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Debt rollover risk, credit default swap spread and stock returns: Evidence from the COVID-19 crisis

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ABSTRACT

This paper studies how the COVID-19 shock affects the CDS spread changes and abnormal stock returns of U.S. firms with different levels of debt rollover risk. We use the COVID-19 crisis as a quasi-natural experiment of adverse cash flow shock that increases the default risk of firms facing an immediate liquidity shortfall. We find that the COVID-19 shock significantly increased the CDS spread and decreased the shareholder value for firms facing higher debt rollover risk. The effect is stronger for non-financial firms, for firms that are financially constrained, and for firms that are highly volatile. Moreover, we find that firms with immediate refinancing needs suffered more than firms with distant refinancing needs during the COVID-19 shock, which further confirms that firms’ debt rollover risk is indeed a key factor that drives the heterogeneous reactions to the shock. The paper provides fresh insights into the role of firms’ debt rollover risk during the COVID-19 health crisis.

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1. Introduction

The COVID-19 health crisis has caused significant disruptions to the economic activities around the globe. Businesses of all sizes have been adversely affected due to both the lockdown imposed by the local governments and the panic from local residence, causing a precipitous drop in customer attendance rates. The health crisis creates a liquidity shock by triggering a sudden plunge in firms’ cash flow, leaving those firms with pressing financing needs and little cash reserve vulnerable to default. With unemployment rate skyrocketed to 14.7% within a few weeks’ time and the huge economic uncertainty due to the unpredictability of the COVID pandemic, it is expected that firm default risk will increase significantly, and a bankruptcy boom will arrive should the crisis persists. In the event of actual bankruptcies, shareholders can only claim the residual value of the firms, which often results in a total loss to the shareholder value. How do investors react to the heightened bankruptcy risks at firms? Do firms facing significant debt rollover risk (i.e., firms that have the immediate needs of repaying maturing debt but may not have enough liquidity to meet the repayment obligation) suffer more from the health crisis? These are very pressing questions to understand the economic impact of the pandemic. In this paper, we use the COVID-19 crisis as a quasi-natural experiment of adverse cash flow shock to investigate the effects of debt rollover risk on firms’ default risk and thus shareholder value.

The unprecedented health crisis provides a unique opportunity to study the heterogeneous impact of debt rollover risk on firms’ default risk and shareholder value. The presence of capital market frictions makes firms’ debt maturity structure matters (e.g., Diamond, 1991). The cash flow shock induced by COVID-19 crisis exacerbates the rollover risks for firms having a large amount of debt due shortly and insufficient cash reserves. First, the significant cash flow plunge caused by the COVID-19 crisis makes it difficult for firms with large amount of debt maturing and little cash reserves to meet its debt payment obligation and thus need to roll over their maturing debt to future periods. Second, it is unclear whether such firms can rely on alternative sources for refinancing given that it is costly to acquire external financing through new equity or bond issuance during the market downturns caused by COVID-19. Thus, without meaningful cash reserves, borrower firms with a large amount of debt due shortly face significant debt rollover risk, as lenders’ possible refusal to roll over the maturing...
debt (due to poor cash flows and huge uncertainties) to future periods could force the borrower firms into default. If the cash reserve is large enough to pay back the debt due, there is no need to roll the maturing debt over to future periods. The literature also suggests that the negative impact of the Global Financial Crisis on firm investment is more pronounced for firms with lower level of pre-cautionary cash reserves and firms with more short-term debt outstanding (Duchin et al., 2010). Thus, we construct a debt-rollover-risk measure based on the ratio of firms' short-term debt (debt due within one year) to cash reserve before the crisis, and identify firms facing significant debt rollover risk in the near future.

We focus on the credit default swap (CDS) spread changes and abnormal stock returns when evaluating the heterogeneous market reactions to the shock. To the extent that the financial markets are efficient enough to digest the potential effects from the shock, we will be able to capture the heterogeneous impacts on firms' default risk and shareholder value through these measures. As firms with debt maturing shortly and insufficient cash reserve to pay off the maturing debt may face severe debt rollover risk, their market measures are likely to react more strongly to the shock. Similar to the Great Recession, the recent COVID-19 shock features a sudden collapse in asset prices. With the S&P 500 stock price index dropping 34% within 33 days (from February 19 to March 23, 2020), the shock is severe enough to hit U.S. public firms unexpectedly. Although COVID-19 shock is a systemic shock that affects the whole economy, the actual timing of the debt due varies across firms, causing different levels of rollover risk for firms at the time of the COVID shock struck the market and thus the effects are likely to be more pronounced in firms that face significant debt rollover risk.

Using data on firms' CDS spread changes, we investigate whether the COVID-19 crisis significantly increases the default probabilities of firms with significant debt rollover risk. Fig. 1 shows the average cumulative 6-month CDS spread changes for the debt-rollover-risk quartiles. Although CDS spread increases in February and March 2020 across all debt-rollover-risk quartiles, the increase is much more prominent for firms in the highest rollover risk quartile—the cumulative CDS spread change is a startling 900 basis points before declining subsequently. The cumulative 6-month CDS spread change for firms in the highest debt-rollover-risk quartile is more than four times larger than the cumulative change for firms in the other three quartiles. We further examine the cumulative 1-year, 5-year and 10-year CDS spread changes and document similar patterns, as shown in Figs. A1–A3 in the Appendix.

Our regression results also confirm that the COVID-19 shock exerts heterogeneous impact on the default risk and CDS spread of firms with different levels of debt rollover risk. In particular, we find that the shorter the CDS contract maturity, the greater is the increase in CDS spread for firms with high debt rollover risk, indicating that investors are more concerned about the short-term default risk for high rollover-risk firms than these firms' long-term default risk. The COVID-19 shock leads to an increase in CDS spread of 349–880 basis points across different CDS contract maturities for firms in the highest rollover-risk quartile relative to firms in the other rollover-risk quartiles. We also find that the impact of the COVID-19 crisis on CDS spread of high rollover-risk firms is much more pronounced in the later sample period (from 3/2/2020 to 3/26/2020) when the U.S. gradually becoming the most COVID-19 affected country in the world than in the first sample period (from 1/30/2020 to 2/28/2020) when the crisis mostly affecting Asia and Europe. Additionally, we find that the impact of the shock on CDS spread of high rollover-risk firms is much stronger if such firms also face tight financial constraints or have high firm volatilities.

Since shareholders are the residual claimants of a firm's assets once the firm defaults, an increase in firms' default risk negatively affects shareholder wealth. Consistent with the evidence on default risk, we find that the crisis leads to significant negative abnormal stock returns for firms with higher debt rollover risks. Fig. 2 shows the average buy-and-hold abnormal stock returns (BHARs) for different debt-rollover-risk quartiles over the sample period. Although the average BHARs significantly decrease in general across all debt-rollover-risk quartiles in February and March, the decline is more pronounced for the top two firm quartiles with the highest rollover risk.

Our regression results further confirm that relative to firms in the other quartiles of debt rollover risk, the crisis leads to an economically significant decline of -2% to -3% in stock returns for real-sector firms in the highest rollover-risk quartile over the sample period. Further, the lower stock returns for high rollover-risk firms are confined to real-sector firms and not financial-sector firms, and mainly concentrated in the later sample period when the U.S. becomes heavily impacted by COVID-19. This finding is consistent with the notion that different from the Global Financial Crisis, the COVID-19 crisis is a health crisis that directly hits the real sector and not the financial sector.1 In addition, we show that the negative stock return reactions are much stronger for high debt-rollover-risk firms when such firms also face tight financial constraints, or have higher stock return volatilities, consistent with the earlier findings from CDS spread changes and the findings from the Global Financial Crisis (e.g., Ivashina et al., 2015).

Our evidence that financial constraints amplify the magnitude of the impact of the COVID-19 crisis on stock returns of high debt-rollover-risk firms is consistent with the implications from the literature. For example, previous studies suggest that stock returns of financially constrained firms tend to comove together, and such firms tend to earn higher returns on average (e.g., Whited and Wu, 2006). However, during crisis time, such firms tend to suffer more likely due to their corporate liquidity shortfall. For example, Campello et al. (2010) find that during the Global Financial Crisis, financially constrained firms planned deeper cuts in tech spending, employment, and capital spending, burned through more cash, drew more heavily on lines of credit, sold more assets to fund their operations, and bypassed attractive investment opportunities. Our evidence indicates that the liquidity shortfall due to the COVID-19 cash flow shock exposes firms, especially those facing tight financial constraints, to debt rollover risk. Moreover, the literature suggests that stock returns are primarily driven by firm's cash flow news (e.g., Vuolteenaho, 2002). Our evidence that firm's cash flow uncertainty amplifies the magnitude of the impact of the COVID-19 crisis on stock returns of high debt-rollover-risk firms is consistent with the implications from the literature. That is, firms with high cash flow uncertainty are likely to be hit particularly hard by the cash flow shock of COVID-19 and thus should earn lower stock returns during the crisis.

To strengthen the identification on the effects of rollover risk, we further zoom in on the timing of firms' debt rollover, and compare the effects of rollover risk on CDS spreads and BHARs for firms with debt maturing immediately and firms with debt due later in the year. The COVID-19 crisis is an exogenous shock to firms. As the outbreak of the COVID-19 pandemic is entirely unexpected, the percentage of firms' debt that is maturing in the first few months of year 2020 when the COVID-19 shock hit the U.S. is exogenous to firms' choice ex ante. Even if the total amount of debt due in year 2020 is the same for two firms, the actual timing of the debt due is different, causing different levels of rollover risk for firms at the time of the COVID-19 shock. The COVID-19 crisis creates a liquidity shortfall by causing a sudden plunge in firms' cash flow. If debt rollover risk is indeed a driver for the heterogeneous reactions in 1 The banking and financial industries are much better prepared when the COVID-19 crisis hit possibly also due to the resilience built up through various post-Great Recession regulations.
firms’ CDS spread and shareholder value, then we should expect a stronger effect for firms that face immediate refinancing needs than for firms that face refinancing needs in the second half of year 2020 (in other words, distant refinancing needs). Indeed, our empirical results show that firms with immediate refinancing needs suffered more than firms with distant refinancing needs during the COVID-19 cash flow shock. The results thus further strengthen the finding of our main tests. Finally, we perform various robustness tests including controlling for new debt issuance in the first quarter of 2020 and using alternative measures of debt rollover risk. The results of these robustness tests are all consistent with our main findings and suggest that firms’ debt rollover risk is indeed a key factor that drives the heterogeneous reactions to the COVID-19 shock. We further separate the impact of the COVID-19 shock

![Fig. 1. CDS Spread Changes (6-Month) and Debt Due within One Year under the COVID-19 Shock.](image1)

Figure 1 shows the cumulative CDS spread changes (6-month) for various groups. We divide our sample firms into quartiles according to their debt due within one-year scaled by cash and short-term investments (DD\textsubscript{One})—group 1 has the lowest DD\textsubscript{One} value and group 4 has the highest DD\textsubscript{One} value.

![Fig. 2. BHARs and Debt Due within One Year under the COVID-19 Shock.](image2)

Figure 2 shows the cumulative buy and hold abnormal returns (BHARs) for various groups. We divide our sample firms into quartiles according to their debt due within one-year scaled by cash and short-term investments (DD\textsubscript{One})—group 1 has the lowest DD\textsubscript{One} value and group 4 has the highest DD\textsubscript{One} value.)
from that of the U.S. government relief package. We investigate CDS spread changes and stock returns for high rollover-risk firms around the launch of the government relief package. The results suggest moderate mitigating effects of the government relief package on improving the high rollover-risk firms’ resilience to the COVID-19 shock.

This paper contributes to a few strands of literature. First, the paper contributes to the literature on firms’ debt rollover risk. The extant literature highlights the importance of carefully managing the risks from maturing debt (e.g., Froot et al., 1993). Earlier research on debt maturity choice discusses the trade-offs between having long-term versus short-term debt. For example, the use of short-term debt overcomes underinvestment problems by mitigating the conflicts of interest between managers, debt holders and equity holders (e.g., Myers, 1977; Barclay and Smith, 1995), but exposes firms to rollover risks more often and heightens the chance of inefficient liquidation (e.g., Diamond, 1991; He and Xiong, 2012). In the presence of credit market imperfections, short-term debt can lower firm value if it has to be refinanced at an overly high interest rate (e.g., Froot et al., 1993; Sharpe, 1991; Titman, 1992). Looking at the Global Financial Crisis, Almeida et al. (2012) demonstrate the adverse impact on investment for firms having large proportion of debt maturing right after August 2007. Gopalan et al. (2014) employ a similar framework and find that firms with a large portion of debt maturing likely experience credit downgrades and face higher spreads in the bond market.2

Our paper contributes to the literature on debt rollover risk in two important aspects. First, our study provides fresh empirical evidence on the adverse effects of debt rollover risk on firm default risk as reflected in CDS spread changes and abnormal stock returns. Second, our study is the first that looks at the adverse effects of debt rollover risk in a unique setting of the COVID-19 crisis. Differing from the Global Financial Crisis which first affected the financial market and credit supply to firms, the COVID-19 health crisis directly affected firms’ cash flows. Stable cash flows are not only essential for covering maturing debt but also crucial for raising new debt. Given the unprecedented COVID-19 shock to cash flows, it is uncertain ex ante whether firms with large amount of debt maturing and little cash reserves can successfully roll over their maturing debt. This study takes advantage of the unique setting of the COVID-19 shock to study the impact of debt rollover risk on corporate default and shareholder value.

Moreover, the paper is related to the literature on the impact of economic crises. The literature shows that economic crises are associated with reductions in the aggregate output level (e.g., Reinhart and Rogoff, 2008). Some studies examine the impact of the financial crises on banks and show that there are significant negative effects on banks’ capital that reduces the supply of loans to the corporate sector. Further evidence suggests that adverse consequences from increased losses in the banking sector spill over to the corporate sector and negatively affect borrowing firms’ performance (Lehmann and Roberts, 2010; Chava and Purnanandam, 2011). This paper contributes to the literature by documenting the heterogeneous effects of the COVID-19 crisis on real-sector firms and financial firms from a financial market perspective. Unlike the Global Financial Crisis, the COVID-19 crisis is a health crisis that directly hits the real sector and not the financial sector.

The paper is also related to research on firms’ holding of cash reserves. Many empirical papers on corporate liquidity management focus on cash and cash equivalent as an important source of liquidity in the presence of market frictions. For example, financially constrained firms may benefit from holding cash that mitigates the underinvestment problem (e.g., Opler et al., 1999; Almeida et al., 2004; Faulkender and Wang, 2006; Denis and Sibilkov, 2010; Duchin et al., 2010). However, in firms with agency problems, holding cash provides the chance for managers to engage in value-destroying investment activities (Jensen, 1986; Harford, 1999). Thus, holding excess cash reserve is regarded as expensive in practice (Holmström and Tirole, 2000, 2001). This paper contributes to the literature by emphasizing the importance of holding enough cash reverses to mitigate the rollover risks under the context of the COVID-19 health crisis.

Last but not least, this paper relates to the contemporaneous work on the market reaction to COVID-19 crisis for firms.3 For instance, Ramelli and Wagner (2020) find that investors were moving away from U.S. firms with exposures to China when the virus was contained in China. Moreover, when the virus spread to Europe and the U.S., leverage ratio and cash holding are important value drivers as they have significant negative and positive effects on stock prices respectively. Ding et al. (2020) investigate the stock market reactions of firms around the world in the early 2020. They find that the drop in stock price was milder for firms with stronger pre-2020 finances, less exposure to COVID-19 through global supply chains and customer locations, more CSR activities, and less entrenched executives. Focusing on non-financial firms during the COVID-19 crisis, Fahlenbrach et al. (2020) find a worse decline in stock prices for firms with less cash reserves, and firms with more short-term or long-term debt. The difference between the effects of short-term and long-term debt is insignificant. The authors also find levered firms experienced stronger increase in the CDS premia but do not find firms with more short-term debt to be affected differently from firms with more long-term debt. In addition, they find that the decline in the stock prices was not affected by firms’ ability of accessing financial markets as measured by the financial constraint indices prior to the crisis. Alfaro et al. (2020) find that an unanticipated doubling (halving) of projected COVID-19 infections forecasts next-day decreases (increases) in aggregate US stock market value of 4–11 percent, and firms with higher leverage, lower profitability or higher capital intensity experienced worse COVID-19 related losses. These contemporaneous papers on the market reactions during the COVID-19 crisis do not focus on the effects of debt rollover risk as we do.

In this paper, we focus on both financial and real-sector firms with immediate refinancing needs of rolling over debt at the time of COVID-19 shocks. Given an immediate liquidity shortfall as implied by the COVID-19 crisis, we document a substantial increase in CDS spread changes and decline in stock returns for firms with higher levels of debt rollover risk. We also find that being financially constrained or having greater firm volatilities makes these firms with higher rollover risks suffered more from the COVID-19 crisis.

The rest of the paper proceeds as follows. Section 2 describes data and explains how we measure debt rollover risk and market reactions. Section 3 investigates the relation between debt rollover risk and CDS spread changes during the COVID-19 crisis. Section 4 examines the relation between debt rollover risk and abnormal stock returns during the crisis. Section 5 investigates whether firms with immediate refinancing needs suffered more during the COVID-19 cash flow shock compared with firms with distant refinancing needs. Section 6 reports the results from various robustness tests. Section 7 investigates how firms’ CDS spread

2 A related stream of research looks at the granularity of the entire maturity structure of outstanding debt and provides evidence on the availability and costs of financing (e.g., Norden et al., 2016; Choi et al., 2018).

