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Financial distress heterogeneity and capital structure adjustments during Covid-19: Evidence from Chinese listed firms

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Abstract

This study examines the heterogeneous effects of the COVID-19 pandemic on corporate capital structure decisions among Chinese listed firms, with particular attention to how firms' pre-existing financial distress risk shapes their leverage responses. Using a difference-in-differences (DID) framework applied to 17,214 firm-year observations spanning 2017 to 2022, and employing both Altman's Z-Score and Ohlson's O-Score as complementary measures of financial distress, the paper documents a significant pandemic-driven increase in financial leverage across firms. Crucially, firms with low financial distress risk exhibit substantially larger leverage increases than their high-distress counterparts, with the differential concentrated in short-term debt. Further analysis confirms that this pattern reflects differential access to external credit: financially healthier firms obtained greater incremental borrowing during the pandemic due to their superior creditworthiness, consistent with pecking order theory and credit-rationing mechanisms. Robustness checks using tercile groupings corroborate the main findings. These results contribute novel firm-level evidence on the interaction between pandemic shocks, financial vulnerability, and capital structure dynamics in an emerging market context.

***Keywords*:** Financial Distress, Capital Structure, COVID-19 Pandemic, Leverage Heterogeneity, Difference-In-Differences, Chinese Listed Firms, Pecking Order Theory, Short-Term Debt

JEL Classification: G32, G01, G33, C23

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1. Introduction

It's well-known that the global coronavirus pandemic that broke out at the end of 2019 (the Covid-19) has had a far-reaching impact on the human society. Due to the threat of the Covid-19 to human life and health, as well as its transmission characteristics and intervention measures implemented by governments around the world, it slows down economic activities (Zhang, et.al, 2020), causes a great negative effect on the firms' operation (Huang et al., 2022) and then emergency management behaviors are born to cope with this shock, which inevitably influences the financial performance of enterprises (Vichtsarawong & Eng, 2023; Xie, 2025). This has attracted much attention and research of many scholars.

To the best of our knowledge, existing literature about the direct relationship between financial performance and COVID-19 mainly focuses on the changes of corporate earning management, financial distress and leverage adjustment. Aljughaiman et al. (2023) explores the differential effects of the COVID-19 in the corporate earnings management using data from 1832 China-listed firms from 2015 to 2021. Leng and Sun (2024) studies the heterogeneious influence and mechanism of COVID-19 on the risk of corporate financial distress using Z-Score predictor; Archanskaia et al. (2023) examine the asymmetric effect of COVID-19 on the enterprise financial station by a novel approach to quantifying financial distress across industries. Vo et al. (2022) explores the impact of COVID-19 economic crisis on the adjustment speed toward target leverage ratio from an international analysis; Rehman et al. (2024) find that COVID-19 has a heterogeneious influence on the speed of leverage adjustment. Xie (2025) demonstrates that financially constrained companies increase more leverage ratio than less constrained companies during the COVID-19 pandemic period. However, there is almost no literature to study the impact of COVID-19 on the financial leverage ratio of companies with different financial conditions. In this paper, we try to fill this gap.

Since 2008, the leverage ratio of non-financial enterprises in China has grown rapidly, and it even reached 146.9% in 2015, ranking among the top in the world. At the end of 2015, the Chinese government identified "deleveraging" as one of the five major tasks of supply side structural reform. Thus, the growth speed of leverage ratio of non-financial enterprises slowed down in the year 2016 and 2017 and gradually decreased in 2018 and 2019. However, with the outbreak of COVID-19 in 2020, the leverage ratio rose rapidly again, as shown in Fig.1. Under the impact of the COVID-19, the consumption capacity of the people declined significantly, the investment and output of enterprises also declined sharply, and the cash flow has been affected. In addition, there is a risk of default in the timely repayment of financial contracts. Therefore, enterprises have to increase funding to maintain normal operation. According to the the pecking order theory, companies prioritize debt instruments for their external financing. Whether a company can obtain external loans and how much loan it can obtain are greatly related to its credit score, enterprise scale, ownership structure, corporate social performance and financial situation, etc. (Liu,et

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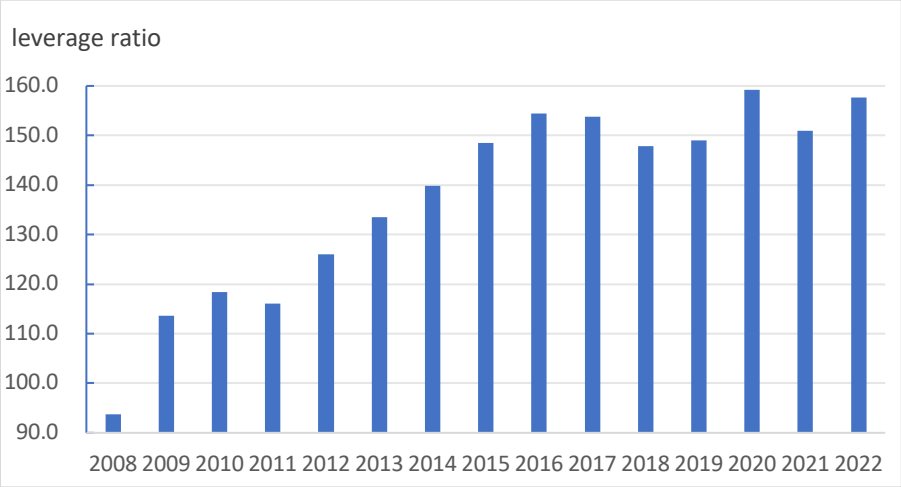
al.,2022;Bai, Ho, 2022; Archanskaia et al., 2023). The leverage ratio of Chinese firms exhibits structural heterogeneity for cross-sectional firms based on firm characteristics (Gong et al., 2019). It is curious and interesting whether the leveraged growth exhibits heterogeneity for firms with different financial status during COVID-19. In this paper, our purpose is to verify whether COVID-19 has a heterogeneious impact on the changes of leverage ratio for companies with different level of financial distress.

