Cash Holding, Rollover Risk and M&A*

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December 9, 2022

Abstract

We develop a unified framework to connect cash holding, debt maturity and mergers and acquisitions. We provide empirical support for four internally consistent predictions: i) equity and debt values of highly distressed firms are more sensitive to cash reserve than those of healthy firms; ii) the relation between equity-(debt-)cash sensitivities and debt maturity is negative (positive), particularly in distressed firms short of cash; iii) acquirers with low debt maturity prefer equity payment to cash payment in mergers and acquisitions; and iv) cash payment triggers positive abnormal stock returns mainly among high-maturity acquirers.

JEL Classification Numbers: G32, G33, G34.
Keywords: Mergers, Cash Holding, Debt Maturity, Leverage.

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1. Introduction

Debt rollover is an important aspect of corporate debt management and significantly impacts firms' joint decisions on cash management and investment. Typically, firms with shorter debt maturity have to roll over debt more frequently and have higher risk of being unable to reissue new debt when the market conditions deteriorate. To mitigate rollover risk, these firms tend to hold more cash than their counterparts with longer maturity (Harford, Klasa and Maxwell (2014)). When investment opportunities arrive, those firms have to make decisions on investment, payment method and cash holding, in anticipating the potential rollover-inducted default.

In a unified framework that features dynamic cash accumulation, risky debt maturity and lumpy investments, this paper examines how rollover risk (debt maturity) affects cash management and mergers and acquisitions (M&A) jointly through the lens of the sensitivities of debt and equity values to cash. Our theoretical and empirical analyses reveal an important role of rollover risk in shaping corporate cash and investment policies in the context of M&A, the largest type of investments (Moeller, Schlingemann and Stulz (2004)).

We build on Bolton, Chen and Wang (2011) and Della Seta, Morellec and Zucchi (2020) and develop a dynamic model to formally examine the interaction of rollover risk and cash reserve and their implications for M&A. Specifically, we assume that a representative firm holds cash and risky debt, and resort to external financing for capital investments. The firm commits to its initial debt structure and keeps rolling over its debt at the prevailing market price. The firm can gain or lose from debt rollover given the difference between fixed principal repayments of debt and changing issuance values. The firm's debt maturity determines the amount of debt expiring each period. Importantly, a firm with lower debt maturity suffers larger potential losses from debt rollover, because a larger portion of its total debt becomes due at any given point in time. At the same time, the firm has an opportunity to acquire a target to expand its future cash flow with internal cash or stock payment. While cash payment incurs a lower cost but induces a higher probability of default in the future, equity payment is more costly but with a lower rollover risk. Acquirers then make the optimal payment method choice based on their debt maturity.

Our model generates a few novel results about sensitivity of firm value to cash holdings. The first prediction is intuitive: equity and debt values of financially distressed firms short of cash are more sensitive to cash holding than those of healthy firms, because both types of stakeholders are concerned about their claims.

Second, the sensitivity of equity to cash is decreasing in debt maturity. As cash holdings decrease, firms with lower maturity have higher rollover risk and roll over debt at a discounted price. This wealth transfer from equity holders to debt holders leads to a high sensitivity of equity value to cash among low debt-maturity firms. Moreover, this relation between debt maturity and equity-cash sensitivity is more pronounced among distressed firms. Compared to non-distressed firms, a decrease in debt maturity leads to a higher increase in equity-cash sensitivity in distressed firms.

Third, our model predicts that the sensitivity of debt value to cash is increasing in debt maturity. For debt holders, though the probability of default is higher among low-maturity firms, the wealth transferred from equity holders offsets the potential loss from default more when debt maturity is lower. Thus, the net effect is that low-maturity firms have lower sensitivity of debt value to cash. Like the equity-cash sensitivity, debt maturity has a more positive impact on the debt-cash sensitivity for distressed firms than it does for healthy firms.

Lastly, our model also predicts the method of payment in mergers and acquisitions through the channel of sensitivity to cash. Compared to their counterparts, managers of high-maturity acquirers prefer cash payment to stock payment, when they face a low rollover risk but costly equity issuance, to maximize their equity value. Consequently, equity markets react positively when those high-maturity acquirers use more cash in their payment.