3 There are many contemporaneous papers that are broadly related to the impact of COVID-19 crisis, but not on the effects on the financial markets (e.g., Acharya and Steffen, 2020; Cejněk et al., 2020; Halling et al., 2020; Li et al., 2020; Bartik et al., 2020; Baker et al., 2020).
changes and stock returns react to the government relief package. Section 8 concludes.

2. Background and data

2.1. COVID-19 crisis in the United States

The COVID-19 pandemic, also known as the coronavirus pandemic, is an ongoing pandemic of coronavirus disease, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The outbreak was first identified in Wuhan, China, in December 2019. The virus then quickly spread across the globe, and the U.S. too was hard hit by the COVID-19 crisis in early 2020. After the first death in the United States was reported in Washington state on February 29, Governor Jay Inslee declared a state of emergency, an action soon followed by other states. President Trump then declared a national emergency on March 13, making federal funds available to respond to the crisis. As of May 17, 2020, more than 4.71 million cases of COVID-19 have been reported in more than 188 countries and territories, resulting in more than 315,000 deaths. The outbreak of COVID-19 pandemic has far-reaching consequences on the society than the spread of the deadly disease itself. Various levels of mandatory shutdowns and social distancing measures implemented by local and states governments have brought many parts of the U.S. economy to a standstill. In April alone, nearly a quarter of residents (renters and homeowners) did not pay full housing costs. Many workers were furloughed or laid off as a result of business and school closures and the cancellation of public events. According to data released by the U.S. Bureau of Labor Statistics on May 8, the U.S. economy lost a staggering record 20.5 million jobs in April, pushing the unemployment rate to 14.7%—the highest monthly rate since record keeping began in 1948.

2.2. Data and variables

We measure firms’ stock price reactions and CDS spread changes over the entire sample period from 1/30/2020 to 3/26/2020 (whole period). We also separately examine two subperiods: 1/30/2020–2/28/2020 (period 1) and 3/2/2020–3/26/2020 (period 2).4 The sample period and subperiods are based on three major milestones related to the development of COVID-19 crisis, including 1/30/2020, the date when the World Health Organization (WHO) declared a global public-health emergency, 2/29/2020, the date when the US reports the first death on American soil, and 3/26/2020, the date when the US became the world’s most affected country—total confirmed cases in the US reached 82,404 on this date, surpassing China’s 81,782 and Italy’s 80,589.5

To analyze the stock market reactions, we obtain daily stock price data of all common stocks (CRSP share code 10 or 11) listed on NYSE, AMEX, and NASDAQ from the Center for Research in Security Prices (CRSP). We obtain information on firms’ CDS spread from Markit database for firms with CDS contracts of various maturities. Only the CDS contracts on public firms for which we have data in CRSP and COMPSTAT are used in our study. To control for firm characteristics, we obtain one-quarter lagged financial data from Compustat. We then link firms’ stock price and CDS reactions to firms’ characteristics such as rollover risk in the quarter prior to the COVID crisis to study the cross-sectional variation in the market reactions to the shocks. We also include standard firm-level control variables such as firm size (Size), profitability (Roor), firm market-to-book equity ratio (MTB), leverage ratio (Leverage), past stock returns of the firm (Past_Return) and past volatility of stock returns (Vol) as it is well known that these firm characteristics are related to cross-sectional stock returns.

We measure the potential impact of debt rollover risk based on the ratio of firms’ debt that matures shortly (debt due within one year) to cash and short-term investment before the crisis (DD_One). Having a larger percent of debt maturing shortly subjects a firm to liquidity risks of creditors’ refusing to roll over the debt due to the cash flow shock imposed by the COVID-19 crisis.6 And having abundant cash reserves help mitigate the adverse effects from potentially not being able to roll over the debt due. If the cash reserve is large enough to pay back the debt due, there is no need to roll the debt over to future periods. The literature also suggests that the negative impact of the Global Financial Crisis on firm investment is more pronounced for firms with lower level of pre-cautionary cash reserves and firms with more short-term debt outstanding (Duchin et al., 2010). A higher value of this ratio thus indicates higher potential effects from debt rollover risk. In other words, firms with immediate needs of repaying maturing debt and insufficient cash reserves will face significant debt rollover risk. In the robustness tests, we also construct two alternative debt-rollover-risk measures by scaling the amount of debt due within one year with the amount of total debt outstanding (Friedewald et al., 2018) and the amount of total long-term debt outstanding (Almeida et al., 2012; Hu, 2010), respectively.

Our dataset consists of 3047 firm observations with non-missing stock returns and financial data. Then, we create a subsample that contains 234 firms having CDS contracts with non-missing main spread data in Q1 2020. Table A1 provides the detailed definition and data source for each of the variables used in the study and Table 1 provides the summary statistics. All continuous variables are winsorized at the 1st and 99th percentiles to limit the influence of outliers.

3. Debt rollover risk and CDS spread during the COVID-19 crisis

This section investigates how the COVID-19 shock affects the CDS spread of firms with different levels of debt rollover risk. We also examine whether financial constraints and firm volatilities amplify the impact of the COVID-19 shock on the default risk and CDS spread of high debt-rollover-risk firms.

3.1. Debt rollover risk and CDS spread

We sort firms with available CDS spread data (i.e., 234 firms) equally into quartiles according to their debt rollover risk (DD_One) and construct an indicator variable, DD_One_High25, which equals 1 if the firm falls in the top quartile of debt due within one year scaled by cash and short-term investment (with available CDS data) and equals 0 otherwise. We then employ the following regression model to examine the impact of the COVID-19 shock on CDS spread of firms with different levels of debt rollover risk:

\[
\text{Spread}_{i,t} = \alpha + \beta_1 \text{DD}_{One,H} + \beta_2 \text{Controls}_{i,t} + \text{Industry}_FE + \epsilon_{i,t}
\]

We update the coefficient estimates to include a series of controls (listed in Table 2) as we take into consideration both firm-specific and industry-specific factors. To further test the differential impact of the shock on different types of firms, we split the sample into various subsamples, including levered and levered firms, large and small firms, and firms with varying levels of forecast ability.
In Eq. (1), the dependent variable, Spread, is the change in firm’s 6-month, 1-year, 5-year or 10-year CDS spread over the sample period (CDS\_6M, CDS\_1Y, CDS\_5Y or CDS\_10Y). The regression coefficient of DD\_One\_High25 reflects the incremental impact of the crisis on firms in the highest debt-rollover-risk quartile relative to firms in the other quartiles. Control variables include firm characteristics such as firm size (Size), profitability (Roa), market-to-book equity ratio (MTB), financial leverage (Leverage), past stock returns (Past\_Return), stock return volatility (Vol) and stock illiquidity (Illiquidity). Industry fixed effects (i.e., 2-digit SIC industry indicators) are included to control for potential heterogeneous responses of firms from different industries.\(^7\) Standard errors are clustered at the 2-digit SIC industry level. The results are reported in Table 2.

We separately estimate Eq. (1) for the first period from 1/30/2020 to 2/28/2020 (i.e., the period from the date when WHO declares a global public-health emergency to the date when the U.S. reports the first death on American soil), the second period from 3/2/2020 to 3/26/2020 (i.e., the period when the U.S. gradually develops into the most COVID-19 affected country in terms of the number of cases identified), and the full sample period from 1/30/2020 to 3/26/2020 and report the results in Panels A, B, and C respectively. Panel A of Table 2 shows that the regression coefficient of DD\_One\_High25 is significantly positive at the 1% level across different regression models with CDS\_6M, CDS\_1Y, CDS\_5Y and CDS\_10Y as the dependent variables respectively. The results indicate that relative to firms in the other quartiles of debt rollover risk, the COVID-19 crisis leads to an economically significant increase in CDS spread of 104–207 basis points across different CDS contract maturities for firms in the highest rollover-risk quartile in the first period when the US reports the first death on American soil.

Panel B shows even more significant results in the second period. Again, the regression coefficient of DD\_One\_High25 is significantly positive across different regression models. The results indicate that the crisis leads to a startling increase in CDS spread of 270–673 basis points across different CDS contract maturities for firms in the highest rollover-risk quartile relative to firms in the other rollover-risk quartiles. Moreover, the shorter the CDS maturity, the larger is the increase in CDS spread, indicating that investors are more concerned about the short-term default risk for high rollover-risk firms than these firms’ long-term default risk.

Panel C shows the impact of the COVID-19 crisis on the CDS spread of firms with different levels of debt rollover risk over the entire sample period from 1/30/2020 to 3/26/2020. Consistent with the earlier results, the results in Panel C suggest that the COVID-19 crisis leads to an increase in CDS spread of 349–880 basis points across different CDS contract maturities for firms in the highest rollover-risk quartile relative to firms in the other rollover-risk quartiles—again, the shorter the CDS maturity, the greater is the impact. The regression coefficients of three control variables, Roa, Past\_Return and Vol, are also statistically significant, indicating that firms with lower past stock returns, greater stock return volatility or greater profitability experience greater increase in CDS spread during the COVID-19 crisis.

As a robustness test, we use the first (lowest) rollover-risk quartile as the reference group and construct three indicator variables, DD\_One\_Group2, DD\_One\_Group3, and DD\_One\_Group4, to indicate the other three quartiles and reestimate Eq. (1). The results are reported in Table A2 in the Appendix. We consistently find that only the regression coefficient of the highest rollover-risk quartile (DD\_One\_Group4) is significantly positive across different regression models with CDS\_6M, CDS\_1Y, CDS\_5Y and CDS\_10Y as the dependent variables respectively in the first, second and whole periods. The results indicate that relative to firms in the lowest debt-rollover-risk quartile, firms in the highest debt-rollover-risk quartile on average experience a highly significant increase in CDS

\(^7\) For example, firms from transportation industries may react very differently from internet or online gaming firms.
Table 2
CDS Spread Changes and Debt Due within One Year (DD_One_High25) under the COVID-19 Shock.

Panel A. CDS spread change in Period 1
2020-01-30 – 2020-02-28 (Period 1)

| Variables | (1) CDS_6M | (2) CDS_1Y | (3) CDS_5Y | (4) CDS_10Y |
|-----------|------------|------------|------------|-------------|
| DD_One_High25 | 190.596*** | 206.575*** | 124.165*** | 104.084*** |
| (69.014) | (69.099) | (44.835) | (38.643) |
| Size | 27.301 | 24.878 | 19.379 | 12.824 |
| (26.177) | (26.175) | (17.006) | (14.693) |
| Roa | 16.565*** | 16.057*** | 10.872*** | 8.884*** |
| (4.931) | (4.931) | (3.204) | (2.759) |
| MTB | 1.221 | 1.101 | 0.782 | 0.557 |
| (2.303) | (2.303) | (1.496) | (1.287) |
| Leverage | 0.100 | -0.379 | -0.106 | -0.187 |
| (1.135) | (1.135) | (0.737) | (0.636) |
| Past_Return | -3.518*** | -2.982*** | -2.076*** | -1.972*** |
| (0.979) | (0.979) | (0.636) | (0.561) |
| Vol | 14.812*** | 13.676*** | 11.073*** | 9.742*** |
| (2.543) | (2.543) | (1.652) | (1.456) |
| Illiquidity | -0.698 | -0.517 | -0.324 | -0.200 |
| (2.365) | (2.365) | (1.537) | (1.322) |
| Industry FE | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes |
| Number of Obs. | 234 | 234 | 234 | 232 |
| Adj R2 | 0.211 | 0.132 | 0.270 | 0.243 |

Panel B. CDS spread change in Period 2
2020-03-02 – 2020-03-26 (Period 2)

| Variables | (1) CDS_6M | (2) CDS_1Y | (3) CDS_5Y | (4) CDS_10Y |
|-----------|------------|------------|------------|-------------|
| DD_One_High25 | 673.498*** | 568.930*** | 319.250*** | 270.181*** |
| (238.709) | (211.349) | (122.189) | (103.619) |
| Size | 94.141 | 87.151 | 47.331 | 33.984 |
| (90.542) | (80.164) | (46.346) | (39.202) |
| Roa | 54.117*** | 46.533*** | 25.694*** | 21.910*** |
| (17.057) | (15.102) | (8.731) | (7.495) |
| MTB | 3.849 | 3.360 | 1.668 | 1.336 |
| (7.967) | (7.054) | (4.078) | (3.528) |
| Leverage | 0.760 | 0.701 | 0.534 | 0.350 |
| (3.926) | (3.476) | (2.009) | (1.691) |
| Past_Return | -11.106*** | -10.082*** | -5.138*** | -4.720*** |
| (3.386) | (2.998) | (1.733) | (1.488) |
| Vol | 53.058*** | 49.138*** | 29.010*** | 24.711*** |
| (8.797) | (7.788) | (4.503) | (3.840) |
| Illiquidity | -2.362 | -2.177 | -1.122 | -0.878 |
| (8.181) | (7.243) | (4.187) | (3.511) |
| Industry FE | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes |
| Number of Obs. | 234 | 234 | 234 | 227 |
| Adj R2 | 0.264 | 0.302 | 0.338 | 0.343 |

Panel C. CDS spread change in the Whole Period
2020-01-30 – 2020-03-26 (Whole Period)

| Variables | (1) CDS_6M | (2) CDS_1Y | (3) CDS_5Y | (4) CDS_10Y |
|-----------|------------|------------|------------|-------------|
| DD_One_High25 | 880.088*** | 762.400*** | 424.455*** | 349.181*** |
| (307.119) | (272.419) | (159.402) | (133.576) |
| Size | 121.062 | 111.543 | 65.421 | 42.471 |
| (116.490) | (103.328) | (60.461) | (50.369) |
| Roa | 71.123*** | 62.377*** | 35.104*** | 27.753*** |
| (21.946) | (19.466) | (11.390) | (9.520) |
| MTB | 5.064 | 4.418 | 2.324 | 1.713 |
| (10.250) | (9.092) | (5.320) | (4.547) |
| Leverage | 0.755 | 0.284 | 0.534 | 0.364 |
| (5.051) | (4.480) | (2.621) | (2.177) |
| Past_Return | -14.586*** | -13.018*** | -6.973*** | -6.532*** |
| (4.356) | (3.864) | (2.261) | (1.918) |
| Vol | 67.711*** | 62.532*** | 38.572*** | 32.570*** |
| (11.318) | (10.039) | (5.874) | (4.922) |

Table 2 reports the OLS regression results for CDS spread changes. The sample consists of 234 firm observations with CDS spread data from January 30, 2020 to March 26, 2020. We divide our sample firms into quartiles according to their debt due within one-year scaled by cash and short-term investment (DD_One). DD_One_High25 is a dummy variable that equals 1 if the firm belongs to the top DD_One quartile and equals 0 otherwise. Panel A presents the regression results for CDS spread changes in Period 1 (from January 30, 2020 – February 28, 2020). Panel B presents the regression results for CDS spread changes in Period 2 (from March 2, 2020 – March 26, 2020). Panel C presents the regression results for CDS spread changes in the Whole Period (from January 30, 2020 – March 26, 2020). + indicates significance at the 10% level; ++ significance at 5%; +++ significance at 1%. Variable definitions are provided in Table A1 in the Appendix.

3.2. Debt rollor risk and CDS spread conditional on financial constraints or firm volatilities

Given that the COVID-19 crisis posts a significant hit to firm cash flow, it may be particularly challenging for a financially constrained firm with little cash reserves and large amount of debt due in the near future to meet its payment obligation, resulting in significant default risk. The literature suggests that stock returns of financially constrained firms tend to comove together, and such firms tend to earn higher returns on average (e.g., Whited and Wu, 2006). However, during crisis time, such firms tend to suffer more likely due to their corporate liquidity shortfall (e.g. Campello et al., 2010). We expect the negative cash flow shock due to the COVID-19 crisis to increase the default risk for high debt-rollor-risk firms particularly when these firms also face tight financial constraints. In other words, financial constraints can amplify the impact of the COVID-19 shock on the default risk and CDS spread of high debt-rollor-risk firms.

We thus partition the sample firms with available CDS spread data (i.e., 234 firms) into high- and low-constraint groups based on six commonly used financial-constraint measures: 1) the Hadlock and Pierce (2010) index (HP), 2) the Whited and Wu (2006) index (WW), 3) the Altman’s Z score (Z_Score), 4) the Kaplan and Zingales (1997) index (KZ), 5) whether the firm paid any cash dividend over the past fiscal year (Non_div), and 6) whether the firm’s Standard & Poor’s (S&P) long-term debt is rated below investment grade (Non_Invest_Grade). For each of the first four financial-constraint measures, the indicator variable, High_Fc, equals 1 for firms with greater-than-sample-median financial constraints and equals 0 otherwise. For the fifth measure, High_Fc equals 1 if the Non_Div
Table 3
CDS Spread Changes and Debt Due within One Year (DD_One_High25) Conditional on Financial Constraints and Volatilities.