Figure 1. The leverage ratio of non-financial companies in China at the end of each year from 2008 to 2022



When a company's current assets fail to pay current debts, which means it is in financial distress, it will fall into the crisis of going bankrupt (Li et al..2020). In this paper, however, the financial distress indicator is just used to measure the risk level of a company falling into financial distress. The higher the level of financial distress, the greater the risk of the company falling into financial distress, which indicates that the company's financial status is much worse. Hence, our sample consists of Chinese listed companies operating normally, not companies that are truly in financial distress.

As is known to all, during the COVID period, especially in the year 2020, Chinese people's travel is somewhat restricted, their purchasing power accordingly is declining, and the business and production activities of enterprises are impacted, the companies' business shrinks, and the cash flow situation deteriorates. Thus enterprises have to increase external loans to maintain operations. Generally, compared to companies with low levels of financial distress, companies with high levels of financial distress have higher leverage, lower credit levels, higher loan costs, and thus weaker financing capabilities. In addition, against the backdrop of the Chinese government's deleveraging policy, highly leveraged companies will face greater pressure if too much leverage is added. Therefore, we propose these hypothesis:

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H1: During the COVID-19 period, the leverage is increased for both high and low financial distress companies.

H2: During the COVID-19 period, low distress companies' financial leverage is increased more than high distress companies'.

This paper may contribute to two strands of literature. First, it enriches the empirical literature about the relationship between the COVID-19 and capital structure decisions (Vichitsarawong & Eng, 2023;Rehman et al., 2024; Xie, 2025) ; Second, the existing literature mainly focus on the direct impact of the COVID-19 on company financial distress or leverage adjustment speed, and this paper is the first to study the heterogeneous effects of the COVID-19 on financial leverage from perspective of firm financial distress.

The remainder of this paper is organized as follows. Section 2 introduces our research design, including the measures of capital structure and financial distress, our empirical method, and our data and sample selection. Section 3 reports and analyzes our empirical results. Section 4 draws a simple conclusion.

2. Research Design

2.1 Measurement of Key Variables

2.1.1 Measurements of capital structure

We have used total leverage ratio *ttlLev*, short-term leverage ratio *shtLR* and long-term leverage ratio *lngLev* these three proxies as the measurements of firm capital structure. *shtLev* refers to the ratio of short-term liabilities (excluding notepayable) to total assets; *lngLR* equals to the ratio of long-term liabilities to total assets; and *shtLev* pluses *lngLev* is *ttlLev.*

2.1.2 Measurements of financial distress

According to the existing literature, there are many traditional and new attempts to measure financial distress situation. In this paper, we first select the famous measurement Altman(1968)'s Z-Score, which has been commonly and widely used in prior studies. It is a linear combination of 5 financial indicators, the specific formulate is as follows:

$$Z = 1.2 \times \frac{working\ capital}{total\ assets} + 1.4 \times \frac{retained\ earnings}{total\ assets} + 3.3 \times \frac{EBIT}{total\ assets} + 0.6 \times \frac{market\ value\ of\ equity}{otal\ book\ liabilities} + 1.0 \times \frac{total\ sales}{total\ assets} \quad (1)$$

In addition, in order to ensure the robustness of the empirical results, we also choose the alternative measurement Ohlson(1980)' O-Score. Its specific model is as follows:

$$O = -1.32 - 0.407\mathbf{size} + 6.03TLTA - 1.43WCTA + 0.757CLCA - 2.37NITA - 1.83FUTL$$
$$+0.285INTO - 1.72OENEG - 0.521CHIN \quad (2)$$

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Where: size=ln(total book assets);TLTA=total liabilities/total assets; WCTA= working capital/total assets; CLCA=current liabilities/current assets; NITA=net profit /total assets; FUTL=operating cash flow/total liabilities; INTWO=1, if the net profit for two consecutive years is negative, other else INTWO=0; OENEG=1, if total liabilities>total assets, other else OENEG=0; CHIN= $(NI_t-NI_{t-1})/(|NI_t|+|NI_{t-1}|)$ (NI is net profit).

