Costly External Finance, Liquidity Risk and Default Risk

Jun Yang*

Bank of Canada

March 15, 2011

*Financial Markets Department, Bank of Canada, 234 Wellington Street, Ottawa, ON K1A 0G9. Email: junyang@bankofcanada.ca.

Abstract

Costly External Finance, Liquidity Risk and Default Risk

I use the 2007-2008 financial crisis to gauge how internal financial resources and external financial constraints mitigate or worsen the impact of the crisis on default risk of US industrial firms. I identify heterogeneity in short-term funding needs at the onset of the crisis by exploiting ex-ante variation in long-term debt structure. I also compute excess cash reserves with pre-crisis data to measure exogenous cross-firm variations in internal financial resources. A differences-in-differences method is implemented to assess the mitigating effect of internal financial resources during the crisis, controlling for firm fixed effects and firm characteristics related to default risk. Consistent with the predictions in He and Xiong (2010) and Morris and Shin (2009), the results show that firms that need not to refinance long-term debt in 2008 see an increase of 104 basis points in CDS spreads following the onset of the crisis, while firms, which need to refinance long-term debt equivalent to 4.6% of total assets, experience an additional 53 basis point increase. Holding extra cash reserves equivalent to 9.6% of total assets dampens the increase by 28 basis points. In addition, the impact of the crisis is substantially severe for financially constrained firms. A financially constrained firm that needs not to refinance long-term debt in 2008 sees an additional increase of 129 basis points in CDS spreads comparing to a similar but financially unconstrained firm. Moreover, the relation between pre-crisis internal financial positions and post-crisis default risk becomes stronger for financially constrained firms. That same financially constrained firm, if needs to refinance long-term debt equivalent to 5.1% of total assets, will experience an additional 117 basis point increase in CDS spreads.

1 Introduction

Default risk and liquidity risk have long been perceived as two of the main justifications for a positive corporate spread, the yield difference between a corporate bond and a comparable government bond. It is widely recognized that corporate spreads reflect not only default risk determined by firms' ability to meet their debt obligations but also liquidity risk affected by transaction costs occurred in the secondary bond market. However, many structural models of credit risk[1] ignore liquidity risk when they study default risk. They implicitly assume that default risk, which is determined by firms' fundamentals, is independent from liquidity risk, which is affected by microstructure frictions in the corporate bond market. As a result, a number of empirical studies, such as Longstaff, Mithal, and Neis (2004), Han and Zhou (2008), Beber, Brandt, and Kavajecz (2009), and Schwarz (2010), use this assumption to separate liquidity risk from default risk in their studies. The assumption of independence between liquidity and default risk could be a good approximation in normal times when the difference between internal and external financing cost is low. But default risk and liquidity risk can interact with each other during liquidity crises. The 2007–2008 subprime crisis vividly demonstrates the importance of such an interaction that a deterioration of short-term funding market liquidity caused severe problem for many financial institutions, which in turn exacerbated their credit risk. The historic magnitude of the financial crisis emphasizes the importance of understanding economic channels, such as firms' internal financial resources and external financial constraints, through which liquidity risk could exacerbate default risk. This paper provides empirical evidence on these issues by studying the effect of the financial crisis on default risk of US industrial firms.

The hypotheses I take to the data are based on a couple of recent theoretical papers, i.e. Morris and Shin (2009) and He and Xiong (2010), which explicitly model the interaction between liquidity risk and default risk. They also propose possible economic channels, such as short-term funding needs and cash holdings, through which a liquidity shock can have a magnified effect on default risk. On one hand, short-term funding needs could exacerbate the impact of a liquidity shock on default risk because of either the "bank-run" phenomenon caused by the coordination problem among short-term debt holders (see Morris and Shin (2009)) or the "debt-overhung" problem caused by the conflict between debt holders and equity holders (see He and Xiong (2010)). On the other hand, substantial internal resources, such as

[1]There is a long list of papers in the literature, such as Merton (1974), Leland (1994), Longstaff and Schwartz (1995), Leland and Toft (1996), Collin-Dufresne and Goldstein (2001), and many others. The paper by Ericsson and Renault (2006) is an exception. They develop a structural model to simultaneously capture liquidity and default risk. They, however, do not study the role of firms' internal financial resources in affecting the interaction between default risk and liquidity risk.

cash reserves, can act as a buffer to mitigate the impact of a liquidity shock.

I use the 2007-2008 credit crisis as an event to test their predictions. Gorton (2008) shows that this crisis originated from problems arising from the market of mortgage-backed securities. A sharp price reverse of those securities and the lack of transparency on long-term investments of financial institutions led to a panic that shut down their funding supply. The crisis spilled over into corporate sectors in late 2007 with a large increase in corporate spreads. Ivashina and Scharfstein (2010) show that banks dramatically reduced supply of loans to corporate sectors during the crisis, resulting in a large increase in the cost of external finance faced by US industrial firms. Therefore, the increase in financing cost during the crisis can be arguably treated as an exogenous supply shock to US industrial firms. As shown in Figure 1, the credit crisis was widely known in August 2007 as the funding cost for financial institutions skyrocketed. I choose the third quarter of 2007 as the starting date of the crisis, and characterize the period of 2006:Q1– 2007:Q2 as a normal period and 2007:Q3–2008:Q4 as a crisis period. To measure default risk, I use prices of 5-year credit default swaps (CDS). CDS spreads are better measures of default risk than corporate spreads because the latter are more likely to be affected by microstructure frictions in corporate bond market (see, e.g., Chen, Lesmond, and Wei (2007) and Bao, Pan, and Wang (2010)). I explore cross-firm differences in changes of CDS spreads from the normal period to the crisis period, and investigate how the differences are related to firms' short-term financing needs and cash holdings. Inference, however, can be confounded if firms' decisions on internal financial positions are endogenous to unobservable firm characteristics that are related to default risk.

The literature on debt structure shows that the choice between short-term and long-term debt is correlated with firm characteristics such as size, growth opportunities, profitability, and default risk (see, e.g., Barclay and Clifford W. Smith (1995), Guedes and Opler (1996), and Stohs and Mauer (1996)). As a result, the determination of debt maturity creates difficulties to identify causal effects of debt structure on default risk. Instead of contrasting short-term and long-term debt, I exploit ex-ante heterogeneity in firms' long-term debt maturity. I look at the proportion of long-term debt that matures right after the onset of the credit crisis to gauge the impact of the crisis on default risk. Long-term debt is usually held by various investors and very difficult to renegotiate on short notice, and thus it is reasonable to assume that firms are not at their debt-maturity target all the time. In addition, transaction cost associated with issuing long-term debt and market-timing by managers probably prevent firms from diversifying long-term debt maturity. Because the decision on firms' long-term debt is made many years prior to the

onset of the financial crisis, whether firms are pre-scheduled to refinance a significant portion of their long-term debt is plausibly exogenous to firms' default risk following the crisis. In the base regression, I use the 2005 Compustat annual file to measure the proportion of firms' long-term debt that matures in 2008. As a robustness check, I also use the 2003 and 2004 annual files to measure the proportion of firms' long-term debt that matures in 2008. Almeida, Campello, Laranjeira, and Weisbenner (2010) and Benmelech and Dvir (2010) use the same method to identify exogenous variations in short-term funding needs in their respective studies.

The literature on cash holdings shows that decisions on cash holdings are correlated with firm characteristics such as growth opportunities, riskness of the business, accessibility to external finance and corporate governance (see, e.g., Opler, Pinkowitz, Stulz, and Williamson (1999) and Dittmar and Mahrt-Smith (2007)). Cash holdings are also found to be related to default risk. Archarya, Davydenko, and Strebulaev (2008) demonstrate that the previous puzzling finding of a positive relation between default risk and cash holdings (see, e.g. Altman (1968)) can be explained by a model with endogenously determined optimal cash holdings. To identify exogenous variations in firms' cash holdings that are not related to default risk following the onset of the crisis, I first estimate a regression based on the findings of the cash holding literature to establish the "normal" cash holdings for a firm, and then compute the "excess" cash holdings as the difference between the actual cash holdings and model-predicted cash holdings. I construct excess cash holdings using 2005 financial statements, one and half year before the onset of the crisis, to alleviate concerns about possible endogenous relation between excess cash holdings and default risk. I also use 2003 and 2004 financial statements to compute excess cash holdings as a robustness check.

I am interested in studying the relation between firms' pre-crisis internal financial positions and post-crisis default risk. To address this issue, I employ a differences-in-differences approach in which I compare default risk before and after the onset of the crisis as a function of pre-crisis internal financial positions, controlling for firm fixed effects and firm characteristics related to default risk. I also investigate whether the mitigating effect of internal financial resources depends on external financial constraints. In this paper, the base specification regresses firm-level quarterly CDS spreads over the period of 2006:Q1–2008:Q4 on a dummy variable indicating whether the quarter is after the onset of the financial crisis, and on the interaction of this dummy variable with pre-crisis financial positions, controlling for firm fixed effects and firm characteristics related to default risk. Consequently, the main framework is similar to an instrument variable approach under the assumption that firms' pre-crisis financial positions are not

related to their unobservable within-firm changes in default risk following the onset of the crisis. I also perform falsification tests that replicate the estimation procedure in non-crisis periods. In principle, the default risk of a firm should not be affected by debt maturity if its debt matures at a time when external funding is easily available. Neither should its cash holdings have a significant impact on default risk in non-crisis periods. It is only the incidence of debt maturing during a credit crisis that should exacerbate default risk. The impact of cash holdings on default risk should also be easier to detect in a liquidity crisis.

As an additional source of identification, I conduct cross-sectional analysis based on firm-level measure of financial constraints which have been found to affect corporate investment and equity prices (see, e.g., Kaplan and Zingales (1997), Lamont, Polk, and Saá-Requejo (2001), Whited and Wu (2006), and Livdan, Sapriza, and Zhang (2009)). In this paper, I consider four measures of financial constraints: the Kaplan and Zingales (1997) index (the KZ index), the Whited and Wu (2006) index (the WW index), firm sizes measured by total assets, and credit ratings provided by Standard & Poor's. However, a standard criticism of financial constraints as an identification device is that because financial constraint measures are computed using firm-level variables, they are to some extent endogenous to choices made by firms which could also affect default risk. To alleviate this concern, I compute financial constraint measures at the end of 2005. With cross-firm data on internal financial positions and external financial constraints, I examine whether the relation between pre-crisis internal financial positions and post-crisis default risk is stronger for financially constrained firms. In theory, the impact of the crisis should be greater for firms that are financially constrained. In addition, the lack of internal financial resources should exacerbate the impact of the crisis more for financially constrained firms than for unconstrained firms, and excess cash reserves should be more valuable for financially constrained firms than for unconstrained firms to mitigate the impact. The main findings of this paper are follows.