Panel A. CDS spread change on interacting DD_One_High25 and High_FC

| Variables                  | (1) CDS_6M | (2) CDS_6M | (3) CDS_6M | (4) CDS_6M | (5) CDS_6M | (6) CDS_6M |
|----------------------------|------------|------------|------------|------------|------------|------------|
| Financial Constraint Measures | HP         | WW         | Z_score    | KZ         | Non_Divid  | Non_Invest_Grade |
| DD_One_High25 *High_FC     | 2.312.279*** | 1,210.653** | 1,156.686* | 1,406.551** | 3,575.007*** | 3,074.567*** |
| DD_One_High25              | (393.622)  | (376.135)  | (623.731)  | (386.289)  | (727.971)  | (706.543)  |
| High_FC                    | -99.279    | -583.433*  | -230.566   | -602.803** | -328.115   | -560.806   |
| Number of Obs.             | 234        | 234        | 234        | 234        | 234        | 234        |
| Adj R2                     | 0.318      | 0.266      | 0.256      | 0.273      | 0.344      | 0.317      |

Panel B. CDS spread change on interacting DD_One_High25 and High_Vol

| Variables                  | (1) CDS_6M | (2) CDS_6M | (3) CDS_6M | (4) CDS_6M | (5) CDS_6M | Operating_Cash_Vol |
|----------------------------|------------|------------|------------|------------|------------|-------------------|
| Volatility Measures        |            |            |            |            |            |                   |
| DD_One_High25 *High_Vol   | 2.290.045*** | 1,988.492*** | 2,008.886*** | 1,443.021*** | 1,698.569*** |                   |
| DD_One_High25              | (552.574)  | (555.063)  | (536.418)  | (549.995)  | (574.340)  |                   |
| High_Vol                   | 93.880     | 48.124     | 97.908     | 128.436    | 180.845    |                   |
| Number of Obs.             | 234        | 234        | 234        | 234        | 234        |                   |
| Adj R2                     | 0.331      | 0.309      | 0.325      | 0.280      | 0.282      |                   |

Table 3 reports the OLS regression results for CDS spread changes conditional on different measures of financial constraints (i.e., HP; WW; Z_score; KZ; Non_Divid; Non_Invest_Grade) and volatilities (i.e., Vol; ImplVol; Ivol; RoaVol; Operating_Cash_Vol). The sample consists of 234 firm observations with CDS spread data from January 30, 2020 to March 26, 2020. DD_One_High25 is a dummy variable that equals 1 if the firm belongs to the top DD_One quintile and equals 0 otherwise. High_FC is a dummy that indicates high financial constraints. High_Vol is a dummy that indicates high firm volatility. Panel A presents the regression results for CDS spread changes on interacting DD_One_High25 and High_FC. Panel B presents the regression results for CDS spread changes on interacting DD_One_High25 and High_Vol. Regressions include the same set of controls appeared in the baseline results (i.e., Table 2). Main dummies used to construct the interaction terms are also included in regressions. * indicates significance at the 10% level; ** significance at 5%; *** significance at 1%. Variable definitions are provided in Table A in the Appendix.

indicator (which takes the value of 1 if the firm did not pay any cash dividend in 2019) equals 1 and equals 0 otherwise. For the sixth measure, High_FC equals 1 if the Non_Invest_Grade indicator (which takes the value of 1 if the firm’s long-term debt is rated below the investment grade by S&P) equals 1 and equals 0 otherwise. We then interact High_FC with the DD_One_High25 indicator in CDS spread regressions. Component terms of the interaction terms (i.e., High_FC and DD_One_High25) are also included in the regressions. Moreover, we include the firm-level control variables and industry fixed effects as in Table 2. The results are reported in Table 3. For brevity concern, we only report the regression results using 6-month CDS spread (CDS_6M) as the dependent variable in the full sample period (as the results with other CDS maturities and with the first and second subperiods are qualitatively similar to the reported results) and only report the regression coefficient of the interaction term (which is our main interest).

Panel A of Table 3 shows that the regression coefficient of the interaction term DD_One_High25*High_FC is significantly positive and large in magnitude across all regressions with different financial-constraint measures. Moreover, the coefficient of DD_One_High25 remains positive but becomes statistically insignificant across the regressions. The results suggest that the COVID-19 shock increases the CDS spread for the firms in the top quartile of debt rollover risk relative to firms in the other rollover-risk quartiles by an incremental 1157 to 3575 basis points over the full sample period if these high-rollover-risk firms also face tight financial constraints. That is, financial constraints amplify the positive impact of the COVID-19 shock on the default risk and CDS spread of high debt-rollover-risk firms.

It is known that firms with greater volatilities tend to have greater default risk and CDS spread (Ericsson et al., 2009). Thus, we further conjecture that the negative cash flow shock occasioned by the COVID-19 crisis should significantly increase the default risk for high debt-rollover-risk firms especially if such firms also have high volatilities prior to the crisis. That is, high volatilities can also amplify the impact of the COVID-19 shock on the CDS spread of firms with high debt rollover risk.

We next partition the sample firms with available CDS spread data equally into high- and low-volatility groups based on five commonly used volatility measures, including their past total stock return volatility (Vol), idiosyncratic stock return volatility (Ivol), options-implied volatility (ImplVol), ROA volatility (RoaVol), and operating cash flow volatility (Operating_Cash_Vol), respectively. For each of these volatility measures, we construct an indicator

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9 In Panel A of Table A3 in the Appendix, instead of interacting High_FC only with DD_One_High25, we interact High_FC with three different debt-rollover-risk indicators (i.e., DD_One_Group2, DD_One_Group3, and DD_One_Group4) in CDS spread regressions. The results are qualitatively similar to those in Panel A of Table 3.

10 Options-implied volatility is a market-based, forward-looking measure of firm stock return volatility (e.g., Christensen and Prabhala, 1998; Fleming et al., 1998; Busch et al., 2011; Guo and Qiu, 2014).
variable High_Vol, which equals 1 for firms with greater-than-sample-mean-level of volatility and equals 0 otherwise. We then interact High_Vol with the DD_One_High25 indicators in CDS spread regressions. Component terms of the interaction terms, firm-level control variables and industry fixed effects are also included in the regressions. The results are reported in Panel B of Table 3. For brevity concern, again we report only the regression results using 6-month CDS spread (CDS_6M) as the dependent variable in the full sample period (the results with other CDS maturities and with the first and second subperiods are qualitatively similar to the reported results) and only report the regression coefficient of the interaction term.

Consistent with our expectation, Panel B of Table 3 shows that the coefficient of the interaction term DD_One_High25*High_Vol is positive and statistically significant across all five regressions. Moreover, the coefficient of DD_One_High25 is positive but insignificant across the regressions. The results indicate that the COVID-19 shock increases the CDS spread for the firms in the top quartile of debt rollover risk relative to firms in the other rollover-risk quartiles by an incremental 1.443–2.290 basis points over the full sample period if these high-rollover-risk firms also have high volatilities. Thus, our empirical results strongly support the conjecture that firm volatilities amplify the positive impact of the COVID-19 shock on the default risk and CDS spread of high debt-rollover-risk firms.

4. Debt rollover risk and stock returns during the COVID-19 crisis

In the last section, we document that the COVID-19 shock significantly increases the default risk and CDS spread of firms with high debt rollover risk. Because a sharp increase in default risk should significantly decrease the firm’s equity value, we next examine how the COVID-19 shock affects stock returns of firms with different levels of debt rollover risk.

4.1. Debt rollover risk and stock returns

We first use the event study approach to discern the impact of the COVID-19 shock on stock returns of firms with different levels of debt rollover risk. The sample consists of 3,047 firms with non-missing stock return data from CRSP and financial data from Compustat. We sort the sample firms equally into quartiles according to their levels of debt due within one-year scaled by cash and short-term investment (DD_One). For each firm, we then calculate its buy and hold abnormal stock returns (BHARs) and cumulative abnormal returns (CARs) for three periods: 1) 1/30/2020 – 2020-01-30 – 2020-02-28 (Period 1) – 2020-03-02 – 2020-03-26 (Period 2) – 2020-03-01 – 2020-03-26 (Whole Period)

Table 4 reports event study results of the impact of COVID-19 on individual stock returns for U.S. listed firms. The sample consists of 3,047 firm observations from January 30, 2020 to March 26, 2020. We divide our sample firms into quartiles according to the debt due within one-year scaled by cash and short-term investment (DD_One) – group 1 has the lowest DD_One value and group 4 has the highest DD_One value. We report the mean of the buy and hold abnormal returns (BHARs) and cumulative abnormal returns (CARs) for three periods: January 30, 2020 – February 28, 2020 (Period 1); March 2, 2020 – March 26, 2020 (Period 2); and January 30, 2020 – March 26, 2020 (Whole Period). We calculate CARs using both the market model and the market-adjusted model. We use the S&P 500 stock market index as the market portfolio. The market model estimation window is days (-150, -50) before the event date (midpoint of each period). Panel A demonstrates results in BHARs. Panel B demonstrates results in CARs calculated using the market model. Panel C demonstrates results in CARs calculated using the market-adjusted model. * indicates significance at the 10% level; ** significance at 5%; *** significance at 1%. Variable definitions are provided in Table A1 in the Appendix.

11 We check and find that the high- and low-volatility firms are allocated quite equally into the different debt-rollover-risk quartiles.
12 In Panel B of Table A3 in the Appendix, instead of interacting High_Vol only with DD_One_High25, we interact High_Vol with three different debt-rollover-risk indicators (i.e., DD_One_Group2, DD_One_Group3, and DD_One_Group4) in CDS spread regressions. The results are very similar to those in Panel B of Table 3.
2/28/2020 (period 1); 2) 3/2/2020 – 3/26/2020 (period 2); and 3) 1/30/2020 – 3/26/2020 (whole period) similar to Table 2. We use the S&P 500 stock market index as the market portfolio. We calculate CARs using both the market model and the market-adjusted model. The market-model estimation window is days (-150, -50) before the midpoint of each period. The event-study results are reported in Table 4.

Panel A of Table 4 reports the mean BHARs for firms with different levels of debt rollover risk during the first, second and full sample periods. We expect the COVID-19 shock to disproportionately affect the equity value of high debt-rollover-risk firms. Consistent with our expectation, we find that firms in the high rollover-risk group (i.e., group 4) have the most negative mean BHARs among the four groups of firms in both the second period (14.62 %) and the full sample period (14.08 %), which are statistically significantly at the 1% level. During the first period, firms in group 4 have similar mean BHAR (-1.92 %) as those in group 3 and their mean BHARs are lower than the BHARs of groups 1 and 2. We also find that although firms in the high rollover-risk group generally have the lowest BHARs, the relation between mean BHAR and debt rollover risk is not monotonic in the first three groups—firms in group 2 have higher mean BHARs than firms in the other two groups. The significantly negative average BHARs for all sample firms during the first, second and full sample periods suggest that small firms generally fare worse than large firms during the COVID-19 crisis. Results are qualitatively similar when we examine CARs estimated using the market model (Panel B) and the market-adjusted model (Panel C). In particular, firms with the highest debt rollover risk (group 4) generally have the lowest CARs among the four debt-rollover-risk groups during the COVID-19 crisis.

Next, we use the following regression specification to examine the impact of the COVID-19 shock on stock returns of firms with different levels of debt rollover risk:

\[ \text{Return}_i = \alpha + \beta_1 \text{DD}_i \text{High25}_i + \beta_2 \text{Controls}_i + \text{Industry FE} + \epsilon_i. \]  

(2)

In Eq. (2), the dependent variable, Return, is the BHAR or CAR of firm i in the first, second or full sample period. \( \text{DD}_i \text{High25} \) equals 1 if firm i’s debt rollover risk falls in the highest quartile of 3047 sample firms with available stock returns and financial data and equals 0 otherwise. Similar to Eq. (1), the regression coefficient of \( \text{DD}_i \text{High25} \) reflects the incremental impact of the crisis on firms in the highest debt-rollover-risk quartile relative to firms in the other quartiles. Control variables include firm size (Size), profitability (RoA), market-to-book equity ratio (MTB), financial leverage (Leverage), past stock returns (Past_Return), stock return volatility (Vol), stock illiquidity (Illiquidity), and industry fixed effects (i.e., 2-digit SIC industry indicators). Standard errors are again clustered at the 2-digit SIC industry level. The results are reported in Table 5. For brevity, we report only the results using BHAR as the dependent variable (as results using CAR as the dependent variable are qualitatively very similar to the reported results).

We separately report the results of estimating Eq. (2) for real-sector firms, banking and financial firms and the full sample in Panels A, B and C of Table 5, respectively. Panel A shows that while the regression coefficient of \( \text{DD}_i \text{High25} \) is insignificantly negative in the first period (Columns 1 and 2), it is significantly negative in the second and the full periods (Columns 3–6)—comparing with firms in the other debt-rollover-risk quartiles, high rollover-risk firms on average produce significantly lower BHARs by 2.3 % during the COVID-19 crisis (mainly due to their low returns in the second period). This finding is consistent with our earlier findings on the CDS spread changes of firms with high debt rollover risk.

In terms of control variables, the regression coefficients of Size, MTB, Past_Return, and Illiquidity are significantly positive, while those of Leverage and Vol are significantly negative. This finding indicates that larger firms and firms with higher valuation, better past stock performance or lower stock liquidity fare better, while firms with greater leverage or more volatile past stock returns fare worse, during the COVID-19 crisis.

Panel B shows the regression results for banking and financial firms. Interestingly, we find that the regression coefficient of high debt rollover risk is generally statistically insignificant in the regressions. This finding suggests that the uncovered heterogeneous effect of the COVID-19 shock on firms with different levels of debt rollover risk is mainly concentrated in the main-street firms. Different from the Global Financial Crisis, which is a financial crisis first starting from the banking and financial industries and then spreading to the real sector through the decrease in credit supply, the COVID-19 crisis is a health crisis that directly hits the real sector and not the financial sector. Moreover, the banking and financial industries are much better prepared when the COVID-19 crisis hit, possibly also due to the resilience built up through various post-global-financial-crisis regulations (e.g., the Dodd-Frank Act, the stress tests, etc.). Thus, the finding that the uncovered effect is mainly concentrated in the real sector is perhaps not too surprising.

Panel C shows the regression results using the full sample of both real-sector and financial-sector firms. The results are qualitatively similar to, but understandably weaker than, those reported in Panel A. We generally find that firms in the highest rollover-risk quartile produce lower stock returns than firms in the other rollover-risk quartiles during the crisis.

To ensure the robustness of the findings, we use the first (lowest) rollover-risk quartile as the reference group and construct three indicator variables, \( \text{DD}_i \text{Group2} \), \( \text{DD}_i \text{Group3} \), and \( \text{DD}_i \text{Group4} \), to indicate the other three rollover-risk quartiles and reestimate Eq. (2). The results are reported in Table A4 in the Appendix. Panel A of Table A4 shows the regression results for real-sector firms, which are qualitatively similar to those reported in Panel A of Table 5. The regression coefficient of \( \text{DD}_i \text{Group4} \) is negative across all the six regressions and significantly so in the latter four regressions. The results indicate that relative to firms in the lowest rollover-risk quartile, firms in the highest debt-rollover-risk quartile on average produce significantly lower BHARs by around 2.5–3 % during the full sample period. Moreover, the low stock returns of high rollover-risk firms are mainly concentrated in the second period. Panels B and C of Table A4 also show qualitatively similar results as those reported in Panels B and C of Table 5. In particular, the heterogeneous impact of the COVID-19 shock on firms with different levels of debt rollover risk is mainly confined to the real sector and not the financial sector.

To summarize, we find that the COVID-19 shock exerts heterogeneous impact on stock returns of firms with different levels of debt rollover risk. Consistent with the patterns depicted in

\[ \text{It is valuable to compare the CDS spread changes between the real-sector and financial firms. However, we are constrained by the limitation of the CDS data—only about 20% of financial firms have complete and non-missing data on CDS spreads. Thus, it is challenging to draw general conclusion on the comparison between the financial and real-sector firms on CDS spread changes.} \]
Table 5
BHARs and Debt Due within One Year (DD_One_High25) under COVID-19 Shock.