In general, the value of Z-Score is greater than zero, and a firm with a high Z- Score indicates that it is in a low risk level to fall into financial distress. Conversely, the value of O-Score is less than zero, and a firm with a low O-Score means it is in a less risk degree to fall into financial distress. In this paper, in order to research the treatment of COVID-19 on leverage, we divide all the sample into two groups by Z-Score and O-Score respectively, the high Z-Score group and the low O-Score group are our treatment groups (in low risk level falling to financial distress), the low group in Z-Score and the high group in O-Score are our control groups (in high risk level falling to financial distress).

2.2 Model Design

Due to almost all firms are affected by the pandemic, and to test the heterogeneity effects of COVID-19 on leverage ratio choices for firms with different financial distress, we construct a difference-in-differences (DID) model as follows:

$$Lev_{it} = \beta_0 + \beta_1 FC\_dum_{it} \times During_t + \beta_2 During_t + \gamma X_{it} + Firm_i + Year_t + \varepsilon_{it} \quad (3)$$

Where subscript i and t refers to a firm and a year respectively. Lev_{it} refers to one of three leverage ratios in section 3.1.1. FC_dum_{it} denotes a dummy variable about firm financial distress discussed above: *Z-dum* and *O-dum*. Specially, *Z-dum* =1 if the firm is in the high Z-Score group, while Z-dum=0 if it's in the low Z-Score group; Similarly, *O-dum*=1 if the firm is in the low O-Score group, while *O-dum*=0 if in the high O-Score group. $During_t$=1 if the observation year of a firm is during the COVID-19 pandemic(2020-2022), and $During_t$=0 if it's before the pandemic (2017-2019). X_{it} is a series of control variables related to capital structure decision described in table 1. This model also controls the firm-level fixed effect $Firm_i$ and the year fixed effect $Year_t$. ε_{it} is a random error term.

Our focus is the coefficient of interaction term *FC_dum*during*, we expect it be greatly positive, which indicates financially less distress companies increase more leverage than more distress companies in the years during COVID-19 period.

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Table 1. Variables and Definition

Variables	Symbol	Definitions
Leverage	*ttlLev*	Total leverage, which is the sum of *shtLev* and l*ngLev*.
	shtLev	(Short liabilites-notepayable)/total book assets.
	lngLev	Long-term liabilities/total book assets.
Financial distress （FD）	*Z*	Z-Score proposed by Altman(1968), the smaller the Z value, the higher risk level falling into financial distress.
	O	O-Score, the smaller the O value, the lower risk degree falling into financial distress.
Asset size	*size*	The natural logarithm of total book assets.
Asset tangibility	*fix*	The ratio of fixed assets and total book assets.
Firm growth	*growth*	(sales in current year-sales in last year)/total book assets.
Firm profitability	*ROA*	Total net profits/ total book assets.
Tuobin's Q	*q*	Market value of equity/ total book assets.
Firm age	*age*	The natural logarithm of firm age plus one.

2.3 Data and Sample Selection

All the sample firms are listed in Shanghai and Shenzhen stock Exchange. Due to the COVID-19 pandemic broke out at the end of December 2019 and finished at December 2022 in China, we choose 2017-2022 as the sample period. All the data related to firm capital structure, financial distress and other financial data we used are from the CSMAR database. In addition, the sample data are processed as follows: First, ST and *ST firms are deleted; Second, the firms whose observation is less than 5 are excluded; Third, all construction and financial firms are dropped; Finally, to avoid the outliers' impact, we winsorized all main variables at 1% and 99% level.

3. Empirical Results

3.1 Descriptive Statistics and Relationship Analysis

Table 2 reports the descriptive statistics of the key variables. As shown, the mean values of *ttlLev*, *shtLev* and *lngLev* are 0.416, 0.332 and 0.084 respectively. Obviously, the mean value of *shtLev* is much bigger than that of *lngLev*, which indicates that Chinese firms mainly rely on short-term liabilities to support operations. Z-Score has a mean value of 5.671 and O-Score has a mean of -8.575.

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Table 2. Descriptive Analysis of Main Variables

	obs	mean	std.dev	min	max
ttlLev	17214	0.361	0.173	0.049	0.963
shtLev	17214	0.297	0.144	0.049	0.702
lngLev	17214	0.064	0.088	0	0.413
Z	17214	5.671	6.406	0.142	38.887
O	17214	-8.575	1.667	-13.236	-4.487
size	17214	22.373	1.290	20.089	26.456
fix	17214	0.206	0.149	0.004	0.666
growth	17214	0.151	0.332	-0.551	1.895
q	17214	1.801	1.536	0.099	8.605
ROA	17214	0.036	0.067	-0.258	0.213
age	17214	3.029	0.269	2.303	3.555

Table 3 shows the correlation coefficients between main variables. Z-Score is significantly and highly negative with all three leverage ratios, and O-Score is highly positive with them. This is consistent with literature, The firm with large Z-Score or small O-Score owns a low financial leverage. Notably, O-Score is highly negative to Z-Score, which indicates that O-Score is a good alternative measure of financial distress.