In empirical analysis, we refer to Harford, Klasa, and Maxwell (2014) and use fraction of short-maturity debt as a proxy for overall debt maturity. Since the market value of corporate debt is not reflected on the balance sheet, we rely on the corporate bond transaction data from TRACE and NAIC and aggregate all bonds belonging to a firm to proxy for the market value of corporate debt. For firms with corporate bond data, we also construct value-weighted bond maturity as an alternative proxy for overall maturity. With the transaction-based market value of bonds, we establish more new regularities that also are consistent with our model's predictions.

Notably, our empirical analysis confirms the negative relation between equity-cash sensitivity and maturity and the positive relation between debt-cash sensitivity and maturity. Moreover, it also supports the model's novel prediction of a stronger relation between debt maturity and equity-cash sensitivity/debt-cash sensitivity in distressed firms. Furthermore, we directly test the effect of rollover risk on payment choice in mergers and acquisitions. We confirm that firms with lower debt maturity are more likely to pay with equity. These results are all robust across different proxies for debt maturity.

The paper contributes in important ways to prior research on debt maturity and rollover risk. Custódio, Ferreira and Laureano (2013) and Harford, Klasa, and Maxwell (2014) find that there has been a trend toward greater use of short-term debt combined with holding more cash for precautionary motives. Custodio, et al. point to supply-side factors that make this trend partially exogenous to firm choices. Choi, Hackbarth, and Zechner (2018 and 2021) show that firms manage their debt maturity profile and disperse maturity dates to reduce debt rollover risk. He and Xiong (2012) study the channel in which shocks in debt market liquidity can also cause debt rollover loss when maturity is low. Our paper complements the literature by showing the heterogeneity in equity- and debt-sensitivity across firms with different maturities, and importantly, its implications for capital investments.

We extend earlier work by showing the relation between the sensitivity of debt value to cash holdings. The previous literature mainly studies how equity value corresponds to cash. For example, Harford, Mansi and Maxwell (2008) and Dittmar and Mahrt-Smith (2007) document that cash is less valuable among firms with agency costs. Faulkender and Wang (2006) find that cash contributes less to equity value among firms with larger cash holding and higher leverage. Relatedly, Harford, Klasa and Maxwell (2014) show that the value of cash reserves is higher for the firms with lower debt maturity. In contrast, to our best knowledge, we are the first to examine the sensitivity of a firm's debt value to its cash holdings.

Our work is also related to the literature on payment choice in mergers and acquisitions. Early evidence shows that all-cash bids deliver higher takeover premiums (Huang and Walkling (1987) and Hayn (1989)). Harford (1999) shows that cash acquisitions are typically value-decreasing when acquirers hold excess cash. Shleifer and Vishny (2003) and Fu, Lin and Officer (2013) find that overvalued acquirers are more likely to use stock payment. Dasgupta, Harford and Ma (2022) provide evidence on the role that desired EPS accretion plays in the acquirer's preferred acquisition payment method. Our work emphasizes the new role of rollover risk in determining the payment choice.

The remainder of the paper is organized as follows. Section 2 presents the model, and Section 3 generates theoretical predictions. Section 4 describes data sources and variables, and Section 5 reports empirical results. Finally, Section 6 concludes the paper. Model derivations and additional robustness tests are relegated to the appendix.

2. Model

We develop a dynamic model to better understand the interaction between corporate cash holding and debt rollover and their implications for mergers and acquisitions (M&As). Our model incorporates lump-sum investments, i.e., M&As and their payment methods, into a dynamic model in the spirit of Bolton, Chen and Wang (2011) and Della Seta, Morellec and Zucchi (2020).

2.1 Setup

We consider a representative firm with productive capital, K_s, in stage *s*, where $s = pre, post$, denotes the pre- and post-merger stage. That is, the capital of the firm will increase from K_{pre} to K_{post} after the merger. The asset, K_s, generates after-tax cash flow dY_t over a time increment *dt*.

$$dY_t = (1-\theta)[K_s^{\alpha}(\mu dt + \sigma dZ_t) + G(K_s)dt] \tag{1}$$

where μ and σ represent the average cash flow rate and its volatility, respectively, and Z_t is a standard Brownian motion. $\theta \in (0,1)$ denotes the corporate tax rate, and $\alpha < 1$ implies decreasing returns to scale.