Panel A. BHARs for the real-sector firms

| Variables       | (1) BHAR (Period 1) | (2) BHAR (Period 1) | (3) BHAR (Period 2) | (4) BHAR (Period 2) | (5) BHAR (Whole Period) | (6) BHAR (Whole Period) |
|-----------------|---------------------|---------------------|---------------------|---------------------|-------------------------|-------------------------|
| DD_One_High25   | 0.0703 (0.631)      | -0.356              | -3.063***           | -1.992**            | -3.174***               | -1.961**                |
| Size            | 0.015               | 0.568***            | (0.210)             | 0.568**             | (0.238)                 | 0.478**                 |
| Roa             | 0.010               | 0.003               | (0.013)             | 0.014               | (0.014)                 | 0.004                   |
| MTB             | 0.024               | 0.084***            | (0.032)             | 0.092**             | (0.037)                 | 0.070***                |
| Leverage        | -0.011              | -0.070***           | (0.011)             | -0.070***           | (0.013)                 | -0.070***               |
| Past_Return     | 0.013***            | 0.037***            | (0.007)             | 0.039***            | (0.008)                 | 0.075***                |
| Illiquidity     | 0.003               | 0.003               | (0.017)             | 0.005**             | (0.020)                 | 0.020                   |
| Industry FE     | Yes                 | Yes                 | Yes                 | Yes                 | Yes                     | Yes                     |
| Constant        | Yes                 | Yes                 | Yes                 | Yes                 | Yes                     | Yes                     |
| Number of Obs.  | 2,279               | 2,279               | 2,279               | 2,279               | 2,279                   | 2,279                   |
| Adj R2          | 0.048               | 0.054               | 0.224               | 0.272               | 0.203                   | 0.240                   |

Panel B. BHARs for the financial firms

| Variables       | (1) BHAR (Period 1) | (2) BHAR (Period 1) | (3) BHAR (Period 2) | (4) BHAR (Period 2) | (5) BHAR (Whole Period) | (6) BHAR (Whole Period) |
|-----------------|---------------------|---------------------|---------------------|---------------------|-------------------------|-------------------------|
| DD_One_High25   | 0.833 (0.615)       | 0.517               | 0.517               | 0.462               | 0.343                   | 0.955                   |
| Size            | -0.523***           | -0.541              | (0.323)             | -0.864***           | (0.336)                 | 0.080**                 |
| Roa             | 0.046***            | 0.055               | (0.035)             | 0.080**             | (0.036)                 | 0.080**                 |
| MTB             | -0.048              | 0.020               | (0.077)             | -0.028              | (0.080)                 | -0.028                  |
| Leverage        | 0.038***            | -0.110***           | (0.022)             | -0.071***           | (0.023)                 | -0.071***               |
| Past_Return     | 0.001               | 0.067***            | (0.022)             | 0.063***            | (0.023)                 | 0.063***                |
| Illiquidity     | 0.003***            | 0.003               | (0.002)             | 0.004**             | (0.003)                 | 0.004**                 |
| Industry FE     | Yes                 | Yes                 | Yes                 | Yes                 | Yes                     | Yes                     |
| Constant        | Yes                 | Yes                 | Yes                 | Yes                 | Yes                     | Yes                     |
| Number of Obs.  | 768                 | 768                 | 768                 | 768                 | 768                     | 768                     |
| Adj R2          | 0.005               | 0.076               | 0.118               | 0.161               | 0.099                   | 0.136                   |

Panel C. BHARs for all firms

| Variables       | (1) BHAR (Period 1) | (2) BHAR (Period 1) | (3) BHAR (Period 2) | (4) BHAR (Period 2) | (5) BHAR (Whole Period) | (6) BHAR (Whole Period) |
|-----------------|---------------------|---------------------|---------------------|---------------------|-------------------------|-------------------------|
| DD_One_High25   | -0.305 (0.495)      | -0.075              | -2.599***           | -1.348*             | -2.440***               | -1.152                  |
| Size            | -0.133              | 0.227               | (0.175)             | 0.075               | (0.194)                 | 0.011                   |
| Roa             | 0.016*              | 0.009               | (0.012)             | 0.011               | (0.013)                 | 0.011                   |
| MTB             | 0.014               | 0.087***            | (0.029)             | -0.069***           | (0.033)                 | -0.069***               |
| Leverage        | -0.001              | -0.077***           | (0.010)             | -0.069***           | (0.011)                 | -0.069***               |
| Past_Return     | 0.018***            | 0.032***            | (0.007)             | 0.041***            | (0.007)                 | 0.041***                |
| Illiquidity     | 0.004***            | 0.003               | (0.002)             | 0.005***            | (0.002)                 | 0.005***                |
| Industry FE     | Yes                 | Yes                 | Yes                 | Yes                 | Yes                     | Yes                     |
| Constant        | Yes                 | Yes                 | Yes                 | Yes                 | Yes                     | Yes                     |
| Number of Obs.  | 3.047               | 3.047               | 3.047               | 3.047               | 3.047                   | 3.047                   |
| Adj R2          | 0.047               | 0.056               | 0.208               | 0.251               | 0.188                   | 0.222                   |

Table 5 reports the OLS regression results for BHARs. The sample consists of 3,047 firm observations from January 30, 2020 to March 26, 2020. We divide our sample firms into quartiles according to their debt due within one-year scaled by cash and short-term investment (DD_One). DD_One_High25 is a dummy variable that equals 1 if the firm belongs to the top DD_One quartile and equals 0 otherwise. Panel A presents the regression results for the real-sector firms. Panel B presents the regression results for the financial-sector firms. Panel C presents the regression results for all firms. * indicates significance at the 10% level; ** significance at 5%; *** significance at 1%. Variable definitions are provided in Table A1 in the Appendix.
Fig. 2, the crisis leads to a significantly lower stock returns for firms with high debt rollover risk than other firms—the finding is mainly driven by real-sector firms and not financial-sector firms and mainly concentrated in the second period (when the U.S. becomes heavily impacted by the health crisis).

4.2. Debt rollover risk and stock returns conditional on financial constraints or firm volatilities

In earlier results, we document that financial constraints amplify the impact of the COVID-19 shock on the default risk and CDS spread of high debt-rollover-risk firms. In this section, we similarly examine whether financial constraints affect the magnitude of the impact of the COVID-19 shock on stock returns of high debt-rollover-risk firms.

We partition the sample firms with available stock returns and financial data (i.e., 3047 firms) into high- and low-constraint groups based on the following six financial-constraint measures: 1) the Hadlock and Pierce (2010) index (HP), 2) the Whited and Wu (2006) index (WW), 3) the Altman’s Z score (Z_Score), 4) the Kaplan and Zingales (1997) index (KZ), 5) whether the firm paid any cash dividend over the past fiscal year (Non_Div), and 6) whether the firm’s Standard & Poor’s (S&P) long-term debt is rated below the investment grade (Non_Invest_Grade). For each of these measures, we then similarly construct the indicator variable High_FC to indicate firms facing tight financial constraints. We then interact High_FC with the DD_One_High25 indicator in stock return regressions. Component terms of the interaction term (i.e., High_FC and DD_One_High25), firm-level control variables and industry fixed effects are included in all regressions. The results are reported in Table 6. For brevity concern, we only report the regression results using BHAR as the dependent variable in the full sample period and only report the regression coefficient of the interaction term.

Panel A of Table 6 shows that the regression coefficient of the interaction term DD_One_High25*High_FC is negative in all regressions and significantly so in three out of the six regressions. Moreover, the coefficient of DD_One_High25 is negative but becomes statistically insignificant across the regressions. The results suggest that the COVID-19 shock decreases stock returns for the firms in the top quartile of debt rollover risk relative to firms in the other rollover-risk quartiles by an incremental 2–4% over the full sample period if these high-rollover-risk firms also face tight financial constraints according to the financial-constraint measures of HP, Z-Score, and KZ. Thus, consistent with the earlier finding on CDS spread, we also find that financial constraints amplify the negative impact of the COVID-19 shock on stock returns of high debt-rollover-risk firms.15

As our earlier findings suggest that high firm volatilities amplify the impact of the COVID-19 shock on the default risk and CDS spread of high debt-rollover-risk firms, we further exam-

15 In Panel A of Table A5 in the Appendix, instead of interacting High_FC only with DD-One_High25, we interact High_FC with three different debt-rollover-risk indicators (i.e., DD_One_Group2, DD_One_Group3, and DD_One_Group4) in stock return regressions. The results are qualitatively similar to those in Panel A of Table 6.
ine whether firm volatilities similarly amplify the impact of the COVID-19 shock on stock returns of such firms. We again partition the sample firms with available stock returns and financial data equally into high- and low-volatility groups based on five commonly used volatility measures, including their past total stock return volatility (Vol), idiosyncratic stock return volatility (ivol), options-implied volatility (Impl_Vol), ROA volatility (Roa_Vol), and operating cash flow volatility (Operating_Cash_Vol). For each of these volatility measures, we then construct an indicator variable \( \text{High}_\text{Vol} \) to indicate above-sample-median level of volatility. We then interact \( \text{High}_\text{Vol} \) with the \( \text{DD}_\text{One}_\text{High25} \) indicator in stock return regressions, respectively. Component terms of the interaction term, firm-level control variables and industry fixed effects are also included. The results are reported in Panel B of Table 6.

Consistent with our expectation, Panel B of Table 6 shows that the regression coefficient of the interaction term \( \text{DD}_\text{One}_\text{High25} \times \text{High}_\text{Vol} \) is negative in all regressions and significantly so in three out of the five regressions. Moreover, the coefficient of \( \text{DD}_\text{One}_\text{High25} \) is negative but insignificant across the regressions. The results indicate that the COVID-19 shock decreases BHARs for firms in the top quartile of debt rollover risk relative to firms in the other rollover-risk quartiles by an incremental 3% over the full sample period if these high-rollover-risk firms also have high stock return volatilities according to Vol, Ivol and Impl_Vol. Thus, our empirical results confirm that firm volatilities amplify the negative impact of the COVID-19 shock on stock returns of high debt-rollover-risk firms.\(^\text{16}\)

5. Immediate refinancing needs versus distant refinancing needs

In this section, we further strengthen the identification on the effects of debt rollover risk. Our identification strategy hinges on the assumption that the COVID-19 shock was entirely unexpected and thus the percentage of firms’ debt that was maturing in the first few months of year 2020 when COVID-19 hit the U.S. is largely exogenous to firms’ choice.\(^\text{17}\) To identify the effect of debt rollover risk on firms’ CDS spread and stock return reactions during the COVID-19 crisis, we thus zoom in on the timing of firms’ debt rollover, and compare the effects of rollover risk on CDS spread changes and BHARs for firms with debt maturing immediately and firms with debt due later in the year. Even if the total amount of debt due in year 2020 were the same for two firms, the actual timing of the debt due would be different, causing different levels of rollover risk for firms at the time of the COVID shock. The COVID-19 crisis creates a liquidity shortfall by causing a sudden plunge in firms’ cash flow. If debt rollover risk is indeed a driver for the heterogenous reactions in firms’ CDS spread and shareholder value, then we should expect a stronger effect for firms with debt maturing immediately rather than for firms with debt due later in the year (firms with distant refinancing needs).

Thus, we distinguish firms with immediate needs of repaying maturing debt and firms with distant refinancing needs, and test whether firms with immediate refinancing needs suffered more during the COVID-19 cash flow shock. In particular, we collect comprehensive bond and bank loan data from the SDC New Debt Issuance and Thomson Reuters Dealscan Syndicated Loan databases over the past 30 years. We extract the maturity information on firms’ outstanding bonds and bank loans and construct the maturity profiles of firms’ debt outstanding. We identify firms in the highest quartile in terms of the immediate refinancing needs with debt maturing in March-June, and firms in the highest quartile in terms of distant refinancing needs with debt maturing in the rest of year 2020 (July-December). We then run the baseline regressions of Eqs. (1) and (2), using the new rollover risk variables constructed. The results are reported in Table 7.

As shown in Table 7, the regression coefficients of \( \text{DD}_\text{One}_\text{High25} \) (March-June) on changes in CDS spread are significantly positive and very large in magnitude (e.g., 751 basis points for 6-month CDS spread changes). Similarly, relative to the other firms, real-sector firms in the highest immediate debt-rollover-risk quartile (debt due in March-June) on average produce significantly lower BHARs by around 2.3 percent. By contrast, the effect of having a large proportion of debt maturing in July to December is largely muted. These empirical results hence confirm the finding from our main tests, showing that firms’ debt rollover risk is a key factor that drives the heterogenous CDS spread and stock return reactions to the COVID-19 shock.

6. Robustness results

6.1. Controlling for new debt issuance in the first quarter of 2020

The existing evidence shows that firms had substantially borrowed from banks (Acharya and Steffen, 2020) and the public bond market (Halling et al., 2020) during the COVID-19 crisis period. It is likely that those firms with a larger amount of debt maturing within one year may borrow more. Thus, firms’ default risk may increase if there is a surge in firms’ leverage ratio during the sample period. In that case, controlling for the leverage ratio measured at the end of 2019Q4 cannot fully reflect the effects from potential new debt issuance.\(^\text{18}\)

To address this valid concern, we collect new data on firms’ new debt (including both bonds and bank loans) issuance in the first quarter 2020, from Compustat, SDC New Debt Issuance and Thomson Reuters Dealscan Syndicated Loan databases. The idea is that if it is the potential surge in firm leverage during the sample period that drives up default risks, then controlling for the new debt issuance will likely mute the effect of debt rollover risk (i.e., the coefficient of \( \text{DD}_\text{One}_\text{High25} \) indicator, which indicates firms in the top quartile of debt rollover risk). We include the new debt issuance measures constructed from Compustat and merged SDC/DealScan databases in our baseline regressions, respectively. The results are reported in Table 8.

Panel A of Table 8 reports the regression results controlling for new debt issuance (\textit{New Debt Issuance}) constructed from Compustat database, while Panel B reports the regression results controlling for \textit{New Debt Issuance} constructed from SDC New Issuance and Dealscan Syndicated Loan databases. Indeed, we find that new debt issuance (scaled by lagged total assets) during the sample period is significantly and positively related to CDS spread changes and significantly and negatively related to BHARs (real sector). Nevertheless, it is clear that the coefficient of \( \text{DD}_\text{One}_\text{High25} \) remains statistically and economically significant in the regressions of CDS spread changes and BHARs. For example, after controlling for new debt issuance (constructed from merged SDC/DealScan), Panel B of Table 8 shows that the regression coefficient of \( \text{DD}_\text{One}_\text{High25} \) on CDS spread changes is significantly positive and very large in mag-

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\(^{16}\) In Panel B of Table A5 in the Appendix, instead of interacting \( \text{High}_\text{Vol} \) only with \( \text{DD}_\text{One}_\text{High25} \), we interact \( \text{High}_\text{Vol} \) with three different debt-rollover-risk indicators (i.e., \( \text{DD}_\text{One}_\text{Group2}, \text{DD}_\text{One}_\text{Group3}, \) and \( \text{DD}_\text{One}_\text{Group4} \)) in stock return regressions. The results are qualitatively similar to those in Panel B of Table 6.

\(^{17}\) We are grateful to a referee for suggesting this identification strategy to us.

\(^{18}\) When controlling for leverage ratio, we use book leverage to be consistent with other accounting variables which also use book value. We also conduct additional robustness check controlling for market leverage instead of book leverage. As shown in Table A6 in the Appendix, the results controlling for market leverage are consistent with the original results.
Table 7
CDS Spread Changes, BHARs and Debt Due within One Year by Months (Immediate Refinancing Needs vs Distant Refinancing Needs) under COVID-19 Shock.

| Variables | Immediate Refinancing (March-June) | Distant Refinancing (July-December) |
|-----------|------------------------------------|-------------------------------------|
|           | CDS,GM                             | CDS,1Y                              | BHR (Real Sector) | BHR (Financial Sector) | BHR (Real Sector) | BHR (Financial Sector) |
| DD, OneHigh25 (March-June) | 750.713** | 666.566** | 2.299** | 0.918 | 1.770* | 0.507 |
| DD, OneHigh25 (July-December) | 218.567 | 133.312 | (314.426) | (278.813) | 0.464* | −0.860** | 0.469** | −0.850** |
| Size      | 149.885 | 135.922 | 165.301 | 152.965 | (0.237) | (0.336) | (0.237) | (0.336) |
| Roa       | 81.350** | 71.453** | 69.800** | 61.112** | −0.003 | 0.086** | −0.003 | 0.086** |
| MTB       | 1.479 | 1.258 | 4.102 | 3.459 | 0.093** | −0.028 | 0.093** | −0.027 |
| Leverage  | 0.198 | −0.237 | 1.650 | 1.141 | −0.069*** | −0.071*** | −0.070*** | −0.069*** |
| Past_Return | −12.780*** | −11.423*** | −14.130*** | −12.632*** | 0.039*** | 0.067*** | 0.039*** | 0.067*** |
| Vol       | 71.697*** | 65.961*** | 71.515*** | 65.929*** | −0.075*** | −0.007 | −0.076*** | −0.008 |
| Illiquidity | −6.097 | −5.368 | −3.579 | −3.396 | 0.005** | 0.004 | 0.005** | 0.004* |
| Industry FE | 4.404 | 3.902 | 4.449 | 3.945 | (0.008) | (0.023) | (0.008) | (0.023) |
| Constant  | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 234 | 234 | 233 | 234 | 2279 | 768 | 2279 | 768 |
| Adj R2    | 0.244 | 0.272 | 0.217 | 0.245 | 0.240 | 0.136 | 0.240 | 0.135 |

Table 7 reports the OLS regression results for both CDS spread changes and BHARs under debt due within one-year measures with different maturity months. The sample consists of 3,047 firm observations from January 30, 2020 to March 26, 2020. We merge and collect relevant debt maturity by months information in the past 30 years from merged SDC New Debt Issuance and Dealscan Syndicated Loan databases. We divide our sample firms into quartiles according to either their immediate debt due amount (debt due from March-June) or their distant debt due amount (debt due from July-December), both scaled by cash and short-term investment, respectively. DD, OneHigh25 (March-June) is a dummy variable that equals 1 if the firm belongs to the top debt due from March to June scaled by cash and short-term investment and equals 0 otherwise. DD, OneHigh25 (July-December) is a dummy variable that equals 1 if the firm belongs to the top debt due from July to December scaled by cash and short-term investment and equals 0 otherwise. + indicates significance at the 10% level; ** indicates significance at 5%; *** indicates significance at 1%. Variable definitions are provided in Table A1 in the Appendix.