Table 3. Correlation Coefficient Matrix

	ttlLev	shtLev	lngLev	Z	O	size	fix	growth	ROA	q	age
shtLev	0.862***										
lngLev	0.560***	0.062***									
Z	-0.615***	-0.526***	-0.351***								
O	0.816***	0.750***	0.377***	-0.633***							
size	0.174***	0.064***	0.238***	-0.031***	-0.157***						

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fix	0.086***	-0.083***	0.305***	-0.151***	0.068***	0.087***					
growth	0.030***	0.018***	0.028***	-0.051***	0.077***	0.086***	-0.004				
ROA	-0.332***	-0.307***	-0.152***	0.360***	-0.607***	0.204***	0.005	0.285***			
q	-0.424***	-0.317***	-0.316***	0.770***	-0.385***	0.048***	-0.159***	0.124***	0.302***		
age	0.115***	0.077***	0.101***	-0.121***	0.080***	0.143***	0.074***	-0.092***	-0.070***	-0.158***	
post	0.087***	0.041***	0.105***	-0.067***	0.061***	0.216***	-0.012	-0.095***	-0.104***	-0.022***	0.274***

3.2 Univariate Test of Leverage Changes

As important precursors of our DID analysis, Table 4 shows the uni-variate t-test *results of leverage changes for the two financial distress proxies, in particular,* Z-Score in panel A and O-Score in panel B. In panel A, our all sample firms are divided into two groups by the median of Z-Score in pre-COVID period, specially, Z_high and Z_low. Panels A1-A3 exhibits the t-test results for *ttlLev*, *shtLev* and *lngLev*. As shown, the three leverage ratios of firms both with high Z-Score (low distress) and low Z-Score (high distress) are increased during COVID, which is consistent H1. And low distress groups has a small mean of the three leverage ratios relatively to high distress group. However, it's worth noting that the pre-and during-COVID relative changes in leverage ratio between low-Z-Score and high-Z-Score groups (row(3)) in Panels A1-A3, and it shows that firms in top groups have great increases in *ttlLev* (Panel A1), *shtLev* (Panel A2) and *lngLev* (Panel A3) during COVID-19 pandemic, compared to the firms in bottom groups. These preliminary tests confirm the hypothesis H2 that low financial distress firms' leverage ratios are increased more than high distress firms'.

In panel B, our all sample firms are divided into O_high and O_low groups by their pre-COVID median of O-Score. Similarly, Panels B1-B3, which report the pre- and during-COVID changes in the three leverage ratios, shows that firms with low O-Score (low distress) have a small mean of the three leverage ratios relatively to firms with high O-Score (high distress), and the three leverage ratios of firms both with low O-Score and high O-Score are increased during COVID,

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which is also consistent with H1. The row (3)s we focus on shows that relative to high-O-Score group, the low-O-Score group experience significant increase in *ttlLev*, *shtLev* and *lngLev* during COVID-19 pandemic, which simply verifies the hypothesis H2 again.

Table 4 Univariate T-test of Leverage Changes Before and During COVID

Panel A: Leverage changes by Z-Socre					
	before		during		
	n	mean	n	mean	diff
	Panel A1: ttllev				
(1)Z_high	1503	0.240	1503	0.286	0.046***
(2)Z_low	1366	0.463	1366	0.476	0.013***
(3)diff(1)-diff(2)					0.033***
	Panel A2: shortlev				
(1)Z_high	1503	0.219	1503	0.241	0.022***
(2)Z_low	1366	0.370	1366	0.370	0.000
(3)diff(1)-diff(2)					0.022***
	Panel A3: longlev				
(1)Z_high	1503	0.021	1503	0.045	0.024***
(2)Z_low	1366	0.093	1366	0.105	0.012***
(3)diff(1)-diff(2)					0.012***
Panel B: Leverage changes by O-Socre					
	before		during		diff
	n	mean	n	mean	
	Panel B1: ttllev				
(1)O_low	1551	0.237	1551	0.278	0.041***
(2)O_high	1318	0.474	1318	0.491	0.017***
(3)diff(1)-diff(2)					0.024***
	Panel B2: shortlev				
(1)O_low	1551	0.208	1551	0.229	0.021***
(2)O_high	1318	0.388	1318	0.389	0.001
(3)diff(1)-diff(2)					0.020***
	Panel B3: longlev				
(1)O_low	1551	0.029	1551	0.049	0.020***

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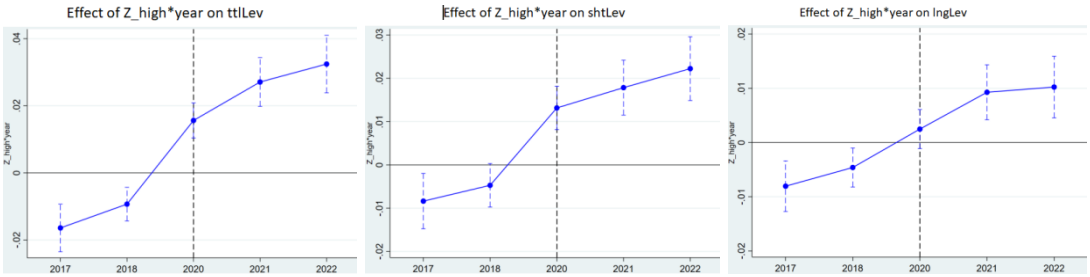
(2)O_high	1318	0.086	1318	0.102	0.016***
(3)diff(1)-diff(2)					0.004*

