A to B, the results show that the effect of credit line is more pronounced for the high financial constraint subsample group, both for cash flow sensitivity and for leverage as indicator. therefore, the results are consistent with our assumption that the effect of credit line is stronger in the subsample of financial constraint firms.

Table 5 Subsample analyses: financial constraints

	NCSKEW	DUVOL	DOWN	NCSKEW	DUVOL	DOWN
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Leverage ratio						
	Low			High		
CL	-0.183*	-0.199	-0.791	-0.425***	-0.473**	-1.385*
	（0.090）	（0.147）	（0.228）	（0.002）	（0.011）	（0.068）
Controls	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
N	6468	6468	6468	6468	6468	6468
Adj-R2	0.052	0.061	0.028	0.048	0.098	0.039
Panel B: Cash- cash flow sensitivity						
	Low			High		
CL	-0.276**	-0.242*	-0.571	-0.387**	-0.317**	-1.177*
	(0.048)	(0.072)	(0.131)	(0.026)	(0.015)	(0.086)
Controls	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
N	6468	6468	6468	6468	6468	6468
Adj-R2	0.069	0.068	0.034	0.072	0.084	0.057

Notes: This table represents the results of subsample tests. We divide the sample into two part based on the financial constraint, panel A is the leverage ratio of firms, panel B is the sensitivity of cash- cash flow model. T-statistics reported in parentheses are based on robust standard errors. *, ** and *** stand for significance at 10%, 5% and 1% levels, respectively.

4.4.3 The effect of tunneling activities

Tunneling activities, such as transferring firm's assets for their own benefit or occupying the cash flow of listed firms, will cause the contradiction between major shareholders and minor shareholders. This kind of activities will not only damage the confidence of most shareholders, but also infringes on the interests of external creditors. Consequently, we assume that commercial banks have the motivation to supervise the tunneling activities of major shareholders. If bank credit line can mitigate the risk of tunneling activities, we can expect that bank credit can reduce the crash risk by supervising the tunneling activities.

Empirically, we divide the sample into two parts according to the proportion of largest shareholder and related party transaction indicator. according to Liu et al. (2016), we use the related party transaction as a proxy for tunneling activities.

The results are in table 6, panels A to B, the results indicate that the effect of credit line is more useful in the high tunneling activities risk subsample group, two measurements both support the results. Thus, we propose that credit line can reduce the risk of crash through mitigating tunneling activities.

Table 6 Subsample analyses: tunneling activities

	NCSKEW	DUVOL	DOWN	NCSKEW	DUVOL	DOWN
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: proportion of largest shareholder						
	Low			High		
CL	-0.203*	-0.141**	-0.884	-0.299**	-0.256**	-0.973
	（0.089）	（0.044）	（0.180）	（0.016）	（0.020）	（0.118）
Controls	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
N	6468	6468	6468	6468	6468	6468
Adj-R2	0.057	0.045	0.039	0.053	0.057	0.036
Panel B: Related party transaction						
	Low			High		
CL	-0.371**	-0.236***	-0.954**	-0.235**	-0.194*	-0.747
	(0.011)	(0.007)	(0.034)	(0.030)	(0.066)	(0.241)
Controls	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
N	6468	6468	6468	6468	6468	6468
Adj-R2	0.059	0.054	0.036	0.055	0.047	0.040

Notes: This table represents the results of subsample tests of tunneling activities panel A is the proportion of largest shareholder, Panel B is the related party transaction. T-statistics reported in parentheses are based on robust standard errors. *, ** and *** stand for significance at 10%, 5% and 1% levels, respectively.

4.5 Heterogeneous tests

4.5.1 The effect of common loan

Previous studies found that the confusing effect of common loan. Studies like Holmstrom (1979), Mezzetti (1997) find that when there is complementary effect between different principals, the common agency is better than single, that is the reason why banks adopt syndicated loans in advanced economy. However, other literature like Liu et al. (2015) argue that non-cooperative behavior in common loans like loan competition will further jeopardize the monitoring effect of banks. In this paper, we test whether the monitoring effect or the competitive effect take the dominating effect in the common loan from the perspective of the extreme risk.

Empirically, we rebuild our sample and select the common loan announcement out. We get 4775 firms with more than one credit lender. After that, we divide the sample into two parts, and run regression using three different dependent variables respectively.