Consistent with a serious liquidity shock worsened by short-term funding needs, post-crisis CDS spreads are significantly positively related to the proportion of long-term debt maturing in 2008. CDS spreads increase by 104 basis points for firms without any long-term debt maturing in 2008. A one-standard-deviation increase in the proportion of long-term debt maturing in 2008 adds an additional 53 basis point increase in CDS spreads, or 51% of the increase for firms that need not to refinance long-term debt. In addition, post-crisis CDS spreads significantly negatively related to pre-crisis excess cash holdings, consistent with internal resources mitigating the impact of a liquidity shock. CDS spreads

increase by 172 basis points for firms with zero pre-crisis excess cash reserves. A one-standard-deviation increase in pre-crisis excess cash holdings mitigate the increase by 28-40 basis points depending on the models used to compute excess cash holdings.

To further rule out differences in CDS responses caused by unobserved firm heterogeneity, such as "smart managers" anticipating the upcoming credit crisis and adjusting their financial positions prior to the crisis, I also use the 2003 and 2004 financial statements to compute the proportion of long-term debt that matures in 2008. I obtain very similar results using the 2004 data and slightly stronger results using the 2003 data. I lag the excess cash reserve measures by one and two years respectively, and obtain very similar results too. In addition, I repeat these specifications for a non-crisis (placebo) period of 2004-2006 in which there is no economy-wide shocks comparable to the financial crisis. The results show that debt maturity and excess cash reserves are unrelated with changes in CDS spreads, providing evidence that the results are not spuriously driven by some mechanical factors.

Further consistent with a severe liquidity shock worsened by financial constraints, the increase in CDS spreads is significantly larger for financially constrained firms. As I do with firms' internal financial positions, I measure financial constraints at the end of 2005, one and half year prior to the onset of the financial crisis. Coefficient estimates are both economically large and statistically significant for three of the four measures of financial constraints, the exception being the firm size. The estimates imply that a one-standard-deviation increase in the KZ index and the WW index respectively is associated with an additional 65 and 37 basis point increase in CDS spreads following the onset of the crisis. A one nudge reduction in pre-crisis bond ratings is associated with an additional 36 basis point increase in CDS spreads. I obtain similar results with financial constraints measures computed at the end of 2003 and 2004.

I also explore the interaction between internal financial positions and external financial constraints by first dividing firms into three groups according to their financial constraint measures, and then assessing the relation between their pre-crisis internal financial positions and post-crisis default risk for each group. Point estimates suggest that the impact of internal financial positions on post-crisis default risk generally becomes stronger as firms become more financially constrained. The coefficient estimates are economically large and statistically significant only for the top tercil firms (the most financially constrained firms), and only in three of the four constraint measures in the case of the debt maturity, and only in two of the four constraint measures in the case of excess cash reserves. From the regression results with debt maturity

and the KZ index, I estimate an additional increase of 129 basis points in CDS spreads following the onset of the crisis for a top tercil firm comparing to a bottom tercil firm, both without any long-term debt that matures in 2008. If the top tercile firm needs to refinance its long-term debt equivalent to 5.1% (the one-standard-deviation of the debt maturity variable for the top tercil group) of total assets in 2008, there is an additional increase of 117 basis points in CDS spreads. The impact of the financial crisis is most severe for firms that are ex-ante financially constrained and have large short-term funding needs or few internal resources right after the onset of the crisis. As discussed in the main body of the paper, firms used in this study have large sizes and have access to bond market. As a result, they are likely less financially constrained than the majority of US industrial firms. The results presented in this paper should be interpreted as a lower bound on the importance of firms' internal financial positions during the crisis.

Overall, the findings regarding the importance of internal liquidity resources, financial constraints, and external funding cost for default risk during the financial crisis are consistent with the predictions of theoretical models developed by Morris and Shin (2009) and He and Xiong (2010) that short-term funding needs exacerbate the impact of a liquidity shock on default risk, while extra cash reserves mitigate the impact. I also find that the impact of the crisis is more severe for financially constrained firms. In addition, the magnifying effect of internal financial positions on the impact of the crisis is further amplified for financially constrained firms.

The paper is organized as follows. Section 2 discuses related literature. Section 3 describes the data and empirical estimation method. Section 4 presents empirical results, and section 5 concludes.

2 Related Literature

This paper is related and contributes to several branches of literature. First, it is naturally related to the literature on credit risk and liquidity risk. Following the seminar work by Merton (1974), most structural models of credit risk assume that a firm defaults when the market value of its assets falls below a threshold. In this framework, new equity can be issued with no cost to finance its funding needs. As a result, the firm's cash holdings do not play any role in the model. In addition, the firm is usually assumed to have a very simple debt structure so there is no conflict between short-term debt holders and long-term debt holders. Although Leland (1994), Longstaff and Schwartz (1995), Leland and Toft

(1996), Collin-Dufresne and Goldstein (2001), and others have extended the structural model in many dimensions, the basic assumption of no costly external finance remains. A large empirical literature has devoted to test these structural models. The general finding is that model-implied corporate spreads are too low compared to observed corporate spreads (see, e.g., Jones, Mason, and Rosenfeld (1984) and Huang and Huang (2003)). In addition, Collin-Dufresne, Goldstein, and Martin (2001) find that economic variables based on the structural models leave a large portion of corporate spread changes unexplained. One approach to reconcile the difference between theoretical prediction and empirical evidence is to assume that illiquidity in the corporate bond market is also priced in corporate yield spreads since the corporate bond market is much less liquid than the government bond market. In fact, empirical studies, such as Chen, Lesmond, and Wei (2007) and Bao, Pan, and Wang (2010), construct firm-level illiquidity measures based on market-microstructure literature and find supporting evidence that illiquidity is priced in corporate bond spreads. Their finding, however, is not inconsistent with the assumption of independence between liquidity risk and default risk. With the development of the CDS market, Ericsson, Jacobs, and Oviedo (2009) test the structural models with CDS spreads, and find that economic variables based on traditional structural models can explain a much larger portion of CDS spread changes than that of corporate spread changes. In addition, Schaefer and Strebulaev (2008) show that traditional structural models, including the simplest Merton (1974) model, can produce accurate hedge ratios, e.g. the sensitivity of corporate bond returns to the value of equity. These findings suggest that although traditional structural models cannot match the level and dynamics of corporate bond spreads, the unexplained portion is likely unrelated to default risk. Moreover, empirical constructed illiquidity measures seem to have low statistical correlation with default risk measures. All the evidence leads a number of studies to explicitly use the independent assumption. For example, Longstaff, Mithal, and Neis (2004) and Han and Zhou (2008) use this assumption to decompose corporate bond spreads into a liquidity component and a default component. Beber, Brandt, and Kavajecz (2009) apply the same assumption to separate "flight to quality" and "flight to liquidity" phenomenons in European sovereign bond markets.

The assumption of independence between liquidity risk and default risk may be a good approximation in normal times when external funds are easily obtained. This assumption does not hold in liquidity crises. Ericsson and Renault (2006) allow bond market liquidity risk to be related to a firm's default risk, and find a positive correlation between liquidity risk and default risk using US corporate bond data. However,

they do not specify economic channels through which firms can mitigate or worsen the impact of liquidity shocks on their default risk. Morris and Shin (2009) incorporate the insights from the bank-run literature (see, e.g., Diamond and Dybvig (1983)) into a stylized model to examine the interaction between liquidity risk and default risk. They show that a negative fundamental shock can increase the probability of bank-runs, i.e. short-term debt holders not rolling over their debt, and thus increase the default probability of a bank. Lack of cash holdings or overly relying on short-term financing will magnify the impact on default risk. Although their model is build to study banks' default risk, the same logic can be applied to industrial firms. He and Xiong (2010) embed the spirit of Myers (1977) into the Leland and Toft (1996) model. They show that even in the absence of any constraints for firms to raise outside equity, an increase in debt market liquidity can cause the firm to default at a higher fundamental threshold because equity holders may not be willing to absorb losses by rolling over short-term debts. Doing that will first benefit existing long-term debt holders since they have senior claims on firm revenue. As a result, a deterioration of debt market liquidity makes it more costly for equity holders to keep the firm alive. It increases the probability of a firm to optimally choose default if the firm has to roll over a large portion of its debt during a liquidity crisis. To test their hypotheses, I study the impact of the financial crisis on default risk by exploring exogenous cross-firm heterogeneity in short-term funding needs and cash reserves. I provide empirical evidence supporting their prediction that short-term funding needs magnify the impact of liquidity shocks on default risk, while cash holdings mitigate the impact. One important implication is that using CDS spreads to control for the default component in corporate spreads can significantly under-estimate the impact of liquidity risk for firms that lack internal resources, especially during a severe liquidity crisis.

This paper contributes to the financial constraint literature by examining the effects of financial constraints on default risk. Lamont, Polk, and Saá-Requejo (2001), Whited and Wu (2006), and Livdan, Sapriza, and Zhang (2009) study the effects of financial constraints on equity prices, and find that financial constraint risk is priced in cross-sectional equity returns. I provide empirical evidence that financial constraints are also priced in the credit derivative market. In addition, I show that financial constraints play an important role in determining the magnifying effect of firms' internal financial positions on default risk during the financial crises. Only for financially constrained firms, pre-crisis internal financial positions are statistically correlated with post-crisis default risk.

This work is also related to a number of papers that study the cause and consequences of the finan-

cial crisis on US industrial firms. Ivashina and Scharfstein (2010) find that banks dramatically reduce their lending to the corporate sector during the crisis. Duchin, Ozbas, and Sensoy (2010) and Almeida, Campello, Laranjeira, and Weisbenner (2010) study the real impact of the crisis on corporate activities, and find that crisis significantly reduces investment. Campello, Graham, and Harvey (2009) survey corporate managers and find evidence that US corporations forgo profitable projects because of external funding constraints. Campello, Giambona, Graham, and Harvey (2010) study how firms managed liquidity during the financial crisis and investigate the interactions between internal liquidity, external funds, and real corporate activities, such as investment and employment. They show that firms substitute between credit lines and internal liquidity when facing a severe credit shortage. They also find that credit lines are associated with greater investment spending when firms are not short of cash. Tong and Wei (2008) focus on explaining equity price changes following the crisis and find that equity prices drop more for financially constrained firms. I show that the financial crisis worsens the default risk of US industrial firms and identify economic channels that magnify the impact. My findings complement theirs.