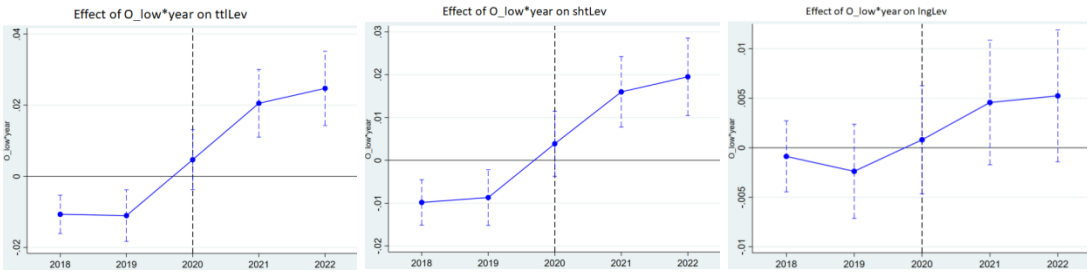
Note：This table reports difference-in differences changes of three leverage indicators before and during COVID. Our leverage indicators are *ttlLev*, *shtLev* ang *lngLev*. Panel A and B present the leverage changes by Z-Score and O-Score, respectively. In Panel A, Z-Socre indicator are dummies, indicating that firms the top 50% and bottom 50% Z-Score as Z_high and Z_low, respectively. In Panel B, O-Socre indicator are dummies, indicating that firms the top 50% and bottom 50% O-Score as O_high and O_low, respectively. *, ** and *** denote 1%, 5% and 10% significance level, respectively, the same below.

Figure 2. Regression coefficients before and during the COVID-19

Panel A: regression coefficients of Z-Score



Panel B: regression coefficients of O-Score



Note: This figure plots the confidence intervals of coefficients of financial distress indicators (Z-Score and O-Score) on financial leverage by year. Panel A plots the coefficients of dummy variable *Z_high*, with *Z_low* as the default category, on *ttlLev*, *shtLev* and *lngLev*, respectively. Panel B plots the coefficients of dummy variable *O_low*, with *O_high* as the default category, on *ttlLev*, *shtLev* and *lngLev*, respectively.

3.3 Parallel Rrend Test

Parallel trend test is a very important step to ensure the accuracy of the results of DID regression analysis. Fig. 2 illustrates the dynamic changes in leverage ratios between high and low financial

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distress group surrounding the COVID-19. Using Z-Score and O-Score as the measure of financial distress respectively, Panel A and B plot the 95% confidence intervals of regression coefficients of FD*year on corporate financial leverage. As shown in Panels A , the coefficients of Z_high*year are all smaller than zero before COVID, while the coefficients are all significantly bigger than zero during COVID, indicating that, compared to low Z_Score firms, the *ttlLev*, *shtLev* and *lngLev* of high Z_Score firms are decreased before the pandemic, while those are increased during the pandemic. These means that the COVID-19 pandemic has heterogenieous effects on the firms with different Z-Score degree. From Panel B, we also can gain a similar result that the *ttlLev*, *shtLev* and *lngLev* of firms with different O-Score level are impacted differently and significantly during COVID-19. These results indicate the firms with different financial distress level experience a differential change on leverage ratios under the impact of COVID-19. Specially, low financial distress firms exhibit a significantly increase in leverage ratios during the COVID-19 period, relatively to the high financial distress firms, preliminarily verifying H2.

3.4 The Effect of COVID-19

The parallel trend test results in Fig.2 and the uni-variate t-test of leverage ratio in Table 3 preliminarily indicate that compared to financial more distressed firms, less distressed firms' leverages are increased more during COVID. In this section, we apply a multivariable DID model to further analyze whether there exists a differential impact of COVID-19 on leverage growth for different financial distressed firms.

Table 5. COVID-19, Z-Score and Capital Structure

	ttlLev		shtLev		lngLev	
	(1)	(2)	(3)	(4)	(5)	(6)
Z*During	0.0336***	0.0187***	0.0221***	0.0157***	0.0116***	0.0030
	(0.0034)	(0.0032)	(0.0002)	(0.0028)	(0.0022)	(0.0021)
During	0.0126***	0.0065	0.0003	-0.0058	0.0123***	0.0123*
	(0.0024)	(0.0097)	(0.0022)	(0.0088)	(0.0017)	(0.0066)
size		0.0184***		0.0032		0.0151***
		(0.0025)		(0.0021)		(0.0016)
fix		0.0522***		0.0214		0.0308*
		(0.0208)		(0.0187)		(0.0156)
growth		0.0389***		0.0311***		0.0078***
		(0.0027)		(0.0026)		(0.0017)
ROA		-0.4348***		-0.3226***		-0.1122***
						(0.0103)