The results are in table 7, columns (1) to (6) are divided according to the number of lender, the subsample of common loan manifest that the coefficient of credit line is bigger and less significant than the single credit loan. The results support the hypothesis that in a weak information market like china, the competitive effect of common loan beat the effect of cooperation, thus weakening the monitoring effect of credit line.

Table 7: The effect of common loan

	Common			Single		
	NCSKEW	DUVOL	DOWN	NCSKEW	DUVOL	DOWN
	(1)	(2)	(3)	(4)	(5)	(6)
CL	-0.166	-0.175*	-1.873	-0.372***	-0.426***	-0.773**
	（0.274）	（0.083）	（0.168）	（0.008）	（0.002）	（0.046）
Controls	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
N	5775	4775	4775	7161	8161	8161
Adj-R2	0.109	0.081	0.055	0.094	0.067	0.044

*Notes: This table represents the difference of common loan and single lender loan, two subsample is divided according to the number of creditors in a single firm-year. T-statistics reported in parentheses are based on robust standard errors. *, ** and *** stand for significance at 10%, 5% and 1% levels, respectively.*

4.5.2 The effect of ownership

Numerous studies mention the difference between the SOE and private enterprises, in this part, we test the difference between this two subsample. In our 12936 firm-year sample, 7934 sample are state owned, other 5002 are private. We can draw a simple conclusion from the data that SOEs have benefit in the credit market, both in quality and quantity. However, the results in table 8 demonstrate that the effect of private firm's credit line is more useful. The wald test of coefficient also confirm the results.

Table 8: The Effect of Ownership

	SOEs			Private		
	NCSKEW	DUVOL	DOWN	NCSKEW	DUVOL	DOWN
	(1)	(2)	(3)	(4)	(5)	(6)
CL	-0.244	-0.231*	--0.729	-0.416**	-0.388***	-1.245**
	（0.088）	（0.073）	（0.272）	（0.011）	（0.001）	（0.027）
Controls	Y	Y	Y	Y	Y	Y
Year	Y	Y	Y	Y	Y	Y
N	7934	7934	7934	5002	5002	5002
Adj-R2	0.062	0.058	0.033	0.081	0.077	0.053

*Notes: This table represents the difference between SOEs and private firms. Two subsample is divided according to ownership. Wald test is based on the results and support the coefficient of Private subsample is significantly smaller than SOEs within 5% confidence interval. T-statistics reported in parentheses are based on robust standard errors. *, ** and *** stand for significance at 10%, 5% and 1% levels, respectively.*

4.6 Robustness tests

First we examine whether the channel of supervising management, tunneling activities and financial constraints is caused by particular dependent variable, we use other equity balance variables, proportion of institutional investors, information transparency index to test the assumption, the unreported results (available upon request) indicate that the estimated coefficients of credit line and dummy are all significantly negative and the Wald test is passed either, which implies that the results

are not caused by the bias of selected variables.

Second, we conduct robustness test to address the potential bias of omitted variable bias, we add some classical variable into the estimation, like accounting conservatism (Kim and Zhang, 2016), turnover rate of stocks, opacity, accounting robustness index of Cscore, the unreported results are consistent with the main regression.

Third, we consider the potential time-lag effect of credit line, we include on period lag of credit line and dummy, the results will not change the main results.

5. Conclusion

This paper attempts to explore the impact of commercial credit line on the risk of stock price crash. Using the data of listed companies from 2010 to 2018, this paper studies whether bank credit can restrain the crash risk from the perspective of principal-agent problem and liquidity. The results show that the higher the amount of credit line, the lower the risk of stock price crash. Mechanism tests verify that credit line can reduce the risk of stock price crash by alleviating the principal-agent problem, monitoring the management and reducing tunneling activities. In addition, our results support the financial constraints hypothesis, that is, Bank Credit provides liquidity protection for enterprises when facing extreme situation, thus reduces the crash risk. The above conclusion has passed the robustness tests including the PSM-DID test, which demonstrate that the conclusion is robust.

On the one hand, our paper contributes to the banking theory and further explores the micro-causes of crash risk. Research shows that principal-agent problem is an important cause of crash risk and strengthen the supervision and management of bank credit can alleviate the bad news hoarding and tunneling activities of internal controllers, which can effectively alleviate the risk of stock price crash.

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