This paper adds to the corporate finance literature on cash holdings. While previous literature (see, e.g., Harford (1999), Pinkowitz and andRohan Williamson (2006), Dittmar and Mahrt-Smith (2007), and Harford, Mansi, and Maxwell (2008)) focuses on the agency cost associated with cash holdings, this paper highlights the precautionary motive associated with cash reserves. I find that "seemingly" excess cash reserves computed based on the previous literature significantly mitigate the impact of the financial crisis on default risk. This paper sheds new light on the precautionary motive associated with cash reserves from a different angle.

Finally, this paper is related to the empirically literature that studies the market microstructure frictions and their impact on credit derivative instruments. Bongaerts, de Jong, and Driessen (2009) and Tang and Yan (2008) show that CDS market frictions, such as transaction cost, searching cost, and inventory risk are priced in CDS spreads. In this paper, I use the number of dealers who provide CDS quotes as a liquidity proxy for CDS contracts. The parameter estimates for the liquidity proxy are economically and statistically and significant across all specifications. A static comparative analysis shows that a 5 basis point reduction in CDS spreads is associated with an increase of one dealer who provides quotes on that CDS contract. My results are consistent with findings in the previous literature.

3 Data and Empirical Method

3.1 Variables

In this study, I use quoted prices of credit default swaps written on US industrial firms to measure default risk. A credit default swap is a bilateral contract that provides default insurance for the protection buyer. The protection seller pays the protection buyer up to the notional value of a reference bond in a credit event, which is triggered by a bankruptcy, failure to pay, or a debt-restructuring by the reference entity. In return, the protection buyer pays the protection seller a quarterly premium, quoted as an annualized percentage of the notional value. I use CDS spreads instead of corporate spreads to measure the price of default risk because the former are less susceptible to various market microstructure frictions that have been found to affect corporate bond spreads (see, e.g., Longstaff, Mithal, and Neis (2004) and Garleanu and Pedersen (2009)). I use issuer ticker and name to merge firms' equity and balance-sheet data with the CDS spread data provided by Markit. Issuer tickers and names are manually checked to ensure the merge accuracy. Markit provides daily composite spread quotes on CDS contracts with maturities from 6 months to 30 years. These composite quotes represent the average of the midpoint of bid and ask quotes from a number of major dealers. Markit calculates daily values only for contracts that have quotes from at least two different contributors after they filter out outliers, stale quotes, and flat curves. I use CDS quotes on corporate U.S. bond issuers denominated in U.S. dollars with reference issues ranked senior. In particular, I focus on 5-year CDS data with modified restructuring clauses because they are the most liquid CDS contracts traded in the credit derivatives market. I use end of quarter CDS quotes to match firms' balance-sheet data obtained from Compustat. I restrict the data set by eliminating firms with CDS quotes for less than one year. In addition, I exclude all firms in financial and utility industries with SIC codes inside the intervals 4900-4949 and 6000-6999. I also eliminate non-profit or government entities with SIC codes larger than 8000. I further restrict the data set by excluding firms without equity or balance-sheet information.

As motivated by structural credit risk models and subsequently validated by empirical findings, a significant portion of variations in default risk can be attributed to firm characteristics. Following this literature, I obtain the following variables from the Compustat quarterly: leverage, cash flow volatility, profit, size, asset growth, sale growth, and Torbin's Q. Details on the construction of these variables are provided in the Appendix. I also obtain Standard & Poor's issuer credit ratings to control for firm-specific

default risk which are not captured by those balance-sheet variables. I convert the S&P's credit ratings into a numeric scale [2] to be used in the following regression analysis. CDS contracts are traded over the counter. Although the 5-year contract is the most liquid among all maturities, it is still subject to market frictions, such as search costs, adverse selection, and inventory costs. Bongaerts, de Jong, and Driessen (2009) and Tang and Yan (2008) show that CDS market frictions are priced in CDS spreads. To control for CDS market frictions, I use the number of dealers who provide CDS quotes as a liquidity proxy for CDS contracts.

As discussed in the previous section, I use firms' long-term debt that matures in 2008 to capture the exogenous variations in short-term funding needs during the 2007-2008 credit crisis. The data on debt maturity variables are only available in the Compustat annual file. I merge the annual and the quarterly files to obtain debt maturity information. Compustat annual items *dd1*, *dd2*, *dd3*, *dd4*, and *dd5* respectively represents the dollar amount of long-term debt maturing during the first year after the annual report, during the second year after the report, and so on. Compustat annual item *dltt* represents the dollar amount of debt matures in more than 1 year. Accordingly, a firm's total long-term debt is the sum of *dd1* and *dltt*. I apply the following filters to the debt maturity variables. First, I delete firms with total long-term debt ($dd1+dltt$) greater than total assets (at). Second, I delete firms for which the data on long-term debt maturity shows inconsistency, such as negative long-term debt maturing in more than 1 year ($dltt$), and debt maturing in more than one year ($dltt$) less than the sum of *dd2*, *dd3*, *dd4*, and *dd5*. I also require that the ratio of long-term debt maturing beyond 1 year ($dltt$) to total assets (at) is larger than 5%. The last restriction is to ensure that this paper is not contrasting firms that can issue long-term debt vs those that cannot. To capture cross-firm variations in long-term debt that matures in 2008, I use item *dd3* from the 2005 annual file to compute the ratio of long-term debt maturing in 2008 to total assets. As a robustness check, I also use item *dd4* from the 2004 annual file and item *dd5* from the 2003 annual file to compute this measure.

To capture exogenous cross-firm variations in cash reserves, I first establish the "normal" cash holdings for a firm. This step is based on the work of Opler, Pinkowitz, Stulz, and Williamson (1999), Dittmar and Mahrt-Smith (2007) and Archarya, Davydenko, and Strebulaev (2008). I then compute excess cash holdings as the difference between actual cash holdings and model predicted. Previous literature

[2] I convert the credit rating into a numerical scale as follows: 22-AAA+, 21-AAA, 20-AA+, 19-AA, 18-AA-, 17-A+, 16-A, 15-A-, 14-BBB+, 13-BBB, 12-BBB-, 11-BB+, 10-BB, 9-BB-, 8-B+, 7-B, 6-B-, 5-CCC+, 4-CCC, 3-CCC-, 2-CC, and 1-C

on optimal cash holding has identified several reasons for firm to hold cash, such as supporting day-to-day operations and preparing for possible investment opportunities. Most empirical models of cash holdings control for firm size, working capital, cash flow, growth opportunities, cash flow volatility, and access to external finance. They also include year fixed effects to control for macroeconomic conditions. Recent work by Archarya, Davydenko, and Strebulaev (2008) provides another motive for firms' to hold more cash, i.e. reducing bankruptcy cost associated with default risk. So I augment specifications in the previous literature with credit ratings. Two specifications are employed to estimate normal cash holdings:

$$\begin{aligned}
\mathrm{CH}_{it} &= \beta_0 + \beta_1 \mathrm{LNAT}_{it} + \beta_2 \mathrm{CF}_{it} + \beta_3 \mathrm{NWC}_{it} + \beta_4 \mathrm{ICFV}_{it} + \beta_5 \mathrm{TBQ}_{it} + \beta_6 \mathrm{SPR}_{it} \\
&\quad + YDM + \epsilon_{it} \\
\mathrm{CH}_{it} &= \beta_0 + \beta_1 \mathrm{LNAT}_{it} + \beta_2 \mathrm{CF}_{it} + \beta_3 \mathrm{NWC}_{it} + \beta_4 \mathrm{ICFV}_{it} + \beta_5 \mathrm{TBQ}_{it} + \beta_6 \mathrm{SPR}_{it} \\
&\quad + \beta_7 \mathrm{LVG}_{it} + \beta_8 \mathrm{CAPEX}_{it} + \beta_9 \mathrm{DVD}_{it} + YDM + \epsilon_{it}
\end{aligned}$$

In the above equations, CH is the ratio of cash holdings to total assets; LNAT is the natural log of total assets; CF is the ratio of cash flow to total assets; NWC is the ratio of net working capital excluding cash to total assets; ICFV is a firm's 3-digit industry cash flow volatility; TBQ is Tobin's Q; SPR is Standard & Poor's credit ratings; LVG is the leverage; CAPX is the ratio of capital expenditure to total assets; DVD is a dividend dummy that equals to one if a firm pays dividends during a fiscal year; and YDM is year dummy. I use a panel data containing balance sheet information from 1995-2004 to estimate the two models, and compute excess cash holdings as the residual cash holdings at the end of 2005. I also estimate these models for the period of 1994-2003, and compute excess cash at the end of 2004 as a robustness check.

I also investigate the interaction between firms' pre-crisis internal financial positions and their external financial constraints. Four measures of financial constraints are used in this study: the KZ index proposed by Kaplan and Zingales (1997), the WW index proposed by Whited and Wu (2006), firm sizes, and credit ratings. These four measures have been widely used in the corporate finance literature to study the impact of firms' external financial constraints on investment (see, e.g., Kaplan and Zingales (1997), Whited and Wu (2006), Duchin, Ozbas, and Sensoy (2010), and others). Some are also used in the asset pricing literature to examine their effects on equity prices (see, e.g., Lamont, Polk, and Saá-Requejo (2001), Whited and Wu (2006), Livdan, Sapriza, and Zhang (2009), and Tong and Wei (2008)). Following the

literature, I compute the KZ index and the WW index respectively according to the following formulas:

$$\begin{aligned} \text{FCKZ}_{it} &= -1.002\text{CF}_{it} + 3.139\text{TLTD}_{it} - 39.368\text{TDV}_{it} - 1.315\text{CH}_{it} + 0.283\text{TBQ}_{it} \\ \text{FCWW}_{it} &= -0.091\text{CF}_{it} - 0.062\text{DVD}_{it} + 0.021\text{TLTD}_{it} - 0.044\text{LNAT}_{it} + 0.102\text{ISG}_{it} - 0.035\text{SG}_{it}, \end{aligned}$$

where TLTD is the ratio of the long-term debt to total assets; TDV is the ratio of total dividends to total assets; ISG is the 3-digit industry sales growth; and SG is the firms' sales growth. I compute the four financial constraint measures using the 2005 data in the benchmark regression. I also use the 2003 and 2004 data to compute the measures as robustness checks.