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		(0.0181)		(0.0165)		
q		-0.0162***		-0.0040***		-0.0122***
		(0.0015)		(0.0012)		(0.0103)
age		0.0411		0.0545		-0.0134
		(0.0390)		(0.0345)		(0.0262)
Cons_	0.3460***	-0.1540	0.2909***	0.0643	0.0551***	-0.2183***
	(0.0008)	(0.1225)	(0.0007)	(0.1079)	(0.0006)	(0.0789)
Firm controlled	yes	yes	yes	yes	yes	yes
Time controlled	no	yes	no	yes	no	yes
N	17188	17188	17214	17188	17188	17188
R^2	0.029	0.242	0.052	0.084	0.018	0.204

3.4.1 The effect by Z-Score

To test the hypothesis 2, we first use model (3) to ascertain whether COVID-19 exists a differential effect on three leverage ratios based on the financial distress measure Z-Score. The sample is divided into two groups by the median of all firms' Z-Score in pre-COVID period, if the value of Z-Score of a firm is bigger than the median, it belongs to the treatment group Z_high, specially, the corresponding dummy variable *Z* is equal to 1, otherwise it belongs to the control group Z_low, specially, *Z*=0. Table 5 represents these regression results. We don't control the firm financial characteristics in the regression analysis of columns (1), (3) and (5), while we do in columns (2), (4) and (6). As shown, the coefficients of interaction term Z*During, which is our focus and interest, are all highly and significantly positive for *ttlLev* and *shtLev* except for *lngLev*. These results signify that the firms in low level of financial distress have a significant increase in *ttlLev* and *shtLev,* compared to the firms in high level of financial distress during COVID period, the low financial distress firms increase their leverage level, especially short loans, consistent with the H2.

3.4.2 The effect by O-Score

To test the hypothesis 2, we then use Z-Score to measure financial distress. Similarly, The sample are divided into two groups by the median of all firms' O-Score in pre-COVID period, if the value of O-Score of a firm is smaller than the median, it belongs to the treatment group O_low, specially, the corresponding dummy variable *O* is equal to 1, otherwise it belongs to the control group O_high, specially, *O*=0. We use model (3) to regress and these results are reported in Table 6. Same as the results of Z-score, the coefficients of *O*During* are significantly positive for *ttlLev* and *shtLev* but not for *lngLev*. These reveal that low distress firms increase more leverage (especially short leverage) compared to high distress firms during COVID period, which also confirms the H2.

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Table 6. COVID-19, O-Score and Capital Structure

	ttlLev		shtLev		lngLev	
	(1)	(2)	(3)	(4)	(5)	(6)
O*During	0.0239***	0.0162***	0.0193***	0.0155***	0.0046**	0.0006
	(0.0035)	(0.0032)	(0.0030)	(0.0029)	(0.0022)	(0.0021)
During	0.0173***	0.0047	0.0014	-0.0079	0.0159***	0.0127*
	(0.0027)	(0.0097)	(0.0025)	(0.0089)	(0.0018)	(0.0067)
size		0.0201***		0.0046**		0.0155***
		(0.0025)		(0.0021)		(0.0016)
fix		0.0556**		0.0245		0.0311**
		(0.0209)		(0.0187)		(0.0156)
growth		0.0391***		0.0313***		0.0078***
		(0.0027)		(0.0026)		(0.0017)
ROA		-0.4378***		-0.3246***		-0.1132***
		(0.0182)		(0.0166)		(0.0103)
q		-0.0169***		-0.0046***		-0.0124***
		(0.0015)		(0.0012)		(0.0008)
age		0.0469		-0.0582*		-0.0113
		(0.0390)		(0.0344)		(0.0262)
Cons_	0.3460***	-0.2093	0.2909***	0.0238	0.0551***	-0.2332***
	(0.0008)	(0.1215)	(0.0007)	(0.1071)	(0.0006)	(0.0787)
Firm controlled	yes	yes	yes	yes	yes	yes
Time controlled	no	yes	no	yes	no	yes
N	17214	17188	17214	17188	17214	17188
R^2	0.018	0.235	0.073	0.076	0.004	0.208

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3.4.3 Robustness test

To ensure the robustness of the empirical results in section 3.4.1 and 3.4.2, we divide all companies equally into three groups according to the Z-score and O-score separately. Specially, treatment groups are top and middle terciles, and low tercile is control group if grouped by Z-score. While if by O-score, low and middle terciles are treatment groups, and control group is top tercile. Tables 7 and 8 respectively reports the regression results based on financial distress measures Z-score and O-score. As shown, the coefficients of all interaction items are all significantly positive for *ttlLev*, and *shtLev,* and the coefficients of *shtLev* is much bigger than those of *lngLev*. But it's worth noting that the coefficient values of Z-high*During are larger than these corresponding coefficient values of Z-mid*During and

Table 7. COVID-19, Z-Score and Capital Structure (Robustness Test)