6.2. Alternative measures of debt rollover risk

To ensure the robustness of our findings, we further construct two alternative measures of firms’ debt rollover risk. Instead of using firm’s cash holding, we use the amount of total debt outstanding (Friedwald et al., 2018) and the amount of total long-term debt outstanding (Almeida et al., 2012; and Hu, 2016) as the denominator to scale the total amount of debt due within the one year, respectively. Accordingly, we construct two alternative debt-rollover-risk measures for robustness (DD, OneAlternative1High25 and DD, OneAlternative2High25) to reflect whether the firm falls in the top quartile in terms of debt rollover risks or not. The results using these alternative debt-rollover-risk measures are reported in Table 9.

The results in Table 9 are very similar to the baseline results in Tables 2 and 5. It is clear that the coefficients of both DD, OneAlternative1High25 and DD, OneAlternative2High25 are significantly positive across the regression models with CDS spread changes as the dependent variables and significantly negative with BHAR (Real Sector) as the dependent variable over the full sample period. The results indicate that relative to the other firms, firms in the highest debt-rollover-risk quartile, as measured using the two alternative debt-rollover-risk variables, on average experience a highly significant increase in CDS spread and a significant decline in stock prices over the full sample period. Moreover, the economic significance of the effects using alternative measures is also comparable to our findings using the original measure of rollover risk. These robustness results suggest that our findings are insensitive to the choice of debt-rollover-risk measures.

7. Two-trillion-Dollar government relief package and federal reverse rate cut

The U.S. Senate passed the two-trillion-dollar relief package—the Coronavirus Aid, Relief, and Economic Security Act—on March 25th. News about the rescue package sent the S&P 500 index up by 9.38% on March 24—its best day since Oct 28, 2008. The market has generally been in an upward trend since then. We conduct additional tests looking at the period leading to the launch of U.S. government’s relief package (i.e., Jan 30 to Mar 23, 2020), and the period around the launch of the relief package (i.e., Mar 24 to Mar 26, 2020). We examine how the CDS spreads and stock returns of firms of different levels of debt rollover risk may have reacted differently to the lockdown from the COVID-19 that happened initially, as compared to the two-trillion-dollar government relief package that was launched at the later stage. The results are shown in Table 10.

We document strong effects of the COVID-19 shock on firms facing high debt rollover risk during the period leading to the launch of the government interventions. The results indicate that relative to firms in the other rollover-risk quartiles, the crisis on average leads to a startling increase in CDS spread of up to 812 basis points for firms in the highest rollover-risk quartile, and significantly...
lower BHARs by around 1.9% for real sector firms in the highest rollover-risk quartile, during the period leading to the launch of the two-trillion-dollar government relief package. In contrast, we observe opposite (albeit statistically insignificant) effects in both CDS spreads and stock returns for high rollover-risk firms around the launch of the government relief package. Since a large portion of the relief package (around $877 billion) is in government loans to small and large businesses, it helps reduce the default risk of firms with high rollover risk. Our results suggest that the government relief package helps stabilize the financial markets and improve the high rollover-risk firms’ resilience to the COVID-19 shock.

We further investigate how firms’ CDS spread changes and stock returns react to the interest rate reduction by the Federal Reserve System on March 15, 2020. As shown in Table A7 in the Appendix, we do not find any significant effect from the changes in Federal Reserve’s interest rate. The results make sense given that the interest cut is largely expected by the market. Also, although a reduction in the interest rate may reduce the cost of a firm’s rolling over maturing debt if it is able to roll it over, it is not immediately clear that the odds for firms to be able to roll over debt will increase.\(^\text{19}\)

### 8. Conclusion

In this paper, we investigate the heterogeneous impacts of the COVID-19 shock on the default risk and abnormal stock returns of firms with different levels of debt rollover risk. The COVID-19 crisis has caused significant disruptions to economic activities and resulted in a sharp decline in firms’ cash flows, leaving those firms with little cash reserve and pressing financing needs vulnerable to default risk. The health crisis is expected to cause a significant surge in bankruptcies should it persists. In the event of actual bankruptcies, shareholders, who are residual claimants of firms’ assets, often suffer a total loss of their shareholder value. Thus, the increased default risk will negatively affect shareholder wealth.

Because both the short-term debt and cash reserve play an important role in determining firms’ funding liquidity risk, we construct a measure based on the ratio of firms’ short-term debt (debt due within one year) to cash reserve to identify those firms facing significant debt rollover risk in the near future. The idea is that firms that have the immediate needs of repaying maturing debt and do not have enough cash to meet the repayment obligation will face significant debt rollover risk; these firms will have to default their debt-repayment obligation if they cannot roll over the maturing debt to future periods. We then sort US public firms equally into quartiles according to their debt rollover risk right before the crisis.

Using data on firms’ CDS spread, we then investigate whether the COVID-19 shock exerts differential impact on the default risk of firms facing different levels of debt rollover risk. We find that the crisis leads to a sharp increase in CDS spread of 349–880 basis points for firms in the highest debt-rollover-risk quartile relative

\(^{19}\) In previous stock return regression results, we use buy-and-hold abnormal stock returns (BHARs) as the dependent variable. For robustness, we also use cumulative abnormal stock returns (CARs) to rerun the stock return regressions in Tables 5, 6, 7, 8, and 10. We use both the market model and the market-adjusted model to estimate CARs. The results, as reported in Tables A8–A12 in the Appendix, are qualitatively similar to those using BHARs.
Table 9
CDS Spread Changes, BHARs and Alternative Debt Due within One Year Measures under COVID-19 Shock.

Panel A. DD_One is defined as debt due within one-year divided by total debt amount

| Variables       | CDS Spread Changes | BHARs               |
|-----------------|--------------------|---------------------|
|                 | CDS_6M  | CDS_1Y  | CDS_5Y  | CDS_10Y | BHAR (Real Sector) | BHAR (Financial Sector) |
| DD_OneAlternative 1,High25 | 815.402*** | 706.693** | 355.366** | 260.421* | −3.962** | 2.835 |
| Controls         | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     |
| Industry FE      | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     |
| Constant         | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     |
| Observations     | 234     | 234     | 234     | 228     | 2.279   | 768     |
| Adj R2           | 0.246   | 0.272   | 0.321   | 0.334   | 0.243   | 0.140   |

Panel B. DD_One is defined as debt due within one-year divided by long-term debt amount

| Variables       | CDS Spread Changes | BHARs               |
|-----------------|--------------------|---------------------|
|                 | CDS_6M  | CDS_1Y  | CDS_5Y  | CDS_10Y | BHAR (Real Sector) | BHAR (Financial Sector) |
| DD_OneAlternative 2,High25 | 719.195** | 617.337** | 298.818* | 214.691 | −4.340*** | 3.785* |
| Controls         | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     |
| Industry FE      | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     |
| Constant         | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     |
| Observations     | 234     | 234     | 234     | 228     | 2.279   | 768     |
| Adj R2           | 0.239   | 0.266   | 0.315   | 0.329   | 0.244   | 0.143   |

Table 8 reports the OLS regression results for both CDS spread changes and BHARs under two alternative debt due within one-year measures for robustness checks. The sample consists of 3,047 firm observations from January 30, 2020 to March 26, 2020. We divide our sample firms into quartiles according to their debt due within one-year scaled by either total debt amount (DD_OneAlternative 1) or total long-term debt amount (DD_OneAlternative 2), respectively. DD_OneAlternative 1,High25 is a dummy variable that equals 1 if the firm belongs to the top debt due within one-year scaled by total debt amount quartile and equals 0 otherwise. DD_OneAlternative 2,High25 is a dummy variable that equals 1 if the firm belongs to the top debt due within one-year scaled by total long-term debt amount quartile and equals 0 otherwise. Panel A presents the regression results for the DD_OneAlternative 1 measures. Panel B presents the regression results for the DD_OneAlternative 2 measures. Regressions include the same set of controls appeared in the baseline results (i.e., Table 2 and Table 5). The regression coefficients of the control variables are omitted for brevity. ∗ indicates significance at the 10% level; ∗∗ significance at 5%; ∗∗∗ significance at 1%. Variable definitions are provided in Table A1 in the Appendix.

Table 10
CDS Spread Changes, BHARs and Debt Due within One Year Before vs. Around Government’s Relief Package.

The Influence of Government Relief Package (Pre-Relief Package vs. Post-Relief Package)

| Variables       | CDS Spread Changes | BHARs               |
|-----------------|--------------------|---------------------|
|                 | Before Relief (Jan 30 to Mar 23, 2020) | Around Relief (Mar 24 to Mar 26, 2020) | Before Relief (Jan 30 to Mar 23, 2020) | Around Relief (Mar 24 to Mar 26, 2020) |
|                 | CDS_6M | CDS_1Y | CDS_5Y | CDS_10Y | BHAR (Real Sector) | BHAR (Financial Sector) | CDS_6M | CDS_1Y | CDS_5Y | CDS_10Y | BHAR (Real Sector) | BHAR (Financial Sector) |
| DD_One,High25   | 812.182*** | 672.897*** | −23.870 | −20.571 | −1.911** | 1.485 | 0.566 | −1.243 |
| Size            | 128.394 | 113.000 | −5.225 | −7.512 | −0.142 | −1.309*** | 0.965*** | 1.241*** |
| Roa             | 67.389*** | 55.055*** | −1.516 | −1.607 | 0.011 | 0.074** | −0.024** | −0.004 |
| MTB             | 4.986   | 4.022   | −0.228 | −0.137 | 0.094*** | −0.083 | −0.043 | 0.103 |
| Leverage        | 0.293   | 0.673   | −0.500 | −0.624 | −0.082*** | −0.075** | 0.061*** | 0.047*** |
| Past_Return     | −13.343*** | −11.515*** | 0.162 | 0.284 | 0.021*** | 0.032 | 0.027*** | 0.025 |
| Vol             | 67.910*** | 60.790*** | −2.064 | −3.154*** | −0.063*** | 0.018 | −0.017 | −0.067 |
| Illiquidity     | 0.277   | 0.246   | 0.065 | 0.110 | 0.006*** | 0.008*** | −0.004* | −0.009*** |
| Industry FE     | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     |
| Constant        | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     | Yes     |
| Observations    | 234     | 234     | 234     | 228     | 2.279   | 768     | 2.279 | 768     |
| Adj R2          | 0.283   | 0.309   | −0.090 | −0.030 | 0.222   | 0.175 | 0.135 | 0.145 |

Table 10 reports the OLS regression results for both CDS spread changes and BHARs before vs. around government’s relief package. The two-trillion-dollar relief package passed the U.S. Senate on March 25 and the House of Representatives on March 27. It was then immediately signed into law by President Trump on March 27. News about the rescue package sent the S&P 500 index up by 9.38% on March 24, which is the best day since October 28, 2008. The market has generally been in an upward trend since then. The sample consists of 3,047 firm observations from January 30, 2020 to March 26, 2020. We divide our sample firms into quartiles according to their debt due within one-year scaled by cash and short-term investment (DD_One). DD_One,High25 is a dummy variable that equals 1 if the firm belongs to the top DD_One quartile and equals 0 otherwise. ∗ indicates significance at the 10% level; ∗∗ significance at 5%; ∗∗∗ significance at 1%. Variable definitions are provided in Table A1 in the Appendix.
to firms in the other quartiles. Moreover, the shorter the maturity of the CDS contract, the greater is the increase in CDS spread for firms with high debt rollover risk, indicating that investors are more concerned about the short-term default risk for high rollover-risk firms than these firms’ long-term default risk. Further, we find that the impact of the crisis on CDS spread of high rollover-risk firms is much more pronounced in the later sample period when the U.S. gradually becoming the most COVID-19 affected country than in the first sample period when the crisis mostly affecting Asia and Europe.

Consistent with the evidence on default risk, we find that the COVID-19 shock also exerts heterogeneous negative impact on the stock returns of firms with different levels of debt rollover risk. The crisis leads to significantly lower abnormal stock returns for firms with high debt rollover risk than other firms. The finding of the lower stock returns for high rollover-risk firms is mainly driven by real-sector firms and not financial-sector firms and mainly concentrated in the later sample period when the U.S. becomes heavily impacted by COVID-19. Real-sector firms with high debt rollover risk produced 2–3% lower abnormal stock returns than other firms during the crisis. The finding is consistent with the notion that different from the Global Financial Crisis, the COVID-19 crisis is a health crisis that directly hits the real sector and not the financial sector. In addition, our evidence indicates that the negative cash flow shock occasioned by the COVID-19 crisis significantly increases default risk (CDS spreads) and depresses stock prices for high debt-rollover-risk firms particularly if such firms also face tight financial constraints or have high firm volatilities.

To strengthen the identification on the effects of rollover risk, we zoom in on the timing of firms’ debt rollover. We find that firms with immediate refinancing needs (debt due in March-June) suffered more than firms with distant refinancing needs (debt due in July-December) during the COVID-19 cash flow shock, which further confirms that firms’ debt rollover risk is indeed a key factor that drives the heterogenous reactions to the COVID-19 shock.

This study is the first that investigates the effects of debt rollover risk on firms’ default risk and shareholder value using the unique quasi-natural experiment of the COVID-19 health crisis. The study contributes new evidence to the literature on debt rollover risk and economic shocks, and sheds light on the economic impact of the unprecedented COVID-19 health crisis.

Appendix A

Table A1

| Variable            | Descriptions                                                                 | Source |
|---------------------|-----------------------------------------------------------------------------|--------|
| BHAR (Period 1)     | Individual daily compounding returns minus market daily compounding returns from 1/30/2020 to 2/28/2020. We use the S&P 500 index as the market portfolio. | CRSP   |
| BHAR (Period 2)     | Individual daily compounding returns minus market daily compounding returns from 1/30/2020 to 3/26/2020. We use the S&P 500 index as the market portfolio. | CRSP   |
| BHAR (Whole Period) | Individual daily compounding returns minus market daily compounding returns from 1/30/2020 to 3/26/2020. We use the S&P 500 index as the market portfolio. | CRSP   |
| CAR (Period 1)      | Cumulative abnormal returns from 1/30/2020 to 2/28/2020 estimated using both the market model and the market-adjusted model. The market model estimation window is days (-150, -50) before the midpoint of period 1. We use the S&P 500 stock market index as the market portfolio. | CRSP   |
| CAR (Period 2)      | Cumulative abnormal returns from 1/30/2020 to 3/26/2020 estimated using both the market model and the market-adjusted model. The market model estimation window is days (-150, -50) before the midpoint of period 2. We use the S&P 500 stock market index as the market portfolio. | CRSP   |
| CAR (Whole Period)  | Cumulative abnormal returns from 1/30/2020 to 3/26/2020 estimated using both the market model and the market-adjusted model. The market model estimation window is days (-150, -50) before the midpoint of the whole period. We use the S&P 500 stock market index as the market portfolio. | CRSP   |
| CDS 6M              | Changes in 6-month CDS spreads measured in basis points. | Market |
| CDS 1Y              | Changes in 1-year CDS spreads measured in basis points. | Market |
| CDS 5Y              | Changes in 5-year CDS spreads measured in basis points. | Market |
| CDS 10Y             | Changes in 10-year CDS spreads measured in basis points. | Market |
| DD One              | Total long-term debt falling due within fiscal year 2020 (including all long-term bank, finance lease and other forms of debt) divided by cash and short-term investments. | Compustat |
| DD One, High25      | A dummy variable that equals 1 if the firm belongs to the top debt due within one year scaled by cash and short-term investment quartile within a regression sample and equals 0 otherwise. | Compustat |
| DD One, Alternative 1, High25 | A dummy variable that equals 1 if the firm belongs to the top debt due within one year scaled by total debt amount quartile and equals 0 otherwise. | Compustat |
| DD One, Alternative 2, High25 | A dummy variable that equals 1 if the firm belongs to the top debt due within one year scaled by total long-term debt amount quartile and equals 0 otherwise. | Compustat |
| Size                | The natural logarithm of total assets measured in $ millions. | Compustat |
| Roa                 | Income before extraordinary items scaled by total assets. | Compustat |
| MTB                 | Market value of equity divide by book value of equity. | Compustat |
| Leverage            | The total of long-term debt and debt in current liabilities divided by total assets. | Compustat |
| Past Return         | Past stock return in percentage points for the last fiscal year. | CRSP   |
| Vol                 | Annualized daily stock return volatility in each month (we require at least 16 nonmissing daily returns in a month for the calculation), averaged over the last fiscal year. | CRSP   |
| KZ                  | As –0.010990([IB+DP]/[lagged PENET]*0.2826389) + PRCC_F*0.044[CEQ - TXDB]/[AT] + 0.00139193([DLTT + DLC]/[DLTT + DLC + SEQ] – 0.3936786) – 1.134759*CHE/(lagged PENET). | Compustat |
| WW                  | As –0.010990([IB+DP]/[lagged PENET]*0.2826389) + PRCC_F*0.044[CEQ - TXDB]/[AT] + 0.00139193([DLTT + DLC]/[DLTT + DLC + SEQ] – 0.3936786) – 1.134759*CHE/(lagged PENET). | Compustat |
Table A1 (Continued)

| Variable                  | Description                                                                                                                                                                                                 | Source
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------
| HP                        | As −0.737Size + 0.043Size2 − 0.404Age, where Size equals the log of inflation-adjusted Compustat item AT (in 2019 dollars), and Age is the number of years the firm is listed with a non-missing stock price on Compustat. In calculating the index, we cap Size at (the log of) $5.6 billion and Age at 50 years. | Compustat
| Z_Score                   | As (1.2*WCAP + 1.4*RE + 3.3*PI + 0.999*SALΕ)/AT.                                                                                                                                                    | Compustat
| Non_Div                   | Takes value of 1 if a firm pays no dividends at the end of the last fiscal year, and 0 otherwise.                                                                                                                                               | Compustat
| Non_Invest_Grade          | Dummy variable equals to 1 if the firm's long-term debt does not belong to an investment grade by Standard & Poor’s, otherwise 0.                                                                                                                 | CRSP
| Ivol                      | Annualized standard deviation of the residuals from regressing daily individual stock returns on the Fama-French three-factors in each month (we require at least 17 nonmissing daily returns in a month for the regression), averaged over the last fiscal year.                     | OptionMetrics
| Impl_Vol                  | Annualized options-implied volatility of the firm's stock, which is the average options-implied volatility of a call option with non-zero trading volume, (closest to) at the money, and (closest to) 30-day expiration and a put option with non-zero trading volume, (closest to) at the money, and (closest to) 30-day expiration, measured at the end of the last fiscal year. | OptionMetrics
| Roa,Vol                   | Standard deviation of the past five years' returns on assets in percentage points. We require at least three years' numbers to calculate the volatility.                                                                                                          | Compustat
| Operating_Cash_Vol        | Standard deviation of the past five years' cash flow from operations excluding extraordinary items scaled by the beginning total assets in percentage points. We require at least three years' numbers to calculate the volatility.                                              | Compustat
| Illiquidity               | Following Amihud (2002), illiquidity is measured as the average daily ratio of absolute return to the dollar volume of each stock in percentage for the last fiscal year. Stocks admitted in the last fiscal year have more than 200 days of data for the calculation of the characteristics and their end-of-year price exceeds $5. | Compustat
| New_Debt_Issuance         | Following Farre, Mensa (2016), debt issues net of debt repurchases in Q1 2020 scaled by lagged total assets in Q4 2019 in percentage.                                                                                                                                           | Compustat, SDC New Issue & Dealscan

Table A2

CDS Spread Changes and Debt Due within One Year (DD_One_Group4, DD_One_Group3, and DD_One_Group2) under the COVID-19 Shock.