3.2 Summary Statistics

The requirement of availability of both Markit and Compustat data limits the number of firms used in this study. There are a number of firms, about 12% of the entire sample, involved in major reorganizations during the sample period of the first quarter of 2006 to the last quarter of 2008. I delete the last 1-year observations for a firm when its stock is delisted from the exchange where its security is listed. Anecdotal evidence suggests that CDS spreads response well before the announcement of the reorganization, and much earlier than the final approval. The information on a firm's balance sheet may not reflect its true default risk if the firm is under a major reorganization. The final sample in the benchmark regression consists of 5303 firm-quarter observations on 470 firms.

Table 1 summarizes variables used in the analysis. The average firm in the sample is quite large with average total assets in excess of $7 billion. It has a leverage ratio of 30.2% and a cash flow volatility of 1.7%. It also has an average Standard & Poor's credit rating of BBB. At the end of fiscal year 2005, the average firm has 2.3% of its long-term debt that matures in 2008. It has about 20% excess cash holdings to assets ratio. Overall, firms used in this study are much larger than those used in Duchin, Ozbas, and Sensoy (2010) and Campello, Graham, and Harvey (2009), and the standard deviation of firm sizes is much smaller. In addition, all firms have Standard & Poor's credit ratings. Previous studies have shown that financial constraints are negatively correlated with firm sizes, and that firms with credit ratings are less constrained than those without ratings. As a result, the impact of the financial crisis on the default risk of an average US company is probably more severe than the impact on the average firm used in this paper. The results should probably be interpreted as a lower bound on the estimate of the impact of the

financial crisis on default risk of US industrial firms.

Table 2 presents the correlation between changes in CDS spreads after the onset of the crisis and variables that describe firms' pre-crisis financial positions and financial constraints. Changes in CDS spreads are positively correlated with the debt maturity variable, and negatively correlated with firms' excess cash holdings computed at the end of 2005. However, the magnitudes of the correlations are low (6%–9%), indicating that CDS changes are probably influenced by other firm characteristics. Changes in CDS spreads are positively correlated with all four financial constraint measures computed at the end of 2005. The magnitudes of the correlations are moderate, ranging from 5% for the measure based on firm sizes to 32% for the measure based on bond ratings. The simple statistics are consistent with the hypothesis that the impact of the financial crisis on the default risk is larger if firms are more financially constrained, have larger short-term funding needs, and have less cash reserves. The cross-correlation among these pre-crisis variables is low except for the one between the two excess cash holding measures and those among the four financial constraint measures.

3.3 Empirical Methodology

I am most interested in examining whether firms' pre-crisis internal financial resources and external financial constraints mitigate or worsen the impact of the financial crisis on default risk. The inference of the effect of the financial crisis on default risk relies on the interaction between firms' pre-crisis financial positions and a dummy variable that takes value of one if a quarter is after the onset of the crisis. Following the standard differences-in-differences approach, I embed the dummy variable and the interaction between the dummy variable and pre-crisis variables into a CDS spread regression, controlling for firm fixed effects and firm characteristics. The basic regression specification is the following:

$$CDS_{it} = \alpha_i + \beta * D + \gamma * D * X_i + \theta' Y_{it} + \epsilon_{it}, \tag{1}$$

where i and t represent firm and quarter respectively. Among included variables, CDS denotes the CDS spread, α firm fixed effects, D the dummy variable, X the pre-crisis variable that measure either firms' internal financial positions or external financial constraints, and Y firm-level control variables, including leverage, cash flow volatility, profitability, size, asset growth, sales growth, Tobin's Q, S&P credit rating, and the liquidity proxy for CDS contracts. The last variable is included to control for

cross-firm heterogeneity in CDS liquidity. I lag the balance sheet variables and credit ratings by one quarter in all regressions to avoid look-ahead bias since the report of financial statements is sometimes delayed.

In the above regression, the level effect of pre-crisis variables is subsumed by firm fixed effects since pre-crisis variables are measured only once per firm. I am most interested in parameter γ because it measures how firms' pre-crisis financial conditions are related to post-crisis default risk. However, the persistence of CDS spreads makes series correlation a concern for the estimation of equation (1). Following Bertrand, Duflo, and Mullainathan (2004) and Petersen (2009), I adjust standard errors to be heteroscedasticity-consistent and cluster them at the firm level.

4 Results

4.1 Debt Maturity and Excess Cash Holdings

In this section I investigate whether firms' pre-crisis internal financial positions affect the impact of the financial crisis on default risk, and present estimates from the base specification described in the previous section. Table 3 reports an estimate of the effect of firms' maturity structure of long-term debt at the end of 2005 on the impact of the financial crisis on their default risk. Columns 1 and 2, which do not include the interaction of the dummy variable and debt maturity variable, establish the basic pattern. Column 1 shows that the CDS level of an average firm increased by 146 basis points following the onset of the crisis, an increase of 114% relative to the pre-crisis unconditional mean. It illustrates the severe impact of the financial crisis on the default risk of US corporate sector. Adding firm-level control variables in Column 2 reduces the increase only to 123 basis points.

Columns 3 to 5 show the effect of firms' pre-crisis debt structure on the impact of financial crisis. In column 3, I include only the dummy variables, the interaction of the dummy variable with the debt maturity variable, and firm fixed effects. The estimate for the interaction term is positive but not statistically significant. In column 4, I introduce firm leverage and cash flow volatility as suggested by traditional structural models in the regression. The estimate for the interaction term becomes bigger and statistically significant at 10% level. In column 5, I introduce into the regression a battery of control variables described in the previous section. The estimate for the interaction term is statistically significant at 5% level with a magnitude of 0.116. The results suggest that the effect of debt maturity on

the impact of the crisis depends on firm characteristics. The estimates for the dummy variables across various specifications are always statistically significant. The coefficient estimates in column 5 imply that the CDS level increases by 104 basis points for a firm without any long-term debt that matures in 2008. Additionally, the standard deviation of the debt maturity variable (reported in Table 1) is 4.6%, so a one-standard-deviation increase in the proportion of long-term debt that matures in 2008 worsens the CDS level by additional 53 basis points, almost half of the impact of the financial crisis on the default risk of an average firm.

Table 4 presents the estimates of the effect of firms' pre-crisis cash reserves computed at the end of 2005 on the impact of the financial crisis on their default risk. As discussed in the previous section, I construct two different measures of excess cash holdings. Table 4 reports the estimates for both of them. Since the estimation results are very similar for the two excess cash holding measures, not a surprise given their high correlation reported in Table 2, I only discuss the result with excess cash holding computed from the first specification in this paper. In column 1 of Table 4, I include only the dummy variable, the interaction of the dummy variable and excess cash holdings, and firm fixed effects. The estimate of the dummy variable is positive and statistically significant, consistent with the findings that the financial crisis increases the default risk of an average firm. The estimate of the interaction term is negative and statistically significant at 5% level. It shows that the increase in default risk is substantially higher for firms that had low excess cash reserves one and half year prior to the onset of the crisis. The coefficient estimate imply a 183 basis point increase in CDS spreads for a firm with no excess cash reserves, and no decline for a firm holding 65% of assets in excess cash reserves.

Columns 2 and 3 of Table 4 further control for firm characteristics and CDS liquidity. The estimated coefficients on the dummy variable as well as the interaction term remain economically large and statistically significant. The estimates in column 3 imply that the CDS spread increases by 172 basis points for a firm without any excess cash reserves at the end of 2005, and that excess cash holding of 58% of assets eliminate the increase. In addition, the standard deviation of excess cash holdings (reported in 1) is 9.6%, so the estimate in Column 3 imply that a one-standard-deviation increase in excess cash reserves mitigates the increase in CDS spreads by 28 basis points, or about 16% of the increase for a firm without any excess cash holdings. Furthermore, the magnitude and t-statistic of the interaction coefficient have barely changed compared to the values in Columns 1 and 2. This suggests that the effect of excess cash holdings on the impact of financial crisis on CDS spreads is above and beyond its impact on firm

characteristics and CDS liquidity.

Among the control variables, most of the estimated coefficients are consistent with the predictions from the structural credit risk models. For example, the coefficients are positive for leverage and firm risk measured by cash flow volatility. They are negative for profitability, assets growth, sales growth, Tobin's Q, credit rating, and a liquidity proxy for the CDS contract. Additionally, firm characteristic variables, such as leverage, cash flow volatility, asset growth, Tobin's Q, and credit rating, are consistently statistically significant across various specifications. The liquidity proxy for CDS contracts, i.e. the number of dealers providing CDS quotes for a firm, is also consistently statistically significant. Its parameter estimate, around -0.050%, imply that additional dealer providing CDS quotes for a firm is associated with 5 basis point reduction in CDS spreads. The results are consistent with the empirical findings of Tang and Yan (2008) and Bongaerts, de Jong, and Driessen (2009).

Table 5 presents several analyses to address potential concerns with the base specification. First, firms' internal financial positions at the end of 2005 may reflect anticipation of the crisis and if so, this may confound the interpretation of the results. For example, "smart mangers" may correctly predict the upcoming financial crisis and shelter their firms from the negative shock by either refinancing (prior o the crisis) the part of their firms' long-term debt that is scheduled to mature in 2008, or building up extra cash reserves. The results obtained in this paper may reflect unobservable managers' endogenous response to the financial crisis. If so, one would not expect to obtain similar results with firms' internal financial conditions measured further back in time. To address this concern, I repeat the base specification measuring firms' maturity structure of long-term debt and excess cash holdings at the end of 2004 and 2003 respectively. Compustat item *dd4* in the 2004 annual file and *dd5* in the 2003 annual file are used to compute the debt maturity variable. Since Compustat aggregates long-term debt that matures in longer than 5 years and embed the information into item *dllt*, 2003 is the furthest year in which I can obtain information on firms' long-term debt that matures during the crisis. Columns 1 to 4 of Table 5 report the results. The coefficients on the interaction between the dummy variable and the new measures of firms' internal financial positions are still large and highly statistically significant, though somewhat smaller in magnitude compared to those in Tables 3 and 4. The result is consistent with weakening instruments due to greater lags.