	High			Mid		
	ttlLev(1)	shtLev(2)	lngLev(3)	ttlLev(1)	shtLev(2)	lngLev(3)
Z_high*During	0.0371***	0.0289***	0.0081***			
	(0.0038)	(0.0035)	(0.0026)			
Z_mid*During				0.0186***	0.0111***	0.0075***
				(0.0040)	(0.0038)	(0.0029)
During	-0.0009	-0.0048	0.0058	-0.0120	-0.0185	0.0065
	(0.0113)	(0.0102)	(0.0077)	(0.0127)	(0.0121)	(0.0097)
size	0.0179***	0.0041*	0.0137***	0.0130***	-0.0051	0.0181***
	(0.0030)	(0.0024)	(0.0018)	(0.0037)	(0.0034)	(0.0025)
fix	0.0290	-0.0032	0.0322*	0.0517*	0.0107	0.0410**
	(0.0243)	(0.0216)	(0.0179)	(0.0273)	(0.0277)	(0.0226)
growth	0.0391***	0.0322***	0.0069***	0.0279***	0.0207***	0.0072***
	(0.0034)	(0.0032)	(0.0020)	(0.0035)	(0.0023)	(0.0025)
ROA	-	-	-	-	-	-
	0.3925***	0.2836***	0.1089***	0.5150***	0.3968***	0.1182***
	(0.0222)	(0.0200)	(0.0122)	(0.0234)	(0.0220)	(0.0145)
q	-	-	-	-	0.0002	-
	0.0159***	0.0045***	0.0111***	0.0197***	(0.0032)	0.0199***
	(0.0016)	(0.0013)	(0.0008)	(0.0037)		(0.0021)
age	0.0205	0.0268	-0.0062	0.0362	0.0504	-0.0142
	(0.0454)	(0.0395)	(0.0299)	(0.0523)	(0.0489)	(0.0397)
Cons_	-0.0895	0.1160	-0.2055	0.0603	0.0324	-0.2640**
	(0.0025)	(0.1234)	(0.0900)	(0.1724)	(0.1588)	(0.1243)
Firm controlled	yes	yes	yes	yes	yes	yes
Time controlled	yes	yes	yes	yes	yes	yes

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	High			Mid		
	ttlLev(1)	shtLev(2)	lngLev(3)	ttlLev(1)	shtLev(2)	lngLev(3)
N	11868	11868	11868	9688	9688	9688
R^2	0.250	0.080	0.252	0.133	0.057	0.160

the coefficient values of O-low*during are larger than these corresponding coefficient values of O-mid*During. These results reveal that the firms with low financial distress level increase more leverage ratios (especially short-term leverage ratios) than the firms with middle distress level, which further verifies the H2.

Table 8. COVID-19, O-Score and Capital Structure (Robustness Test)

	High			Mid		
	ttlLev(1)	shtLev(2)	lngLev(3)	ttlLev(1)	shtLev(2)	lngLev(3)
O_low*During	0.0214***	0.0186***	0.0028			
	(0.0038)	(0.0034)	(0.0026)			
O_mid*During				0.0171***	0.0147***	0.0024
				(0.0040)	(0.0037)	(0.0027)
During	-0.0015	-0.0110	0.0094	-0.0057	-0.0160	0.0103
	(0.0119)	(0.0110)	(0.0086)	(0.0122)	(0.0115)	(0.0085)
size	0.0206***	0.0060**	0.0146***	0.0172***	-0.0001	0.0173***
	(0.0030)	(0.0026)	(0.0019)	(0.0032)	(0.0028)	(0.0020)
fix	0.0549***	-0.0315	0.0233	0.0559**	0.0091	0.0467**
	(0.0265)	(0.0245)	(0.0216)	(0.0255)	(0.0233)	(0.0193)
growth	0.0368***	0.0296***	0.0072***	0.0349***	0.0284***	0.0065***
	(0.0034)	(0.0032)	(0.0022)	(0.0032)	(0.0031)	(0.0020)
ROA	-0.4317***	-0.3206***	-0.1111***	-0.4741***	-0.3697***	-0.1044***
	(0.0217)	(0.0203)	(0.0122)	(0.0212)	(0.0198)	(0.0121)
q	-0.0165***	-0.0045***	-0.0119***	-0.0208***	-0.0054***	-0.0154***
	(0.0018)	(0.0014)	(0.0010)	(0.0023)	(0.0019)	(0.0012)
age	0.0451	0.0499	-0.0048	0.0772	0.0903	-0.0131
	(0.0470)	(0.0423)	(0.0333)	(0.0492)	(0.0454)	(0.0338)
Cons_	-0.2094	0.0198	-0.2293**	0.1672	0.0872	-0.2544**
	(0.0026)	(0.1343)	(0.1009)	(0.11516)	(0.1405)	(0.0998)
Firm controlled	yes	yes	yes	yes	yes	yes
Time controlled	yes	yes	yes	yes	yes	yes

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N	11275	11275	11275	11754	11754	11754
R^2	0.240	0.095	0.191	0.192	0.041	0.226

4. Further Analysis

According to the results in section 3, all sample companies experience an great increase in financial leverage (especially short-term leverage), and the low financial distress companies increase more than the high distress companies. One reason may be that during COVID period companies' business scale, profits and cash flow have sharply decreased so that they have to sell their assets to repay the existing debts. Of course, there may also exist another possibility, due to the government's financing support policies during the COVID, these companies can obtain more external loans compared to usual. Table 9 shows the mean of total assets (fix assets) is greatly increased from 16.2 (4.12) billion to 21.6 (4.93) billion RMB during COVID. This clearly indicates that the asset size of company has increased during COVID and the leverage growth is not because the increase of assets. In order to verify that the leverage's increase is due to the increase of loans and low financial distress companies increase more debts than high distress companies, we still use model (3) to test the COVID's heterogeneous impact on company debts, with total, short-term and long-term debts as the explained variables. Table 10 presents the regression results and it shows that the total, short-term and long-term debts of low financial distress companies are all increased more than those of high distress companies during COVID-19 period. This confirms that companies do increase more debts during COVID period and low financial distress companies obtain more external loans due to their better financial credits, compared to high distress companies.