Panel A. CDS spread change in Period 1
2020-01-30 – 2020-02-28 (Period 1)

| Variables                  | (1) CDS6M | (2) CDS1Y | (3) CDS5Y | (4) CDS10Y |
|----------------------------|-----------|-----------|-----------|------------|
| DD_One_Group4              | 223.574** | 225.216** | 142.974** | 110.008**  |
| (87.798)                   | (88.059)  | (57.116)  | (49.482)  |            |
| DD_One_Group3              | 69.865    | 38.253    | 38.736    | 18.687     |
| (80.341)                   | (80.580)  | (52.265)  | (45.670)  |            |
| DD_One_Group2              | −15.26    | −5.895    | −6.247    | −15.435    |
| (75.122)                   | (75.345)  | (48.870)  | (42.431)  |            |
| Size                       | 25.756    | 23.888    | 18.572    | 12.203     |
| (26.259)                   | (26.317)  | (17.082)  | (14.773)  |            |
| Roa                        | 17.085*** | 16.338*** | 11.157*** | 9.046***   |
| (4.967)                    | (4.981)   | (3.231)   | (2.788)   |            |
| MTB                        | 0.971     | 0.974     | 0.652     | 0.444      |
| (2.321)                    | (2.328)   | (1.510)   | (1.300)   |            |
| Leverage                   | 0.046     | −0.415    | −0.141    | −0.171     |
| (1.172)                    | (1.175)   | (0.762)   | (0.657)   |            |
| Past_Return                | −3.319*** | −2.867*** | −1.958*** | −1.900***  |
| (0.998)                    | (1.001)   | (0.649)   | (0.573)   |            |
| Vol                        | 14.973*** | 13.773*** | 11.740*** | 9.764***   |
| (2.586)                    | (2.594)   | (1.682)   | (1.480)   |            |
| Illiquidity                | −0.700    | −0.515    | −0.323    | −0.214     |
| (2.371)                    | (2.378)   | (1.542)   | (1.328)   |            |
| Industry FE                | Yes       | Yes       | Yes       |            |
| Constant                   | Yes       | Yes       | Yes       |            |
| Number of Obs.             | 234       | 234       | 234       | 232        |
| Adj R2                     | 0.209     | 0.124     | 0.266     | 0.238      |

Panel B. CDS spread change in Period 2
2020-03-02 – 2020-03-26 (Period 2)

| Variables                  | (1) CDS6M | (2) CDS1Y | (3) CDS5Y | (4) CDS10Y |
|----------------------------|-----------|-----------|-----------|------------|
| DD_One_Group4              | 739.926** | 642.418** | 349.903** | 253.807*** |
| (304.586)                  | (309.593) | (155.895) | (133.611) |            |
| DD_One_Group3              | 135.928   | 143.489   | 58.765    | −14.889    |
| (278.718)                  | (246.696) | (142.737) | (123.584) |            |
| DD_One_Group2              | −20.139   | −7.071    | −0.546    | −35.059    |
| (200.611)                  | (230.670) | (133.464) | (114.753) |            |
| Size                       | 91.350    | 84.525    | 46.308    | 33.360     |
| (91.096)                   | (80.630)  | (46.652)  | (39.489)  |            |
### Table A2 (Continued)

#### Panel B. CDS spread change in Period 2

| Variables       | (1) CDS,6M | (2) CDS,1Y | (3) CDS,5Y | (4) CDS,10Y |
|-----------------|------------|------------|------------|-------------|
| Roa             | 55.115***  | 47.967***  | 26.114***  | 21.849***   |
|                 | (17.230)   | (15.251)   | (8.824)    | (7.559)     |
| MTB             | 3.401      | 2.945      | 1.508      | 1.233       |
|                 | (8.054)    | (7.128)    | (4.124)    | (3.565)     |
| Leverage        | 0.630      | 0.524      | 0.455      | 0.464       |
|                 | (4.065)    | (3.508)    | (2.082)    | (1.749)     |
| Past_Return     | −10.696*** | −9.673***  | −4.074***  | −4.715***   |
|                 | (3.461)    | (3.063)    | (1.772)    | (1.528)     |
| Vol             | 53.404***  | 49.552***  | 29.188***  | 24.571***   |
|                 | (8.971)    | (7.940)    | (4.954)    | (3.958)     |
| Illiquidity     | −2.355     | −2.194     | −1.101     | −0.918      |
|                 | (8.225)    | (7.280)    | (4.212)    | (3.533)     |
| Industry FE     | Yes        | Yes        | Yes        | Yes         |
| Constant        | Yes        | Yes        | Yes        | Yes         |
| Number of Obs.  | 234        | 234        | 234        | 227         |

#### Panel C. CDS spread change in the Whole Period

| Variables       | (1) CDS,6M | (2) CDS,1Y | (3) CDS,5Y | (4) CDS,10Y |
|-----------------|------------|------------|------------|-------------|
| DD,One_Group4   | 974.197*** | 858.711**  | 472.998**  | 352.946**   |
|                 | (391.747)  | (347.464)  | (203.394)  | (171.659)   |
| DD,One_Group3   | 194.541    | 188.796    | 95.339     | 28.194      |
|                 | (358.476)  | (317.953)  | (186.120)  | (157.780)   |
| DD,One_Group2   | −32.881    | −10.910    | −5.901     | −45.731     |
|                 | (335.188)  | (297.298)  | (174.029)  | (147.705)   |
| Size            | 116.976    | 108.051    | 63.649     | 41.125      |
|                 | (117.165)  | (103.920)  | (60.832)   | (50.698)    |
| Roa             | 72.557***  | 63.699***  | 35.792***  | 27.974***   |
|                 | (22.161)   | (19.056)   | (11.506)   | (9.316)     |
| MTB             | 4.406      | 3.866      | 2.044      | 1.485       |
|                 | (10.358)   | (9.187)    | (5.378)    | (4.592)     |
| Leverage        | 0.580      | 0.056      | 0.420      | 0.454       |
|                 | (5.229)    | (4.638)    | (2.715)    | (2.252)     |
| Past_Return     | −13.993*** | −12.677*** | −6.699***  | −6.384***   |
|                 | (4.491)    | (3.948)    | (2.311)    | (1.968)     |
| Vol             | 68.213***  | 63.072***  | 38.843***  | 32.506***   |
|                 | (11.538)   | (10.234)   | (5.991)    | (5.001)     |
| Illiquidity     | −3.026     | −2.649     | −1.391     | −1.160      |
|                 | (10.578)   | (9.382)    | (5.492)    | (4.552)     |
| Industry FE     | Yes        | Yes        | Yes        | Yes         |
| Constant        | Yes        | Yes        | Yes        | Yes         |
| Number of Obs.  | 234        | 234        | 234        | 228         |

| Adj R2          | 0.244      | 0.271      | 0.322      | 0.339       |

Table A2 reports the OLS regression results for CDS spread changes. The sample consists of 234 firm observations with CDS data from January 30, 2020 to March 26, 2020. We divide our sample firms into quartiles according to their debt due within one-year scaled by cash and short-term investment (DD,One), DD,One_Group4, DD,One_Group3 and DD,One_Group2 are dummy variables that equal 1 if the firm belongs to the top, second to the top, and third to the top quartile according to the value of DD,One, respectively, and equal 0 otherwise. Panel A presents the regression results for CDS spread changes in Period 1 (from January 30, 2020 – February 28, 2020), Panel B presents the regression results for CDS spread changes in Period 2 (from March 2, 2020 – March 26, 2020), Panel C presents the regression results for CDS spread changes in the Whole Period (from January 30, 2020 – March 26, 2020). ∗ indicates significance at the 10% level; ∗∗ significance at 5%; ∗∗∗ significance at 1%. Variable definitions are provided in Table A1 in the Appendix.
### Table A3

**CDS Spread Changes and Debt Due within One Year (DD_One_Group4, DD_One_Group3 and DD_One_Group2) Conditional on Financial Constraints and Volatilities.**

| Panel A. CDS spread change on interacting DD_One_Group4, DD_One_Group3, DD_One_Group2 and High_FC | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Variables | CDS･6M | CDS･6M | CDS･6M | CDS･6M | CDS･6M | CDS･6M |
| Financial Constraint Measures | | | | | | |
| HP | 2,068.376*** | 1,007.194 | 1,099.353 | 905.904 | 3,733.480*** | 2,720.286*** |
| WW | (688.516) | (691.899) | (775.551) | (694.430) | (857.373) | (913.142) |
| Z･score | -561.427 | -371.384 | -75.908 | 843.476 | 467.741 | -381.958 |
| KZ | (613.152) | (636.804) | (685.165) | (635.372) | (997.822) | (871.202) |
| DD_One_Group4* High_FC | | | | | | |
| 2020 | (614.737) | (637.124) | (668.428) | (638.562) | (897.595) | (954.299) |
| DD_One_Group3* High_FC | Yes | Yes | Yes | Yes | Yes | Yes |
| DD_One_Group2* High_FC | Yes | Yes | Yes | Yes | Yes | Yes |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of Obs. | 234 | 234 | 234 | 234 | 234 | 234 |
| Adj R2 | 0.307 | 0.252 | 0.242 | 0.267 | 0.330 | 0.306 |

| Panel B. CDS spread change on interacting DD_One_Group4, DD_One_Group3, DD_One_Group2 and High_VOL | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Variables | CDS･6M | CDS･6M | CDS･6M | CDS･6M | CDS･6M | CDS･6M |
| Volatility Measures | | | | | | |
| Vol | 2,168.742*** | 2,063.652*** | 1,954.251*** | 1,509.180** | 1,699.692** | |
| (654.293) | (660.761) | (638.541) | (668.365) | (696.629) | |
| Impl･Vol | 209.555 | 209.555 | 138.833 | 138.833 | 138.833 | 138.833 |
| (600.814) | (600.814) | (600.814) | (600.814) | (600.814) | (600.814) |
| Roa･Vol | 52.546 | 130.729 | -32.928 | -32.928 | 17.812 | 147.703 |
| (608.289) | (608.289) | (608.289) | (608.289) | (608.289) | (608.289) |
| Operating･Cash･Vol | Yes | Yes | Yes | Yes | Yes | Yes |
| Main Dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of Obs. | 234 | 234 | 234 | 234 | 234 | 234 |
| Adj R2 | 0.317 | 0.295 | 0.311 | 0.267 | 0.269 | 0.269 |

Table A3 reports the OLS regression results for CDS spread changes conditional on different measures of financial constraints (i.e., HP; WW; Z･score; KZ; Non･Div; Non･Invest･Grade) and volatilities (i.e., Vol; Impl･Vol; Roa･Vol; Operating･Cash･Vol). The sample consists of 234 firm observations with CDS spread data from January 30, 2020 to March 26, 2020. High_FC is a dummy that indicates high financial constraints. High_VOL is a dummy that indicates high firm volatility. Panel A presents the regression results for CDS spread changes on interacting DD_One_Group4, DD_One_Group3, DD_One_Group2 and High_FC. Panel B presents the regression results for CDS spread changes on interacting DD_One_Group4, DD_One_Group3, DD_One_Group2 and High_VOL. Regressions include the same set of controls appeared in the baseline results (i.e., Table 2). Main dummies used to construct the interaction terms are also included. Their regression coefficients are omitted for brevity. * indicates significance at the 10% level; ** significance at 5%; *** significance at 1%. Variable definitions are provided in Table A1 in the Appendix.

### Table A4

**BHARs and Debt Due within One Year (DD_One_Group4, DD_One_Group3, and DD_One_Group2) under COVID-19 Shock.**

| Panel A. BHARs for the real-sector firms | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Variables | BHAR (Period 1) | BHAR (Period 1) | BHAR (Period 2) | BHAR (Period 2) | BHAR (Whole Period) | BHAR (Whole Period) |
| DD_One_Group4 | -0.580 | -0.301 | -3.216*** | -2.752** | -3.237*** | -2.525* |
| (0.832) | (0.881) | (1.110) | (1.143) | (1.244) | (1.291) | |
| DD_One_Group3 | -0.705 | -0.655 | -1.634 | -2.190** | -1.977* | -2.308* |
| (0.775) | (0.813) | (1.035) | (1.055) | (1.159) | (1.192) | |
| DD_One_Group2 | 1.446* | 1.381* | 1.947* | 1.370 | 2.748** | 2.261** |
| (0.772) | (0.780) | (1.030) | (1.012) | (1.154) | (1.143) | |
| Size | 0.062 | 0.062 | 0.685*** | 0.685*** | 0.611** | 0.611** |
| (0.165) | (0.165) | (0.214) | (0.214) | (0.241) | (0.241) | |
| Roa | 0.010 | 0.010 | -0.003 | -0.003 | -0.004 | -0.004 |
| (0.010) | (0.010) | (0.013) | (0.013) | (0.014) | (0.014) | |
| MTB | 0.021 | 0.021 | 0.078** | 0.078** | 0.085** | 0.085** |
| (0.025) | (0.025) | (0.032) | (0.032) | (0.036) | (0.036) | |
| Leverage | -0.009 | -0.009 | -0.064*** | -0.064*** | -0.063*** | -0.063*** |
| (0.009) | (0.009) | (0.012) | (0.012) | (0.013) | (0.013) | |
| Past(Return) | 0.018*** | 0.018*** | 0.029*** | 0.029*** | 0.038*** | 0.038*** |
| (0.005) | (0.005) | (0.007) | (0.007) | (0.008) | (0.008) | |
| Vol | 0.011 | 0.011 | -0.091*** | -0.091*** | -0.075*** | -0.075*** |
| (0.013) | (0.013) | (0.017) | (0.017) | (0.020) | (0.020) | |
| Illiquidity | 0.003*** | 0.003*** | 0.003*** | 0.003*** | 0.005** | 0.005** |
| (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) | |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of Obs. | 2,279 | 2,279 | 2,279 | 2,279 | 2,279 | 2,279 |
| Adj R2 | 0.052 | 0.057 | 0.229 | 0.276 | 0.210 | 0.246 |
Table A4 (Continued)