Another concern is that there is generally a lead-lag relation between firm's internal financial conditions and their subsequent default risk regardless of a financial crisis. Firms, at time t, may choose to

reduce the proportion of long-term debt that matures at time t+1 or increase its excess cash holdings because they expect their default risk to be higher at time t+1. If so, one would expect to see a similar pattern in other time periods. To dress this concern, I repeat the base regression using data from 2004–2006. The results are presented in columns 5 and 6 of Table 5. During the normal period, there is neither a significantly positive lead-lag relation between debt maturity variable and default risk, nor a significant negative lead-lag relation between excess cash holdings and default risk. I obtain similar results (not reported) using 2003–2005 as the placebo period.

Overall, the results in Table 5 suggest that it is unlikely that the main results obtained in this paper are endogenously driven by some spurious or mechanical factors. I further address the concerns in the next section by studying the interaction between internal financial resources and financial constraints.

4.2 Financial Constraints

In this section, I investigate how the effects of the financial crisis vary in the cross-section of firms by financial constraints. Corporate finance literature on financial constraints suggests that shocks in the supply of external finance will have a more pronounced effect on the activities of financially constrained firms, and possibly affect their default risk too. I empirically examine whether the impact of the financial crisis on default risk is more severe for financially constrained firms. Four measures of financing constraints are considered in the paper: the Kaplan and Zingales (1997) index, the Whited and Wu (2006) index, firm sizes as measured by total assets, and bond ratings provided by Standard & Poor's. All of these measures are standard in the literature, and their construction is described in the previous section. As I do for debt maturity and excess cash holdings, I compute financial constraint measures using the 2005 data.

Table 6 reports the regression results. Three of the four parameter estimates on the interaction of the dummy variable and financial constraint measures are large and highly statistically significant, the one exception being the constraint measure based on firm sizes. The results on the three significant financial constraint measures show that default risk increases for both unconstrained and constrained firms following the onset of the crisis, and the increase is significantly larger for financially constrained firms. The estimate from the regression using the KZ index as the constraint measure implies an increase of 77 basis points in CDS spreads following the onset of the crisis for a firm with the KZ index equal to zero. Additionally, the standard deviation of the KZ index (reported in Table1) is 1.56, so the estimate in

column 1 of Table 6 implies that a one-standard-deviation increase in the pre-crisis KZ index further adds 101 basis points to CDS spreads. I obtain very similar results (not reported) using financial constrain measures computed in 2003 and 2004.

The coefficient estimate on the interaction of the dummy variable and the constraint measure based on firm sizes is negative, consistent with the hypothesis that the financial crisis has a more sever effect on the default risk of small firms. The estimate, however, is not statistically significant, probably due to the fact that the average firm used in this study has much larger size than those used in other studies. In addition, the variation in firm sizes is small, in part contributing to an insignificant coefficient.

I next consider how the interaction between firms' internal financial conditions and external financial constraints affects the impact of the financial crisis on default risk. Firms are divided into three groups, labeled as low, medium, and high, according to the ranking of the four financial constraints respectively. In addition to the interactions of the crisis dummy with the three financial constraint dummies, I also introduce the interactions of the crisis dummy, the financial constraint dummies, and firms' pre-crisis financial conditions into the base regression. This approach is basically a pooled panel regression with firm-level dummy variables interacting with the crisis dummy variable and internal financial conditions. The estimation results are presented in Table 7.

In Table 7, the coefficients on the interaction of the crisis dummy variable with the financial constraint dummies correspond to the post-crisis increase in CDS spreads for a firm either without any long-term debt that matures in 2008 or with zero excess cash holdings in each financial constraint group. The coefficient estimates are consistent with the results reported in Table 6, i.e., the impact of the crisis on default risk is more severe for a financially constrained firm. Except for firm size, every point estimates are monotonically increasing with financial constraint measures. The magnitude of the effect can be better understood by comparing the coefficient estimates for different groups. For example, from the regression using the debt maturity variable, the coefficient estimates across the four measures of financial constraints average an additional 147 basis point increase in CDS spreads for the most constrained firm comparing to the least constrained firm following the onset of the financial crisis, which is more than double the increase in CDS spreads for the least constrained firms.

Moreover, the estimates for the interaction of the crisis dummy, the financial constraint dummies, and firms' pre-crisis financial condition in Table 7 suggest that the relation between firms' pre-crisis financial conditions and post-crisis default risk is generally stronger for firms that are financially constrained. The

point estimate from the regressions using the debt maturity variable goes in this direction in three of the four financial constrain measures, the exception being the firm size measure. The coefficient estimate is also statistically significant for the most financially constrained group except in the case of using firm sizes to measure financial constraint. The coefficient estimate in two other groups is generally not significant. It suggests that, for firms used in this study, their pre-crisis decision on long-term debt structure worsens the impact of the crisis on default risk only for firms that are in the top category in terms of financial constraint measures. The magnitude of the point estimate from the regressions using excess cash holdings generally increases with the financial constraint measures. For the most constrained group, two out of four estimates are statistically significant, the exception being the KZ index and the bond rating. It seems that firms' cash holdings mitigate the increase of default risk following the onset of the crisis only for the most financially constrained firms. As discussed elsewhere in this paper, the result probably reflects the fact that the availability of CDS data excludes many firms that do not issue many corporate bonds, have no credit ratings, and thus are likely more financially constrained than those included in this study.

Nevertheless, the effect of firms' debt structure and excess cash holdings on mitigating or worsening the impact of the crisis on default risk is still economically large for the most financially constrained firms. To illustrate magnitudes, the coefficient estimate from the regression using the debt maturity and the KZ index suggests an additional increase of 129 basis points in CDS spreads for a most constrained firm without any long-term debt that matures in 2008 comparing to a similar firm that is in the least constrained group. If that firm has to refinance its long-term debt equivalent to 5.1% of (the one-standard-deviation of the debt maturity variable for the most constrained group) total assets in 2008, there is an extra 117 basis point increase in CDS spreads, or about 91% of the difference of the increase in CDS spreads between a firm that is most financially constrained and one that is least constrained. The financial consequence of a firm's decision on its debt structure is substantial for a most financially constrained firm. The coefficient estimates for the other measures of financial constrains suggest a similar magnitude.

On the other hand, the effect of excess cash reserves in mitigating the impact of the crisis on default risk of a financially constrained firm is also considerable. Take an example of the regression using the WW index, the coefficient estimate suggests an additional increase of 149 basis point increase in CDS spreads for a most constrained firm with zero excess cash reserves comparing to a similar firm that is least constrained. However, if the most constrained firm holds excess cash reserves equivalent to 9.5% (the

one-standard-deviation of excess cash holdings for the most financially constrained group) of total assets, it will reduce the increase in CDS spreads for 51 basis points, or about 33% of the difference of the increase in CDS spreads between a firm that is most financially constrained and one that is least constrained. The evidence presented here suggests an important role of cash holdings in mitigating the default risk of financially constrained firm. Previous corporate finance literature (see, e.g., Harford (1999), Pinkowitz and andRohan Williamson (2006), Dittmar and Mahrt-Smith (2007), and Harford, Mansi, and Maxwell (2008)) highlights agency cost associated with corporate cash holdings. In contrast, this paper presents beneficial role that seemingly "excess" cash holdings play in mitigating the impact of the financial crisis on the default risk of financially constrained firms. Duchin, Ozbas, and Sensoy (2010) research a similar conclusion studying investment behavior of US companies during the financial crisis.

Overall, the evidence presented in this section is consistent with the hypotheses proposed by He and Xiong (2010) and Morris and Shin (2009) that a firm's short-term financing needs can magnifying the effect of a liquidity shock on its default risk, while holding extra cash reserves can mitigate the impact. Furthermore, these two economic channels are more important for financially constrained firms.

5 Conclusion

In this paper, I study the effect of the credit crisis that began in August 2007 on default risk of US industrial firms. The crisis represents an exogenous liquidity shock to the US corporate sector due to the sudden reduction in the supply of external finance from the financial institutions. Comparing CDS spreads before and after the onset of the crisis, I find that default risk of US industrial firms increases significantly, controlling for firm fixed effects and time-varying firm characteristics that related to default risk. Using the base specification, I find that the CDS spread increases by 123 basis points of its unconditional mean following the onset of the crisis, almost equivalent to the unconditional mean of the CDS spread before the crisis.

More importantly, I use this event to test the hypotheses proposed by He and Xiong (2010) and Morris and Shin (2009) on the interaction between liquidity risk and default risk, and investigate the potential roles of firms' internal financing needs and external financial constraints in mitigating or worsening the impact of the crisis. I explore cross-firm variations in their long-term debt maturity, and construct a plausible exogenous measure of firms' short-term financing needs following the onset of the crisis. In

addition, using pre-crisis data, I compute seemingly "excess" cash holdings to measure firms' internal cash resources during the crisis. The measures are less susceptible to the criticism of endogenous relation among contemporary short-term debt, cash holdings, and default risk. Consistent with the predictions in He and Xiong (2010) and Morris and Shin (2009), firms' short-term funding needs greatly magnify the increase in default risk after the liquidity shock, while extra cash reserves considerably mitigate the increase. The coefficient estimate suggests an extra 53 basis point increase in CDS spreads for a firm that needs to finance additional long-term debt equivalent to 4.6% of its total assets. However, holding extra cash reserves equivalent to 9.6% of total assets dampens the increase in CDS spreads by 28 basis points. To further alleviate endogenous concerns, I measure these financial positions as much as three and half years prior to the crisis and find similar results. The falsification test shows that firms' short-term funding needs and cash reserves matter only when facing a liquidity shock.

I also investigate the interaction between firms' internal financial positions and external financial constraints. The crisis has larger effect on default risk for the financially constrained firms. The difference in the increase in CDS spreads, following the onset of the crisis, between a most financially constrained firm and a least constrained firm is well over 100 basis points across difference specifications. In addition, firms' short-term funding needs greatly worsen the impact of the crisis for most financially constrained firms, while excess cash reserves considerably dampen the impact for the most constrained. Illustrated by the regression results with the KZ index and debt maturity variable, a one-standard-deviation increase in short-term funding needs for the most financially constrained firm exacerbates the impact of the crisis on default risk by adding additional 117 basis points to CDS spreads. On the other hand, a one-standard-deviation increase in excess cash reserves for the most financially constrained firms reduces the increase in CDS spreads by 51 basis points, according to the regression results with the WW index. The availability of CDS data probably biases the sample used in this paper towards less financially constrained firms. Accordingly, the results should be interpreted as a lower bound on the impact of the financial crisis on the default risk of US industrial firms.