Table 9. The Assets Scale Before and During COVID-19

	Total assets	Fix assets
before	16.2	4.12
During	21.6	4.93

Note:Total assets and fix assets are the values in the table multiplied by one billion.

Table 10. COVID-19, financial distress and debts

	(1)			(2)		
	Totaldebts	shortdebts	longdebts	Totaldebts	shortdebts	longdebts
Z*During	0.2281***	0.1873***	0.7728***			
	(0.0181)	(0.0165)	(0.0696)			

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O*During				0.1366***	0.1183***	0.5221***
				(0.0163)	(0.0153)	(0.0678)
Controlled	Y	Y	Y	Y	Y	Y
Firm controlled	Y	Y	Y	Y	Y	Y
Time controlled	Y	Y	Y	Y	Y	Y
N	17188	17188	17188	17188	17188	17188
R^2	0.284	0.296	0.117	0.682	0.666	0.389

5. Conclusion, Limitations, Significance, and Future Research Directions

This paper investigates whether the COVID-19 pandemic had heterogeneous effects on capital structure decisions across Chinese listed firms with differing levels of financial distress risk. Employing a difference-in-differences methodology over the period 2017 to 2022 and cross-validating results using both the Altman Z-Score and the Ohlson O-Score, the study yields three principal findings. First, the pandemic triggered a broad increase in corporate financial leverage, with firms across the distress spectrum taking on additional debt to sustain operations amid declining revenues and deteriorating cash flows. Second, and more importantly, financially sound firms experienced significantly larger leverage increases than their distressed counterparts, with this differential driven predominantly by short-term borrowing. Third, the further analysis confirms that this asymmetric leverage response reflects differential credit access rather than asset revaluation effects: low-distress firms obtained greater incremental external loans during the pandemic, benefiting from stronger credit profiles and lower perceived default risk, consistent with the predictions of pecking order theory and credit-rationing arguments. These findings extend the emerging literature on COVID-19 and corporate finance in several respects. While prior work has examined how the pandemic affected leverage adjustment speeds or earnings management behavior, this paper is the first to document the heterogeneous capital structure response specifically from the vantage point of firms' pre-pandemic financial distress risk. The results also carry implications for policymakers: pandemic-era credit support programs, although broadly available, were disproportionately absorbed by financially healthier firms, raising questions about the effectiveness of relief measures in reaching the most financially vulnerable enterprises.

5.1 Limitations

Several limitations should be acknowledged when interpreting the findings. The analysis is confined to firms listed on the Shanghai and Shenzhen Stock Exchanges, which are relatively large

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and transparent compared to the broader population of Chinese firms. The conclusions may therefore not generalize to unlisted small and medium-sized enterprises, which often face more severe credit constraints and may exhibit markedly different leverage dynamics under economic stress. In addition, the study treats COVID-19 as a binary shock defined by calendar period (2020 to 2022), which does not capture within-period variation in pandemic intensity, regional lockdown severity, or the timing and scale of government relief programs. The DID framework, while appropriate for this research design, assumes parallel pre-trends and cannot fully account for time-varying confounders that may have differentially affected firms across distress levels during this unusual period. Furthermore, the financial distress proxies used, namely Z-Score and O-Score, were developed in non-Chinese institutional contexts and may not perfectly capture credit risk in China's partially state-directed financial system. Finally, the paper does not examine potential channels through which state ownership or political connections may have mediated credit access, which is an important dimension in the Chinese setting.

5.2 Significance and Future Research Directions

Despite these limitations, this study makes a meaningful contribution by providing firm-level evidence on how pre-existing financial conditions shape capital structure responses to an exogenous macroeconomic shock. The results highlight that access to external credit during a crisis is deeply conditioned by a firm's financial health, which has both theoretical and policy relevance. Future research could extend this work in several productive directions. First, studies incorporating unlisted and private firms would provide a more complete picture of pandemic-driven financing dynamics across the firm size distribution. Second, examining heterogeneous effects by industry, geographic region, and ownership type (state-owned versus private) would offer richer insights into the structural determinants of capital structure resilience. Third, comparing the Chinese experience with evidence from other emerging economies would help identify whether the patterns documented here are China-specific or reflect broader emerging-market phenomena. Finally, investigating the longer-term consequences of pandemic-era leverage increases for firm investment, profitability, and financial distress outcomes in the post-COVID period represents an important avenue for future inquiry.

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Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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