Panel B. BHARs for the financial firms

| Variables | (1) BHAR (Period 1) | (2) BHAR (Period 1) | (3) BHAR (Period 2) | (4) BHAR (Period 2) | (5) BHAR (Whole Period) | (6) BHAR (Whole Period) |
|-----------|---------------------|---------------------|---------------------|---------------------|--------------------------|--------------------------|
| DD_One_Group4 | 0.584 (0.648) | 0.213 (0.644) | −0.955 (1.348) | 1.057 (1.356) | −0.238 (1.397) | 1.317 (1.411) |
| DD_One_Group3 | −0.277 (0.752) | −0.426 (0.731) | 0.825 (1.563) | 1.639 (1.539) | 0.626 (1.620) | 1.256 (1.501) |
| DD_One_Group2 | −1.337* (0.758) | −1.388* (0.734) | 1.030 (1.576) | 1.544 (1.545) | −0.153 (1.633) | 0.298 (1.608) |
| Size | −0.526*** (0.154) | −0.577* (0.324) | −0.883*** (0.337) |
| Roa | 0.055 (0.016) | 0.035 (0.035) | 0.086** (0.036) |
| MTB | −0.050 (0.037) | 0.021 (0.077) | −0.028 (0.080) |
| Leverage | 0.038*** (0.010) | −0.112*** (0.022) | −0.073*** (0.023) |
| Past_Return | 0.002 (0.010) | 0.066*** (0.022) | 0.062*** (0.023) |
| Vol | −0.061** (0.024) | 0.013 (0.050) | −0.008 (0.052) |
| Illiquidity | 0.005*** (0.001) | 0.001 (0.003) | 0.004 (0.003) |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of Obs. | 768 | 768 | 768 | 768 | 768 | 768 |
| Adj R2 | 0.066 | 0.078 | 0.117 | 0.160 | 0.097 | 0.134 |

Panel C. BHARs for all firms

| Variables | (1) BHAR (Period 1) | (2) BHAR (Period 1) | (3) BHAR (Period 2) | (4) BHAR (Period 2) | (5) BHAR (Whole Period) | (6) BHAR (Whole Period) |
|-----------|---------------------|---------------------|---------------------|---------------------|--------------------------|--------------------------|
| DD_One_Group4 | −0.309 (0.603) | −0.134 (0.629) | −2.421*** (0.860) | −1.246 (0.879) | −2.285** (0.949) | −1.047 (0.976) |
| DD_One_Group3 | −0.671 (0.588) | −0.665 (0.587) | −0.962 (0.840) | −0.813 (0.858) | −1.323 (0.927) | −1.090 (0.941) |
| DD_One_Group2 | 0.978* (0.589) | 0.935 (0.592) | 2.687** (0.841) | 1.826** (0.826) | 2.537*** (0.928) | 2.325** (0.917) |
| Size | −0.103 (0.127) | 0.266 (0.177) | 0.126 (0.197) |
| Roa | 0.016* (0.008) | 0.009 (0.012) | 0.011 (0.013) |
| MTB | 0.013 (0.021) | 0.084*** (0.029) | 0.083** (0.033) |
| Leverage | 0.004 (0.007) | −0.074*** (0.010) | −0.083*** (0.011) |
| Past_Return | 0.017*** (0.005) | 0.031*** (0.007) | 0.040*** (0.007) |
| Vol | 0.001 (0.002) | −0.089*** (0.016) | −0.078*** (0.018) |
| Illiquidity | 0.004*** (0.001) | 0.003* (0.002) | 0.006*** (0.002) |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of Obs. | 3,047 | 3,047 | 3,047 | 3,047 | 3,047 | 3,047 |
| Adj R2 | 0.049 | 0.058 | 0.212 | 0.253 | 0.192 | 0.225 |

Table A4 reports the OLS regression results for BHARs. The sample consists of 3,047 firm observations from January 30, 2020 to March 26, 2020. We divide our sample firms into quartiles according to their debt due within one-year scaled by cash and short-term investment (DD_One), DD_One_Group4, DD_One_Group3 and DD_One_Group2 are dummy variables that equal 1 if the firm belongs to the top, second to the top, and third to the top, quartile according to the value of DD_One, respectively, and equal 0 otherwise. Panel A presents the regression results for the real-sector firms. Panel B presents the regression results for the financial-sector firms. Panel C presents the regression results for all firms. * indicates significance at the 10% level; ** significance at 5%; *** significance at 1%. Variable definitions are provided in Table A1 in the Appendix.
### Table A5
BHARs and Debt Due within One Year (DD_One_Group4, DD_One_Group3 and DD_One_Group2) Conditional on Financial Constraints and Volatilities.

#### Panel A. BHARs on interacting DD_One_Group4, DD_One_Group3, DD_One_Group2 and High_NC

| Variables | (1) BHAR (Whole Period) | (2) BHAR (Whole Period) | (3) BHAR (Whole Period) | (4) BHAR (Whole Period) | (5) BHAR (Whole Period) | (6) BHAR (Whole Period) |
|-----------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Financial Constraint Measures | | | | | | |
| HP | Z-score | KZ | Non_Div | Non_Invest_Grade |
| DD_One_Group4 | $-3.851^{**}$ | $-3.383^{**}$ | $-3.498^{**}$ | $-1.577$ | $-3.165$ |
| High_NC | (1.473) | (1.363) | (1.324) | (1.344) | (1.831) | (3.418) |
| DD_One_Group3* | $-0.443$ | $-0.449$ | $-2.127$ | $-2.932^{**}$ | $-1.905$ | $-3.156$ |
| High_NC | (1.454) | (1.308) | (1.390) | (1.258) | (1.794) | (3.158) |
| DD_One_Group2* | $0.437$ | $0.309$ | $-1.423$ | $-1.290$ | $2.748$ | $-3.157$ |
| High_NC | (1.478) | (1.340) | (1.363) | (1.337) | (1.796) | (3.148) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Main Dummies | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of Obs. | 3,047 | 3,047 | 3,047 | 3,047 | 3,047 | 3,047 |
| Adj R2 | 0.226 | 0.226 | 0.226 | 0.227 | 0.226 | 0.226 |

#### Panel B. BHARs on interacting DD_One_Group4, DD_One_Group3, DD_One_Group2 and High_VOL

| Variables | (1) BHAR (Whole Period) | (2) BHAR (Whole Period) | (3) BHAR (Whole Period) | (4) BHAR (Whole Period) | (5) BHAR (Whole Period) |
|-----------|-------------------------|-------------------------|-------------------------|-------------------------|-------------------------|
| Volatility Measures | | | | | |
| DD_One_Group4* High_VOL | $-3.574^{**}$ | $-3.836^{**}$ | $-2.610^{*}$ | $-0.486$ | $-1.120$ |
| High_VOL | (1.421) | (1.417) | (1.412) | (1.355) | (1.353) |
| DD_One_Group3* High_VOL | $-3.226^{**}$ | $-2.804^{**}$ | $-0.660$ | $-0.489$ | $-0.489$ |
| High_VOL | (1.320) | (1.332) | (1.322) | (1.277) | (1.276) |
| DD_One_Group2* High_VOL | $-0.483$ | $-1.971$ | $1.163$ | $0.502$ | $0.400$ |
| High_VOL | (1.385) | (1.371) | (1.330) | (1.365) | (1.362) |
| Controls | Yes | Yes | Yes | Yes | Yes |
| Main Dummies | Yes | Yes | Yes | Yes | Yes |
| Industry FE | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes |
| Number of Obs. | 3,047 | 3,047 | 3,047 | 3,047 | 3,047 |
| Adj R2 | 0.227 | 0.228 | 0.229 | 0.224 | 0.224 |

### Table A6
CDS Spread Changes, BHARs and Debt Due within One Year Controlling for Market Leverage under the COVID-19 Shock.

| Variables | CDS Spread Changes | BHARs |
|-----------|-------------------|--------|
| DD_One_High25 | 771,547*** | $-2.840^{***}$ |
| Size | (287.294) | (0.945) |
| Roa | 76,340*** | 0.001 |
| MTB | 5,426 | 0.017 |
| Market_Leverage | 10,067*** | 0.002 |
| Past_Return | $-10.808^{***}$ | 0.007 |
| Vol | 70,726*** | 0.000 |
| Iliquidity | $-4.429$ | 0.005 |
| Industry FE | Yes | Yes |
| Constant | Yes | Yes |
| Observations | 234 | 2.279 |
| Adj R2 | 0.343 | 0.230 |

Table A6 reports the OLS regression results for both CDS spread changes and BHARs further controlling for market leverage ratio for robustness checks. The sample consists of 3,047 firm observations from January 30, 2020 to March 26, 2020. We divide our sample firms into quartiles according to their debt due within one-year scaled by cash and short-term investment (DD_One). DD_One_High25 is a dummy variable that equals 1 if the firm belongs to the top DD_One quartile and equals 0 otherwise. We replace book leverage ratio in the baseline regression with market leverage ratio for robustness check. * indicates significance at the 10% level; ** significance at 5%; *** significance at 1%. Variable definitions are provided in Table A1 in the Appendix.
Table A7: CDS Spread Changes, BHARs and Debt Due within One Year Reacting to Interest Rate Reduction.

| Variables | CDS Spread Changes | BHARs | Debt Due within One Year |
|-----------|--------------------|-------|--------------------------|
|           | One-Day Reactions  | Two-Day Reactions | One-Day Reactions | Two-Day Reactions |
|           | CDS_6M | CDS_1Y | CDS_6M | CDS_1Y | BHAR (Real Sector) | BHAR (Financial Sector) | BHAR (Real Sector) | BHAR (Financial Sector) |
| DD, One_High25 | 18.811 | 54.097** | (38.705) | (26.742) | 0.449 | 0.214 | -0.264 | 1.007 |
| Size | 12.137 | 13.612 | (1.911) | (1.058) | 0.017 | 0.100 | -0.021 | 0.050 |
| Roa | 3.929 | 5.174*** | (0.464) | (0.494) | 0.016 | 0.038 | (0.025) | (0.059) |
| MTB | 0.484 | 0.480 | (0.005) | 0.005 | -0.006 | -0.103* |
| Leverage | 0.481 | 0.002 | 0.229 | 0.209 | -0.031*** | -0.023** | -0.039*** | -0.067*** |
| Past_Return | -1.055* | -1.162*** | (0.006) | (0.011) | (0.009) | (0.017) |
| Vol | 6.071*** | 6.970*** | 0.005 | 0.005 | -0.014 | -0.002 |
| Illiquidity | -0.272 | -0.149 | (0.009) | (0.025) | (0.014) | (0.038) |
| Industry FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Observations | 234 | 234 | 234 | 234 | 768 | 768 |
| Adj R2 | 0.059 | 0.312 | 0.002 | 0.196 | 0.214 | 0.285 |

Table A7 reports the OLS regression results for both CDS spread changes and BHARs reacting to the interest rate reduction by Federal Reserve on March 15, 2020. The sample consists of 3,047 firm observations from January 30, 2020 to March 26, 2020. We investigate both the one-day (March 16) and two-day (March 16 and March 17) market reactions to the interest rate reduction announcement made by Federal Reserve. We divide our sample firms into quartiles according to their debt due within one-year scaled by cash and short-term investment (DD, One). DD, One_High25 is a dummy variable that equals 1 if the firm belongs to the top DD, One quartile and equals 0 otherwise. * indicates significance at the 10% level; ** significance at 5%; *** significance at 1%. Variable definitions are provided in Table A1 in the Appendix.

Table A8: CARs and Debt Due within One Year (DD, One_High25) under COVID-19 Shock.

Panel A. CARs for the real-sector firms Market model

| Variables | CAR (Period 1) | CAR (Period 2) | CAR (Whole Period) | CAR (Whole Period) |
|-----------|---------------|---------------|-------------------|-------------------|
| DD, One_High25 | -0.870** | -1.358*** | -1.680** | -2.042*** | -3.139*** | -4.057*** |
| Controls | No | Yes | No | Yes | No | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of Obs. | 2,279 | 2,279 | 2,279 | 2,279 | 2,279 | 2,279 |
| Adj R2 | 0.051 | 0.083 | 0.129 | 0.177 | 0.138 | 0.172 |

Market adjusted model

| Variables | CAR (Period 1) | CAR (Period 2) | CAR (Whole Period) | CAR (Whole Period) |
|-----------|---------------|---------------|-------------------|-------------------|
| DD, One_High25 | -0.735 | -0.359 | -2.975*** | -2.294** | -3.490*** | -2.374* |
| Controls | No | Yes | No | Yes | No | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of Obs. | 2,279 | 2,279 | 2,279 | 2,279 | 2,279 | 2,279 |
| Adj R2 | 0.047 | 0.053 | 0.171 | 0.193 | 0.177 | 0.192 |

Panel B. CARs for the financial firms Market model

| Variables | CAR (Period 1) | CAR (Period 2) | CAR (Whole Period) | CAR (Whole Period) |
|-----------|---------------|---------------|-------------------|-------------------|
| DD, One_High25 | 0.194 | -0.119 | -1.897* | -1.253 | -1.188 | -0.965 |
| Controls | No | Yes | No | Yes | No | Yes |
| Constant | Yes | Yes | Yes | Yes | Yes | Yes |
| Number of Obs. | 768 | 768 | 768 | 768 | 768 | 768 |
| Adj R2 | 0.088 | 0.123 | 0.108 | 0.133 | 0.148 | 0.168 |
Table A8 (Continued)

| Variables                          | CAR (Period 1) | CAR (Period 1) | CAR (Period 2) | CAR (Period 2) | CAR (Whole Period) | CAR (Whole Period) |
|------------------------------------|----------------|----------------|----------------|----------------|--------------------|--------------------|
| DD_{One,High25}                    | 0.815          | 0.522          | −1.828         | −0.324         | −0.932             | 0.211              |
| Controls                           | (0.694)        | (0.685)        | (1.522)        | (1.539)        | (1.776)            | (1.793)            |
| Constant                           | No             | Yes            | No             | Yes            | No                 | Yes                |
| Industry FE                        | Yes            | Yes            | Yes            | Yes            | Yes                | Yes                |
| Number of Obs.                     | 768            | 768            | 768            | 768            | 768                | 768                |
| Adj R2                             | 0.004          | 0.076          | 0.068          | 0.093          | 0.059              | 0.088              |

Panel C. CARs for all firms Market model

| Variables                          | CAR (Period 1) | CAR (Period 1) | CAR (Period 2) | CAR (Period 2) | CAR (Whole Period) | CAR (Whole Period) |
|------------------------------------|----------------|----------------|----------------|----------------|--------------------|--------------------|
| DD_{One,High25}                    | −0.594*        | −0.999***      | −1.736***      | −1.822***      | −2.633***          | −3.229***          |
| Controls                           | (0.350)        | (0.354)        | (0.587)        | (0.591)        | (0.811)            | (0.819)            |
| Constant                           | Yes            | Yes            | Yes            | Yes            | Yes                | Yes                |
| Industry FE                        | Yes            | Yes            | Yes            | Yes            | Yes                | Yes                |
| Number of Obs.                     | 3,047          | 3,047          | 3,047          | 3,047          | 3,047              | 3,047              |
| Adj R2                             | 0.063          | 0.093          | 0.134          | 0.169          | 0.152              | 0.181              |

Table A8 reports the OLS regression results for cumulative abnormal returns (CARs). The sample consists of 3,047 firm observations from January 30, 2020 to March 26, 2020. We divide our sample firms into quartiles according to their debt due within one-year scaled by cash and short-term investment (DD_{One}). DD_{One,High25} is a dummy variable that equals 1 if the firm belongs to the top DD_{One} quartile and equals 0 otherwise. We calculate CARs using both the market model and the market-adjusted model. We use the S&P 500 stock market index as the market portfolio. The market model estimation window is days (-150 - 50) before the event date (midpoint of each period). Panel A presents the regression results for the real-sector firms. Panel B presents the regression results for the financial-sector firms. Panel C presents the regression results for all firms. Control variables follow those in Table 5 and their regression coefficients are omitted for brevity. * indicates significance at the 10% level; ** significance at 5%; *** significance at 1%. Variable definitions are provided in Table A1 in the Appendix.

Table A9

CARs and Debt Due within One Year Conditional on Financial Constraints and Volatilities.