The results presented in this study have important implications for academics, practitioners, and policy makers alike. For academics, the results point to specific economic channels that are likely to be fruitful in improving our current credit risk models by providing a better understanding of the interaction between default risk and liquidity risk, and the interaction between internal financing resources and external financial constraints. A number of studies (see, e.g., Asvanunt, Broadie, and Sundaresan (2010),

Bolton, Chen, and Wang (2009), and Bolton, Chen, and Wang (2011)) have made considerable progress in this direction. For practitioners, understanding the implications of credit risk and liquidity risk on fixed-income securities aids in both firm-level issuance decisions and hedging strategies of fixed income portfolio managers. If liquidity risk interacts with default risk, hedging one risk against the other becomes more confounded. Finally, the work is important to policy makers, whose objective is the stability of financial markets, because it suggests ways to monitor the default risk of financial institutions [3] and points out the shortcoming of the traditional credit risk models that ignore the interaction between liquidity risk and default risk.

[3] Although this study focuses on industrial firms, internal liquidity management is probably more important for financial firms since they have much higher leverage and rely more short-term funding markets.

Appendix

Variable definitions: All names in parentheses refer to the Compustat item names.

Size = Natural log of total assets (atq).

Cash holding = Cash and short-term investments (cheq) / total assets (atq).

Leverage = (Debt in Current Liabilities (dcq) + long-term debt (dlttq)) / total assets (atq).

Cash flow = (Income before extraordinary items (ibq) + depreciation and amortization (dpq)) / total assets (atq).

Cash Flow Volatility = Standard deviations of cash flow in the last 5 years.

Profitability = Operating income before depreciation (oibdq) / total assets (atq)

Asset growth = Log difference of total assets (atq) between quarter t and t-1.

Sales growth = Log difference of sales (saleq) between quarter t and t-1.

Tobin's Q = Market value of assets (total assets (atq) + market value of common equity (cashoq*prccq) - common equity(ceqq) - deferred taxes(txdbq)) / (0.9*book value of assets(atq) + 0.1*market value of assets).

CAPEX = Quarterly capital expenditure / total assets (atq). Because capital expenditure is reported on a year-to date basis in quarterly financial statements, I subtract the previous quarter's capital expenditure(capxy) from the current quarter's capital expenditure.

NWC = Net working capital excluding cash (current assets(atq) - current liabilities(lctq) - cash(cheq)) / total assets (atq).

References

Almeida, Heitor, Murillo Campello, Bruno Laranjeira, and Scott Weisbenner, 2010, Corporate debt maturity and the real effects of the 2007 credit crisis, Working paper, University of Illionois.

Altman, Edward I., 1968, Financial ratios, discriminant analysis and the prediction of corporate bankruptcy, *Journal of Finance* 23, 589–609.

Archarya, Viral V., Seigei A. Davydenko, and Ilya A. Strebulaev, 2008, Cash holdings and credit risk, Working paper, Columbia University, University of Toronto, and Stanford University.

Asvanunt, Attakrit, Mark Broadie, and Suresh Sundaresan, 2010, Growth options and optimal default under liquidity constraints: The role of corporate cash balances, Working paper, Columbia University.

Bao, Jack, Jun Pan, and Jiang Wang, 2010, The illiquidity of corporate bonds, *Journal of Finance* Forthcoming.

Barclay, Michael J., and Jr. Clifford W. Smith, 1995, The maturity structure of corporate debt, *Journal of Finance* 50, 609–631.

Beber, Alessandro, Michael W. Brandt, and Kenneth A. Kavajecz, 2009, Flight-to-quality or flight-to-liquidity? evidence from the euro-area bond market, *Review of Financial Studies* 22, 925–957.

Benmelech, Efraim, and Eyal Dvir, 2010, Does short-term debt increase vulnerability to crisis? evidence from the east asian financial crisis, Working paper, Harvard University and Boston College.

Bertrand, Marianne, Esther Duflo, and Sendil Mullainathan, 2004, How much should we trust differences-in-differences estimates?, *Quarterly Journal of Economics* 119, 249–275.

Bolton, Patrick, Hui Chen, and Neng Wang, 2009, A unified theory of tobin's q, corporate investment, financing, and risk management, *Journal of Finance* Forthcoming.

——— , 2011, Market timing, investment, and risk management, Working paper, Columbia University and MIT.

Bongaerts, Dion, Frank de Jong, and Joost Driessen, 2009, Derivative pricing with liquidity risk: Theory and evidence from the credit default swap market, *Journal of Finance* Forthcoming.

Campello, Murillo, Erasmo Giambona, John R. Graham, and Campbell R. Harvey, 2010, Liquidity management and corporate investment during a financial crisis, *Review of Financial Studies* Forthcoming.

Campello, Murillo, John R. Graham, and Campbell R. Harvey, 2009, The real effects of financial constraints: Evidence from a financial crisis, *Journal of Financial Economics* Forthcoming.

Chen, Long, David Lesmond, and Jason Wei, 2007, Corporate yield spreads and bond liquidity, *Journal of Finance* 62, 119–149.

Collin-Dufresne, Pierre, and Robert S. Goldstein, 2001, Do credit spreads reflect stationary leverage ratios?, *Journal of Finance* 56, 1929–57.

——— , and J. Spencer Martin, 2001, The determinants of credit spread changes, *Journal of Finance* 56, 2177–2207.

Diamond, Douglas W., and Philip H. Dybvig, 1983, Bank runs, deposit insurance, and liquidity, *Journal of Political Economy* 91, 401–419.

Dittmar, Amy, and Jan Mahrt-Smith, 2007, Corporate governance and the value of cash holdings, *Journal of Financial Economics* 83, 599–634.

Duchin, Ran, Oguzhan Ozbas, and Berk A. Sensoy, 2010, Costly external finance, corporate investment, and the subprime mortgage credit crisis, *Journal of Financial Economics* 97, 418–435.

Ericsson, Jan, Kris Jacobs, and Rodolfo Oviedo, 2009, The determinants of credit default swap premia, *Journal of Financial and Quantitative Analysis* 44, 109–132.

Ericsson, Jan, and Olivier Renault, 2006, Liquidity and default risk, *Journal of Finance* 61, 2219–2250.

Garleanu, Nicolae, and Lasse Heje Pedersen, 2009, Margin-based asset pricing and deviations from the law of one price, *Review of Financial Studies* Forthcoming.

Gorton, Gary, 2008, The panic of 2007, NBER woking paper 14358.

Guedes, Jose, and Tim Opler, 1996, The determinants of the maturity of corporate debt issues, *Journal of Finance* 51, 1809–1833.

Han, Song, and Hao Zhou, 2008, Effects of liquidity on the nondefault component of corporate yield spreads: Evidence from intraday transactions data, Working paper, The Federal Reserve Board.

Harford, Jarrad, 1999, Corporate cash reserves and acquisitions, *Journal of Finance* 54, 1969–1997.

——— , Sattar A. Mansi, and William F. Maxwell, 2008, Corporate governance and firm cash holdings in the us, *Journal of Financial Economics* 87, 535–555.

He, Zhiguo, and Wei Xiong, 2010, Rollover risk and credit risk, Working paper, University of Chicago and Princeton University.

Huang, Jingzhi, and Ming Huang, 2003, How much of the corporate-treasury yield spread is due to credit risk?, Working paper, Pennsylvania State University and Cornell University.

Ivashina, Victoria, and David S. Scharfstein, 2010, Bank lending during the financial crisis of 2008, *Journal of Financial Economics* 97, 319–338.

Jones, E. Philip, Scott P. Mason, and Eric Rosenfeld, 1984, Contingent claims analysis of corporate capital structure: An empirical investigation, *Journal of Finance* 39, 611–627.

Kaplan, Steven N., and Luigi Zingales, 1997, Do investment-cash flow sensitivities provide useful measures of financing constraints?, *Quarterly Journal of Economics* 112, 169–215.

Lamont, Owen, Christopher Polk, and Jesús Saá-Requejo, 2001, Financial constraints and stock returns, *Review of Financial Studies* 14, 529–544.

Leland, Hayne E., 1994, Corporate debt value, bond covenants, and optimal capital structure, *Journal of Finance* 49, 1213–1252.

——— , and Claud Bjerre Toft, 1996, Optimal capital structure, endogenous bankruptcy, and the term structure of credit spreads, *Journal of Finance* 51, 987–1019.

Livdan, Dmitry, Horacio Sapriza, and Lu Zhang, 2009, Financially constrained stock returns, *Journal of Finance* 64, 1827–1862.

Longstaff, Francis, Sanjay Mithal, and Eric Neis, 2004, Corporate yield spreads: Default risk or liquidity? new evidence from the credit default swap market, *Journal of Finance* 59, 2213–2253.

Longstaff, Francis, and Eduardo S. Schwartz, 1995, A simple approach to valuing risky fixed and floating rate debt, *Journal of Finance* 50, 789–819.

Merton, Robert C., 1974, On the pricing of corporate debt: the risk structure of interest rates, *Journal of Finance* 29, 449–470.

Morris, Stephen, and Hyun Song Shin, 2009, Illiquidity component of credit risk, Working paper, Princeton University.

Myers, Stewart, 1977, The determinants of corporate borrowing, *Journal of Financial Economics* 5, 147–175.

Opler, Tim, Lee Pinkowitz, René Stulz, and Rohan Williamson, 1999, The determinants and implications of corporate cash holdings, *Journal of Financial Economics* 52, 3–46.

Petersen, Mitchell A., 2009, Estimating standard errors in finance panel data sets: Comparing approaches, *Review of Financial Studies* 22, 435–480.

Pinkowitz, Lee, and René Stulz andRohan Williamson, 2006, Does the contribution of corporate cash holdings and dividends to firm value depend on governance? a cross-country analysis, *Journal of Finance* 61, 2725–2751.

Schaefer, Stephen M., and Ilya A. Strebulaev, 2008, Structural models of credit risk are useful: Evidence from hedge ratios on corporate bonds, *Journal of Financial Economics* 90, 1–19.

Schwarz, Krista, 2010, Mind the gap: Disentangling credit and liquidity in risk spreads, Working paper, University of Pennsylvania.

Stohs, Mark Hoven, and David C. Mauer, 1996, The determinants of corporate debt maturity structure, *Journal of Business* 69, 279–312.

Tang, Dragon Yongjun, and Hong Yan, 2008, Liquidity and credit default swap spreads, Working paper, University of Hong Kong and University of South Carolina.

Tong, Hui, and Shang-Jin Wei, 2008, Real effects of the subprime mortgage crisis: Is it a demand or a finance shock?, NBER Working paper 14205.

Whited, Toni M., and Guojun Wu, 2006, Financial constraints risk, *Review of Financial Studies* 19, 531–559.

Table 1: Summary Statistics

This table presents summary statistics for the variables used in this study. CDS is the end of quarter quotes of a 5-year CDS contract. LVG is the firm leverage computed as the ratio of the sum of short-term and long-term debt to total assets. CFV is the cash flow volatility computed from past 5-year quarterly data of cash flows. PRFT is the profitability measure computed as the ratio of operating income before depreciation to total assets. LNTA is the natural log of total assets. AGT is the asset growth rate. SGT is the sales growth rate. TBQ is Tobin's Q computed as the ratio of the market value of assets to the sum of 0.9 times book value of assets and 0.1 times market value of assets. SPR is the Standard & Poor's issuer credit rating. NDL is the number of dealers who provide CDS quotes. LDT is the ratio of the amount of long-term debts maturing in 2008 to the total assets reported in the 2005 annual financial statements. EXCH1 and EXCHi2 are the ratios of excess cash holdings to total assets computed at the end of 2005 based on the works of Opler, Pinkowitz, Stulz, and Williamson (1999), Dittmar and Mahrt-Smith (2007), and Archarya, Davydenko, and Strebulaev (2008). FCKZ, FCWW, FCSZ, FCRT are the four financial constraint measures, and they respectively represent the KZ index, the WW index, firm sizes, and bond ratings. All financial constraints are measured at the end of 2005. Information on CDS quotes is from Markit. Information on firm characteristics is obtained from Compustat. The sample period is from 2006:Q1 to 2008:Q4.

Summary Statistics							
Balance sheet variables				Pre-crisis variables			
	Mean	Stdev	Size		Mean	Stdev	Size
CDS (%)	1.854	4.487	5303	LDT	0.023	0.046	470
LVG	0.302	0.196	5142	EXCH1	0.191	0.096	433
CFV	0.017	0.024	5286	EXCH2	0.209	0.094	428
PRFT	0.036	0.028	5108	FCKZ	0.639	1.561	475
LNTA	8.928	1.161	5287	FCWW	−0.416	0.069	494
AGT	0.009	0.106	5280	FCSZ	8.419	1.241	510
SGT	0.005	0.199	5281	FCRT	13.60	3.481	471
TBQ	1.615	0.592	5259				
SPR	13.51	3.194	5061				
NDL	7.275	4.437	5303				

Table 2: Correlation Matrix

This table presents correlations among pre-crisis variables that measure firms' financial positions, and their correlation with the changes of the average CDS spreads from the period 2006:Q1–2007:Q2 to the period 2007:Q2–2008:Q4. Variables describing firms' pre-crisis financial positions are computed at the end of the 2005 fiscal year. The definitions of the variables are described in Table 1.

	ΔCDS	LDT	EXCH1	EXCH2	FCKZ	FCWW	FCSZ	FCRT
ΔCDS	1.000							
LDT	0.060	1.000						
EXCH1	−0.092	0.064	1.000					
EXCH2	−0.085	0.090	0.994	1.000				
FCKZ	0.214	0.136	−0.163	−0.114	1.000			
FCWW	0.139	0.099	−0.012	0.058	0.422	1.000		
FCSZ	0.051	−0.020	−0.084	−0.036	0.228	0.839	1.000	
FCRT	0.320	0.102	0.038	0.076	0.612	0.587	0.431	1.000

Table 3: Maturity Structure of Long-Term Debt

This table presents regression results on the effect of firms' maturity structure of long-term debt on the impact of the financial crisis on their default risk. D is a dummy variable equal to one if a quarter is after the onset of the financial crisis, i.e. the third quarter of 2007. LDT is the ratio of a firm's long-term debt that matures in 2008 to its total assets. LDT is computed based on the item *dd3* in the 2005 Compustat annual file. The definitions of other variables are described in Table 1. Heteroscedasticity-robust t-statistics adjusted for clustering at the firm level are in parentheses. Significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively. The sample period is from 2006:Q1 to 2008:Q4.

	(1)	(2)	(3)	(4)	(5)
D (%)	1.456***	1.230***	1.537***	1.253***	1.038***
	(11.84)	(9.90)	(10.69)	(10.96)	(8.22)
D * LDT			0.017	0.062*	0.116**
			(0.49)	(1.79)	(2.26)
LVG		0.045***		0.076***	0.048***
		(2.62)		(4.25)	(2.61)
CFV		0.197		0.234*	0.466***
		(1.42)		(1.66)	(2.85)
PRFT		−0.064*			−0.053
		(1.69)			(1.37)
LNTA		−0.013***			−0.011**
		(2.60)			(2.18)
AGT		−0.017***			−0.013**
		(2.70)			(2.50)
SGT		0.000			−0.001
		(0.02)			(0.17)
TBQ		−0.019***			−0.020***
		(5.77)			(5.26)
SPR (%)		−0.546***			−0.497***
		(3.14)			(2.90)
NDL (%)		−0.054***			0.051**
		(2.63)			(2.42)
Firm fixed effect	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.04	0.23	0.05	0.19	0.26
Observations	5300	4709	4696	4567	4214
Firms	533	501	462	460	441

Table 4: Excess Cash Holdings

This table presents regression results on the effect of firms' excess cash reserves on the impact of the financial crisis on their default risk. D is a dummy variable equal to one if a quarter is after the onset of the financial crisis, i.e. the third quarter of 2007. EXCH is the ratio of a firm's excess cash reserves to total assets. EXCH is computed based on the works of Opler, Pinkowitz, Stulz, and Williamson (1999), Dittmar and Mahrt-Smith (2007), and Archarya, Davydenko, and Strebulaev (2008). The definitions of other variables are described in Table 1. Heteroscedasticity-robust t-statistics adjusted for clustering at the firm level are in parentheses. Significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively. The sample period is from 2006:Q1 to 2008:Q4.

	Excess Cash 1			Excess Cash 2		
	(1)	(2)	(3)	(1)	(2)	(3)
D (%)	1.829***	1.678***	1.718***	1.834***	1.636***	1.700***
	(6.12)	(5.83)	(5.46)	(5.80)	(5.50)	(5.19)
D * EXCH	−0.028**	−0.024**	−0.029**	−0.026**	−0.020*	−0.026**
	(2.36)	(2.01)	(2.46)	(2.18)	(1.70)	(2.19)
LVG		0.064***	0.036**		0.060***	00.036**
		(3.24)	(2.00)		(3.24)	(1.98)
CFV		0.233	0.192		0.234	0.191
		(1.28)	(1.29)		(1.26)	(1.26)
PRFT			−0.039			−0.038
			(0.81)			(0.79)
LNTA			−0.009			−0.009
			(1.56)			(1.57)
AGT			−0.013***			−0.013***
			(2.61)			(2.60)
SGT			−0.002			−0.002
			(0.71)			(0.27)
TBQ			−0.018***			−0.018***
			(5.57)			(5.52)
SPR (%)			−0.519***			−0.523***
			(2.72)			(2.72)
NDL (%)			−0.050**			−0.050**
			(2.42)			(2.39)
Firm fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.06	0.17	0.23	0.04	0.17	0.23
Observations	4540	4478	4187	4475	4436	4151
Firms	452	451	433	443	443	426

Table 5: Internal Financial Positions in 2003-2004, Placebo Regressions

This table presents regression results on the effect of firms' internal financial positions on the impact of the financial crisis on their default risk. In the robustness regressions, D is a dummy variable equal to one if a quarter is after the onset of the financial crisis, i.e. the third quarter of 2007. LDT is the ratio of a firm's long-term debt that matures in 2008 to its total assets. EXCH is the ratio of a firm's excess cash reserves to total assets. Both LDT and EXCH are computed using financial statements in 2003 and 2004 as robustness checks. The sample period for robustness regressions is from 2006:Q1 to 2008:Q4. The sample period in placebo regressions is from 2003:Q1 to 2006:Q4. The dummy variable in the placebo regressions equals to one if a quarter is after the second quarter of 2005. Firms' internal financial positions used in the placebo regressions are computed at the end of 2003. The definitions of other variables are described in Table 1. Heteroscedasticity-robust t-statistics adjusted for clustering at the firm level are in parentheses. Significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively.

	Previous fiscal years				Placebo periods (2004-06)	
	Long-term debt		Excess cash		Long-term	Excess
	2004	2003	2004	2003	debt	cash
D (%)	1.061***	1.006***	1.710***	1.571***	−0.062	0.011
	(8.63)	(7.27)	(6.48)	(6.20)	(0.84)	(0.09)
D * LDT	0.094**	0.103***			0.003	
	(2.36)	(3.03)			(0.39)	
D * EXCH			−0.030***	−0.021**		−0.004
			(3.07)	(2.21)		(1.06)
LVG	0.048**	0.048***	0.041**	0.041**	0.020*	0.019*
	(2.59)	(2.58)	(2.29)	(2.18)	(1.77)	(1.70)
CFV	0.468***	0.470***	0.178	0.175	0.087*	0.098*
	(2.87)	(2.92)	(1.36)	(1.32)	(1.73)	(2.03)
PRFT	−0.050	−0.050	−0.041	−0.063	−0.027	−0.024
	(1.29)	(1.30)	(0.98)	(1.50)	(1.60)	(1.43)
LNTA	−0.012**	−0.013**	−0.011*	−0.010*	−0.003*	−0.003*
	(2.29)	(2.40)	(1.88)	(1.80)	(1.90)	(1.69)
AGT	−0.012**	−0.012**	−0.011**	−0.013***	−0.002	−0.002
	(2.35)	(2.22)	(2.34)	(2.63)	(1.36)	(1.39)
SGT	−0.001	−0.001	−0.003	−0.002	0.001	0.001
	(0.27)	(0.20)	(0.92)	(0.55)	(0.68)	(0.65)
TBQ	−0.020***	−0.020***	−0.018***	−0.020***	−0.005***	−0.005***
	(5.57)	(5.53)	(5.83)	(6.39)	(3.96)	(4.12)
SPR (%)	−0.509***	−0.545***	−0.495***	−0.571***	−0.168***	−0.161***
	(2.94)	(3.04)	(2.64)	(2.84)	(3.26)	(3.04)
NDL (%)	−0.052**	−0.048**	−0.055***	−0.052**	0.014***	0.014***
	(2.52)	(2.30)	(2.62)	(2.45)	(4.07)	(3.97)
Firm fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.25	0.26	0.23	0.23	0.39	0.36
Observations	4350	4320	4223	4058	4249	4108
Firms	451	448	430	411	478	447

Table 6: Financial Constraints

This table presents regression results on the effect of firms' pre-crisis financial constraints on the impact of the financial crisis on their default risk. D is a dummy variable equal to one if a quarter is after the onset of the financial crisis, i.e. the third quarter of 2007. FC indicates one of four financial constraint measures, i.e., the KZ index, the WW index, firm size and bond rating. All financial constraint measured are computed at the end of 2005. The definitions of other variables are described in Table 1. Heteroscedasticity-robust t-statistics adjusted for clustering at the firm level are in parentheses. Significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively. The sample period is from 2006:Q1 to 2008:Q4.