Panel A. CARs on interacting DD_{One,High25} and High_{FC}

| Variables                          | (1) CAR (Whole Period) | (2) CAR (Whole Period) | (3) CAR (Whole Period) | (4) CAR (Whole Period) | (5) CAR (Whole Period) | (6) CAR (Whole Period) |
|------------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Financial Constraint Measures      | HP                     | WW                     | Z_{score}              | KZ                     | Non_Div                | Non_Invest_Grade       |
| DD_{One,High25}                    | −5.154***              | −1.342                 | −1.889*                | −2.136*                | −2.799                 | −1.071                 |
| (1.940)                            | (1.289)                | (1.135)                | (1.278)                | (2.090)                | (2.199)                |                       |
| DD_{One,High25}                    | −0.612                 | −1.523                 | −1.402                 | −1.512                 | −0.752                 | −1.541                 |
| (1.385)                            | (1.318)                | (1.108)                | (1.114)                | (1.243)                | (1.105)                | (1.539)                |
| High_{FC}                          | −2.410**               | −2.028**               | −3.679***              | −2.176**               | −1.294                 | −3.128**               |
| (1.064)                            | (1.016)                | (1.264)                | (1.020)                | (1.356)                | (1.356)                |                       |
| Controls                           | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    |
| Industry FE                        | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    |
| Number of Obs.                     | 3,047                  | 3,047                  | 3,047                  | 3,047                  | 3,047                  | 3,047                  |
| Adj R2                             | 0.175                  | 0.174                  | 0.177                  | 0.175                  | 0.173                  | 0.174                  |

Market adjusted model

| Variables                          | (1) CAR (Whole Period) | (2) CAR (Whole Period) | (3) CAR (Whole Period) | (4) CAR (Whole Period) | (5) CAR (Whole Period) | (6) CAR (Whole Period) |
|------------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Financial Constraint Measures      | HP                     | WW                     | Z_{score}              | KZ                     | Non_Div                | Non_Invest_Grade       |
| DD_{One,High25}                    | −3.127**               | −1.773                 | −2.038*                | −2.290**               | −2.321                 | −1.585                 |
| (1.448)                            | (1.412)                | (1.130)                | (1.090)                | (1.558)                | (1.508)                | (2.387)                |
| DD_{One,High25}                    | −0.525                 | −0.918                 | −1.034                 | −1.051                 | −0.946                 | −0.943                 |
| (0.496)                            | (1.012)                | (0.943)                | (0.762)                | (0.927)                | (1.148)                |                       |
Table A9 (Continued)

Market adjusted model

| Variables | (1) CAR (Whole Period) | (2) CAR (Whole Period) | (3) CAR (Whole Period) | (4) CAR (Whole Period) | (5) CAR (Whole Period) | (6) CAR (Whole Period) |
|-----------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| High_{FC} | −1.858∗                 | −2.522**               | −3.001***              | −3.118***              | −1.299                 | −3.265***              |
| (*1.035)  | (0.984)                | (0.827)                | (0.832)                | (1.011)                | (0.824)                |                        |
| Controls  | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    |
| Industry FE | Yes                  | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    |
| Constant  | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    |
| Number of Obs. | 3,047                | 3,047                  | 3,047                  | 3,047                  | 3,047                  | 3,047                  |
| Adj R2    | 0.182                  | 0.182                  | 0.184                  | 0.182                  | 0.182                  | 0.182                  |

Panel B. CARs on interacting DD_{One,High25} and High_{Vol}

| Variables | (1) CAR (Whole Period) | (2) CAR (Whole Period) | (3) CAR (Whole Period) | (4) CAR (Whole Period) | (5) CAR (Whole Period) |
|-----------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Volatility Measures | Vol                  | Ivol                  | Impl_{Vol}            | Roa_{Vol}              | Operating Cash_{Vol}   |
| High_{Vol} | −3.726*               | −3.352**              | −2.704***             | −0.819                 | −1.297                 |
| (*1.944)  | (1.935)                | (1.936)                | (1.880)                | (1.872)                |                        |
| DD_{One,High25} | −1.024               | −1.351                | −1.503                | −1.205                 | −1.619                 |
| (*1.376)  | (1.392)                | (1.317)                | (1.321)                | (1.327)                |                        |
| High_{Vol} | −2.030**              | −2.081***             | −2.137***             | −1.063                 | −1.077                 |
| (*1.026)  | (1.046)                | (1.057)                | (1.038)                | (1.055)                |                        |
| Controls  | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    |
| Industry FE | Yes                  | Yes                    | Yes                    | Yes                    | Yes                    |
| Constant  | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    |
| Number of Obs. | 3,047                | 3,047                  | 3,047                  | 3,047                  | 3,047                  |
| Adj R2    | 0.174                  | 0.176                  | 0.176                  | 0.174                  | 0.174                  |

Market adjusted model

| Variables | (1) CAR (Whole Period) | (2) CAR (Whole Period) | (3) CAR (Whole Period) | (4) CAR (Whole Period) | (5) CAR (Whole Period) |
|-----------|------------------------|------------------------|------------------------|------------------------|------------------------|
| Volatility Measures | Vol                  | Ivol                  | Impl_{Vol}            | Roa_{Vol}              | Operating Cash_{Vol}   |
| DD_{One,High25} | −2.706***             | −3.319***             | −3.211***             | −0.551                 | −1.293                 |
| (*1.028)  | (0.990)                | (0.984)                | (1.397)                | (1.401)                |                        |
| DD_{One,High25} | −1.224               | −1.371                | −1.027                | −0.828                 | −1.015                 |
| (*1.452)  | (1.444)                | (1.447)                | (0.919)                | (0.934)                |                        |
| High_{Vol} | −2.592***             | −2.574**              | −2.047**              | −1.091                 | −1.086                 |
| (*0.985)  | (1.039)                | (1.043)                | (0.928)                | (0.941)                |                        |
| Controls  | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    |
| Industry FE | Yes                  | Yes                    | Yes                    | Yes                    | Yes                    |
| Constant  | Yes                    | Yes                    | Yes                    | Yes                    | Yes                    |
| Number of Obs. | 3,047                | 3,047                  | 3,047                  | 3,047                  | 3,047                  |
| Adj R2    | 0.181                  | 0.184                  | 0.181                  | 0.184                  | 0.182                  |

Table A9 reports the OLS regression results for cumulative abnormal returns (CARs) conditional on different measures of financial constraints (i.e., HP; VW; Zscore; KZ; Non_Div; Non_Invest_Grade) and volatilities (i.e., Vol; Ivol; Impl_{Vol}; Roa_{Vol}; Operating Cash_{Vol}). The sample consists of 3,047 firm observations from January 30, 2020 to March 26, 2020. DD_{One,High25} is a dummy variable that equals 1 if the firm belongs to the top DD_{One} quartile and equals 0 otherwise. High_{FC} is a dummy that indicates high financial constraints. High_{Vol} is a dummy that indicates high firm volatility. We calculate CARs using both the market model and the market-adjusted model. We use the S&P 500 stock market index as the market portfolio. The market model estimation window is days (-150, -50) before the event date (midpoint of each period). Panel A presents the regression results for CARs on interacting DD_{One,High25} and High_{FC}. Panel B presents the regression results for CARs on interacting DD_{One,High25} and High_{Vol}. Regressions include the same set of controls appeared in the baseline results (i.e., Table 5). The regression coefficients of the control variables are omitted for brevity. ∗ indicates significance at the 10% level; ∗∗ significance at 5%; ∗∗∗ significance at 1%. Variable definitions are provided in Table A1 in the Appendix.
Table A10
CARs and Debt Due within One Year by Months (Immediate Refinancing Needs vs Distant Refinancing Needs) under COVID-19 Shock.

| Variables | Market Model CARs | Market-Adjusted Model CARs |
|-----------|-------------------|---------------------------|
|           | Immediate Refinancing (March-June) | Distant Refinancing (July-December) | Immediate Refinancing (March-June) | Distant Refinancing (July-December) |
|           | CAR (Real Sector) | CAR (Financial Sector) | CAR (Real Sector) | CAR (Financial Sector) | CAR (Real Sector) | CAR (Financial Sector) |
| DD_One_High25 (March–June) | –3.887*** | –0.665 | –3.709*** | –0.794 | –2.840** | –0.233 | –2.092 | –0.440 |
| DD_One_High25 (July–December) | (0.966) | (1.376) | (0.967) | (1.397) | (1.305) | (1.802) |
| Size      | 1.642*** | 0.730** | 1.668*** | 0.733** | 0.633* | 1.625*** | 0.637* | 1.622*** |
|           | (0.247) | (0.352) | (0.248) | (0.352) | (0.333) | (0.453) | (0.334) | (0.454) |
| Roa       | –0.014 | 0.068* | –0.014 | 0.069* | –0.008 | 0.111** | –0.008 | 0.111** |
|           | (0.015) | (0.038) | (0.015) | (0.038) | (0.020) | (0.049) | (0.020) | (0.049) |
| MTB       | 0.147*** | 0.082 | 0.146*** | 0.081 | 0.140*** | −0.073 | 0.140*** | −0.073 |
|           | (0.038) | (0.084) | (0.038) | (0.084) | (0.051) | (0.108) | (0.051) | (0.108) |
| Leverage  | –0.014 | −0.031 | –0.014 | −0.031 | −0.061*** | −0.036 | −0.063*** | −0.035 |
|           | (0.013) | (0.024) | (0.013) | (0.024) | (0.018) | (0.031) | (0.018) | (0.031) |
| Past_Return | −0.046*** | −0.026 | −0.046*** | −0.026 | 0.044*** | 0.072** | 0.045*** | 0.072** |
|           | (0.008) | (0.024) | (0.008) | (0.024) | (0.011) | (0.030) | (0.011) | (0.030) |
| Vol       | 0.020 | 0.132** | 0.019 | 0.132** | −0.024 | −0.083 | −0.025 | −0.083 |
|           | (0.021) | (0.055) | (0.021) | (0.055) | (0.028) | (0.070) | (0.028) | (0.070) |
| Illiquidity | −0.004* | −0.008*** | −0.005* | −0.008*** | 0.006* | 0.002 | 0.005 | 0.002 |
|           | (0.002) | (0.003) | (0.002) | (0.003) | (0.003) | (0.004) | (0.003) | (0.004) |
| Observations | 2,279 | 768 | 2,279 | 768 | 2,279 | 768 | 2,279 | 768 |
| Adjusted R-squared | 0.172 | 0.168 | 0.172 | 0.168 | 0.193 | 0.088 | 0.192 | 0.088 |

Table A10 reports the OLS regression results for cumulative abnormal returns (CARs) under debt due within one-year measures with different maturity months. The sample consists of 3,047 firm observations from January 30, 2020 to March 26, 2020. We merge and collect relevant debt maturity by months information in the past 30 years from merged SDC New Debt Issuance and Dealscan Syndicated Loan databases. We divide our sample firms into quartiles according to either their immediate debt due amount (debt due from March–June) or their distant debt due amount (debt due from July–December), both scaled by cash and short-term investment, respectively. DD_One_High25 (March–June) is a dummy variable that equals 1 if the firm belongs to the top debt due from March to June scaled by cash and short-term investment quartile and equals 0 otherwise. DD_One_High25 (July–December) is a dummy variable that equals 1 if the firm belongs to the top debt due from July to December scaled by cash and short-term investment quartile and equals 0 otherwise. We calculate CARs using both market model and market-adjusted model. We use the S&P 500 stock market index as the market portfolio. The market model estimation window is days (−150, −50) before the event date (midpoint of each period). ∗ indicates significance at the 10 % level; ∗∗ indicates significance at 5%; *** indicates significance at 1%. Variable definitions are provided in A1 in the Appendix.
Table A11. CARs and Debt Due within One Year Controlling for New Debt Issuance under COVID-19 Shock.

Panel A. Controlling for New Debt Issuance Constructed from Compustat database

| Variables                  | Market Model CARs | Market-Adjusted Model CARs |
|----------------------------|-------------------|---------------------------|
|                            | CAR (Real Sector) | CAR (Financial Sector)    | CAR (Real Sector) | CAR (Financial Sector) |
| DD_One_High25              | −3.850***         | −0.686                    | −2.089            | 0.678                  |
| (0.993)                    | (1.401)           | (1.340)                   | (1.805)           |                       |
| New_Debt_Issue (Compustat) | −0.131***         | 0.101                     | −0.182***         | −0.171**               |
| (0.042)                    | (0.067)           | (0.056)                   | (0.087)           |                       |
| Constant                   | Yes               | Yes                       | Yes               | Yes                    |
| Other Controls             | Yes               | Yes                       | Yes               | Yes                    |
| Industry FE                | Yes               | Yes                       | Yes               | Yes                    |
| Observations               | 2,279             | 768                       | 2,279             | 768                    |
| Adjusted R-squared         | 0.176             | 0.169                     | 0.196             | 0.092                  |

Panel B. Controlling for New Debt Issuance Constructed from SDC New Issuance and Dealscan Syndicated Loan databases

| Variables                  | Market Model CARs | Market-Adjusted Model CARs |
|----------------------------|-------------------|---------------------------|
|                            | CAR (Real Sector) | CAR (Financial Sector)    | CAR (Real Sector) | CAR (Financial Sector) |
| DD_One_High25              | −3.842***         | −0.711                    | −2.082            | 0.564                  |
| (0.993)                    | (1.397)           | (1.340)                   | (1.801)           |                       |
| New_Debt_Issue (SDC&Dealscan) | −0.166***       | −0.136                    | −0.226***         | −0.190*                |
| (0.052)                    | (0.083)           | (0.070)                   | (0.108)           |                       |
| Constant                   | Yes               | Yes                       | Yes               | Yes                    |
| Other Controls             | Yes               | Yes                       | Yes               | Yes                    |
| Industry FE                | Yes               | Yes                       | Yes               | Yes                    |
| Observations               | 2,279             | 768                       | 2,279             | 768                    |
| Adjusted R-squared         | 0.176             | 0.170                     | 0.196             | 0.091                  |

Table A11 reports the OLS regression results for cumulative abnormal returns (CARs) with additional controlling for new debt issuances occurred in Q1 2020 for robustness checks. The sample consists of 3,047 firm observations from January 30, 2020 to March 26, 2020. We divide our sample firms into quartiles according to their debt due within one year scaled by cash and short-term investment (DD_One). DD_One_High25 is a dummy variable that equals 1 if the firm belongs to the top DD_One quartile and equals 0 otherwise. We calculate CARs using both the market model and the market-adjusted model. We use the S&P 500 stock market index as the market portfolio. The market model estimation window is days (−150, −50) before the event date (midpoint of each period). Panel A presents the regression results while obtaining New_Debt_Issuance from Compustat database. Panel B presents the regression results while obtaining New_Debt_Issuance from merged SDC New Debt Issuance and Dealscan Syndicated Loan databases. Regressions include the same set of controls appeared in the baseline results (i.e., Table 5). The regression coefficients of the control variables are omitted for brevity. * indicates significance at the 10% level; ** indicates significance at 5%; *** indicates significance at 1%. Variable definitions are provided in Table A1 in the Appendix.
Table A12
CARS and Debt Due within One Year Before vs. Around Government’s Relief Package.

| Variables       | Market Model CARS                                                                 | Market Adjusted Model CARS                                                                 |
|-----------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
|                 | Before Relief (Jan 30 to Mar 23, 2020)                                           | Before Relief (Jan 30 to Mar 23, 2020)                                                   |
|                 | CAR (Real Sector) CAR (Financial Sector)                                         | CAR (Real Sector) CAR (Financial Sector)                                                 |
|                 | Around Relief (Mar 24 to Mar 26, 2020)                                           | Around Relief (Mar 24 to Mar 26, 2020)                                                   |
|                 | CAR (Real Sector) CAR (Financial Sector)                                         | CAR (Real Sector) CAR (Financial Sector)                                                 |
| DD_One_High25   | -4.845***  (-1.181)                                                               | -2.910* (1.553)                                                                          |
| Size            | 1.637***  (0.295)                                                                | -0.251 (0.388)                                                                           |
| Roa             | 0.016 (0.018)                                                                    | 0.017 (0.024)                                                                            |
| MTB             | 0.135***  (0.045)                                                                | 0.178*** (0.024)                                                                         |
| Leverage        | -0.040**  (0.016)                                                                 | -0.115*** (0.021)                                                                        |
| Past_Return     | -0.043***  (-0.010)                                                              | 0.017 (0.005)                                                                            |
| Vol             | 0.036 (0.010)                                                                    | -0.014 (0.013)                                                                           |
| Illiquidity     | -0.008***  (-0.028)                                                              | -0.105*** (0.012)                                                                        |
| Observations    | 2.279  (0.063)                                                                   | 0.048 (0.013)                                                                            |
| Adjusted R-squared | 0.163  (0.003)                                                                 | 0.165 (0.032)                                                                            |

Table A12 reports the OLS regression results for cumulative abnormal returns (CARS) before vs. around government’s relief package. The two-trillion-dollar relief package passed the U.S. Senate on March 25 and the House of Representatives on March 27. It was then immediately signed into law by President Trump on March 27. News about the rescue package sent the S&P 500 index up by 9.38% on March 24, which is the best day since October 28, 2008. The market has generally been in an upward trend since then. The sample consists of 3047 firm observations from January 30, 2020 to March 26, 2020. We divide our sample firms into quartiles according to their debt due within one-year scaled by cash and short-term investment (DD_One). DD_One_High25 is a dummy variable that equals 1 if the firm belongs to the top DD_One quartile and equals 0 otherwise. We calculate CARs using both the market model and the market-adjusted model. We use the S&P 500 stock market index as the market portfolio. The market model estimation window is days (-150, -50) before the event date (midpoint of each period). * indicates significance at the 10% level; ** significance at 5%; *** significance at 1%. Variable definitions are provided in Table A1 in the Appendix.
Fig. A1. CDS Spread Changes (1-Year) and Debt Due within One Year under the COVID-19 Shock. Figure A1 shows the cumulative CDS spread changes (1-year) for various groups. We divide our sample firms into quartiles according to their debt due within one-year scaled by cash and short-term investments (DD\textsubscript{One})—group 1 has the lowest DD\textsubscript{One} value and group 4 has the highest DD\textsubscript{One} value.

Fig. A2. CDS Spread Changes (5-Year) and Debt Due within One Year under the COVID-19 Shock. Figure A2 shows the cumulative CDS spread changes (5-year) for various groups. We divide our sample firms into quartiles according to their debt due within one-year scaled by cash and short-term investments (DD\textsubscript{One})—group 1 has the lowest DD\textsubscript{One} value and group 4 has the highest DD\textsubscript{One} value.
Fig. A3. CDS Spread Changes (10-Year) and Debt Due within One Year under the COVID-19 Shock.
Figure A3 shows the cumulative CDS spread changes (10-year) for various groups. We divide our sample firms into quartiles according to their debt due within one-year scaled by cash and short-term investments (DD$_{10}$Groups) — group 1 has the lowest DD$_{10}$ value and group 4 has the highest DD$_{10}$ value.

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