	KZ index	WW index	Firm size	Rating
D (%)	0.767^{***}	3.485^{***}	2.326^{***}	6.186^{***}
	(7.07)	(4.29)	(2.86)	(7.12)
D * FC	0.006^{***}	0.053^{***}	0.001	0.004^{***}
	(4.26)	(3.12)	(1.39)	(6.38)
LVG	0.047^{***}	0.046^{***}	0.045^{***}	0.047^{***}
	(2.69)	(2.66)	(2.62)	(2.98)
CFV	0.228	0.199	0.197	0.222^{*}
	(1.62)	(1.34)	(1.45)	(1.74)
PRFT	−0.036	−0.066	-0.063^{*}	−0.022
	(0.92)	(1.59)	(1.67)	(1.17)
LNTA	-0.009^{*}	-0.012^{**}	-0.013^{***}	-0.010^{**}
	(1.80)	(2.44)	(2.65)	(2.15)
AGT	-0.013^{***}	-0.014^{***}	-0.012^{***}	-0.014^{***}
	(2.70)	(2.88)	(2.66)	(3.17)
SGT	−0.001	0.001	−0.000	−0.001
	(0.32)	(0.16)	(0.01)	(0.35)
TBQ	-0.018^{***}	-0.017^{***}	-0.018^{***}	-0.019^{***}
	(5.80)	(5.26)	(5.71)	(6.28)
SPR (%)	-0.468^{***}	-0.567^{***}	-0.545^{***}	-0.686^{***}
	(2.97)	(3.16)	(3.17)	(4.03)
NDL (%)	-0.062^{***}	-0.056^{***}	-0.057^{***}	-0.069^{***}
	(3.00)	(2.72)	(2.80)	(3.48)
Firm fixed effect	Yes	Yes	Yes	Yes
Adjusted R^2	0.25	0.23	0.23	0.26
Observations	4385	4472	4699	4580
Firms	456	470	498	480

Table 7: Long-Term Debt Maturing in 2008 conditional on Financial Constraints

This table presents regression results on the effect of the interaction of internal financial conditions with financial constraints on the impact of the financial crisis on their default risk. D is a dummy variable equal to one if a quarter is after the onset of the financial crisis, i.e. the third quarter of 2007. L, M, and H are dummy variables, and respectively indicate the ranking of a firm's financial constraint measures in the bottom, middle and top tercil. X represents either the proportion of long-term debt maturing in 2008 (LDT) or excess cash holdings (EXCH). All firms' internal financial conditions and financial constraint measured are computed at the end of 2005. The definitions of other variables are described in Table 1. Heteroscedasticity-robust t-statistics adjusted for clustering at the firm level are in parentheses. Significance at the 10%, 5%, and 1% levels is indicated by *, **, and ***, respectively. The sample period is from 2006:Q1 to 2008:Q4.

	Long-term debt				Excess cash 1			
	KZ index	WW index	Firm size	Rating	KZ index	WW index	Firm size	Rating
D * L (%)	0.461***	0.740***	0.726***	0.216*	0.453**	1.233***	1.495***	0.212
	(3.21)	(4.80)	(3.74)	(1.73)	(1.74)	(3.02)	(3.38)	(1.14)
D * L * X	−0.00	0.108*	0.190**	0.030	−0.01	−0.018	−0.025	0.002
	(0.01)	(1.96)	(2.14)	(0.95)	(0.05)	(1.27)	(1.59)	(0.38)
D * M (%)	1.098***	1.237***	1.365***	01.739***	1.235***	1.441***	1.840***	1.096***
	(6.02)	(6.07)	(6.22)	(6.40)	(2.91)	(2.72)	(3.10)	(3.09)
D * M * X	−0.047	−0.043	0.100	0.021	−0.012	−0.016	−0.018	−0.019
	(1.06)	(0.92)	(1.25)	(0.39)	(0.49)	(0.64)	(0.72)	(1.17)
D * H (%)	1.748***	1.425***	1.004***	2.491***	2.671***	2.722***	1.737***	3.493***
	(5.29)	(4.78)	(4.15)	(7.24)	(3.43)	(3.79)	(4.56)	(4.56)
D * H * X	0.230**	0.247**	0.009	0.210**	−0.017	−0.054**	−0.046**	−0.042
	(2.36)	(2.47)	(0.12)	(2.34)	(0.44)	(2.10)	(2.36)	(1.32)
LVG	0.052***	0.050***	0.047***	0.051***	0.047***	0.039**	0.035**	0.037**
	(2.81)	(2.69)	(2.60)	(2.97)	(2.61)	(2.11)	(2.00)	(2.23)
CFV	0.551***	0.548***	0.463***	0.472***	0.224	0.209	0.189	0.227
	(2.91)	(3.02)	(2.86)	(2.91)	(1.46)	(1.42)	(1.27)	(1.58)
PRFT	−0.021	−0.054	−0.051	−0.040	−0.044	−0.040	−0.030	−0.034
	(0.53)	(1.25)	(1.33)	(1.06)	(0.93)	(0.83)	(0.62)	(0.72)
LNTA	−0.008*	−0.011**	−0.011**	−0.012**	−0.010*	−0.009	−0.009	−0.008
	(1.70)	(2.07)	(2.24)	(2.37)	(1.71)	(1.48)	(1.53)	(1.50)
AGT	−0.013**	−0.014**	−0.013**	−0.014***	−0.013**	−0.013**	−0.013***	−0.013***
	(2.36)	(2.53)	(2.49)	(2.84)	(2.65)	(2.71)	(2.58)	(2.81)
SGT	−0.001	−0.000	−0.001	−0.001	−0.002	−0.002	−0.003	−0.003
	(0.52)	(0.01)	(0.25)	(0.40)	(0.60)	(0.73)	(0.88)	(0.89)
TBQ	−0.019***	−0.019***	−0.020***	−0.020***	−0.018***	−0.018***	−0.018***	−0.020***
	(5.32)	(4.94)	(5.22)	(5.97)	(5.89)	(5.31)	(5.41)	(6.42)
SPR (%)	−0.478***	−0.513***	−0.482***	−0.596***	−0.543***	−0.507***	−0.532***	−0.636***
	(2.72)	(2.98)	(2.73)	(3.63)	(2.81)	(2.73)	(2.81)	(3.44)
NDL (%)	−0.057**	−0.049**	−0.053***	−0.064***	−0.051**	−0.051**	−0.052***	−0.057***
	(2.77)	(2.36)	(2.60)	(3.18)	(2.65)	(2.41)	(2.58)	(2.90)
Firm fixed effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.28	0.26	0.25	0.25	0.28	0.26	0.25	0.25
Observations	3920	3994	4038	3880	3920	3994	4038	3880
Firms	403	415	418	402	403	415	418	402

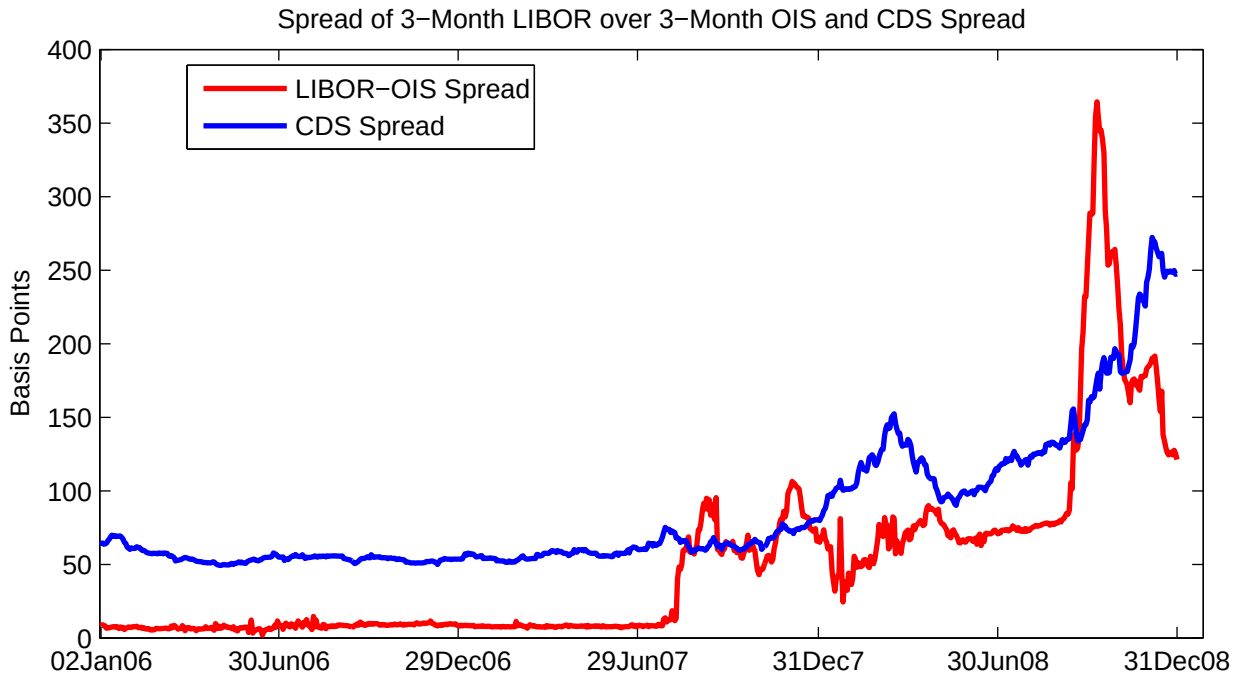

Figure 1: LIBOR-OIS Spread and CDS spread

This graph plots daily LIBOR-OIS spread (obtained from Bloomberg) and the median CDS spread of US industrial firms (obtained from Markit) used in this study. The sample period is January 2 2006 to December 31, 2008.