The firm can choose either cash or stock payment to complete the deal. After the deal completion, it enjoys a synergy gain, G from the transaction, i.e., $G(K_{pre}) = 0$ and $G(K_{post}) > 0$. We focus on operating synergy gains via capital acquisition.

The firm issues equity and risky debt to finance its M&A investment. Its debt structure can be characterized by a triplet, (C, P, M), where C is coupon payment, P is debt principal, and M is average debt maturity. As in Leland (1998) and Hackbarth, Miao and Morellec (2006), the firm retires the amount of debt, P/M, and issues debt to keep its debt structure stationary, with a proportional cost κ (He and Milbradt (2014)).

The firm accumulates cash, W_t, over time, with a carrying cost λ (Jensen (1986)), while earning a risk-free rate r from its existing holding net of carrying cost of cash (Jensen (1986)). Thus, its cash holding, W_t evolves as follows:

$$dW_t = (1-\theta)[\underbrace{(r-\lambda)W_t dt}_{\text{Net interest}} + \underbrace{K_s^{\alpha}(\mu dt + \sigma dZ_t) - Cdt}_{\text{Net income}} + \underbrace{G(K_s)dt}_{\text{Synergy gain}}] + \underbrace{\frac{1}{M}[(1-\kappa)D(W_t) - P]dt}_{\text{Rollover gain/loss}}. \qquad (2)$$

The change in cash holdings, dW_t, has two components. The first component is from operating activities and includes net interest income from carrying the cash, operating income net of coupon payments, and synergy gain $G(K_s)$ if a merger occurs. We assume $G(K_{post}) = gK_{post}$, which implies the additional gain from the increased capital, K_{post}. The second component represents the gain/loss from debt rollover payments. Over the time interval, dt, the firm issues $1/M$ fraction of debt. If the firm is in distress, the market value of debt, $D(W_t)$, can be less than the par value P, resulting in a rollover loss. Intuitively, for low-maturity firms, the rollover loss can be large if they fall into distress and the market value of newly issued debt $D(W_t)$ is low. This rollover risk could lead them to adopt different M&A decisions and payment methods, ex ante.

2.2 Corporate decisions

The firm has an opportunity to acquire additional capital. Given its debt maturity and current cash holding, the firm makes joint decisions in M&A and payment method. Because the model is solved by backward induction, we start with describing default and M&A decisions.

2.2.1 Default decision

We assume the firm has no access to outside equity when in distress. The firm is forced into bankruptcy if its cash holding reaches zero, i.e., $W=0$. At default, the firm has to pay a liquidation cost φ and the remaining liquidation value is denoted as $\iota = 1-\varphi$. Thus, shareholders receive the residual of the liquidation value as follows:

$$E(W=0;K_{pre}) = \max(\iota K_{pre} - P, 0). \quad (3)$$

To keep the firm afloat, equity holders keep issuing debt to roll over the maturing debt. Importantly, the rollover loss, as described in equation (2), exacerbates the reduction in the cash holding, W, especially if debt maturity, M, is low and the firm faces frequent rollover. That is, rollover risk could induce an earlier default than otherwise necessary. Finally, at the time of default, debtholders are not able to claim the full liquidation value if it does not exceed the debt principal.

$$D(W=0;K_{pre}) = \min(\iota K_{pre}, P) \quad (4)$$

Given the process of cash holding, M&As and default policies, we solve the model, and obtain the value functions of equity and debt. The detail can be found in Appendix.

2.2.2 M&A decision

Suppose the M&A opportunity arrives exogenously when corporate cash holdings are at W_t. The acquirer faces a "take it or leave it" decision and completes the M&A deal with either all cash or all stock payment. After the M&A investment, I, the firm's capital increases from K_{pre} to K_{post} with a synergy gain *G*. Accordingly, we have boundary conditions as follows:

$$E(W;K_{pre}) = \begin{cases} E(W;K_{pre}, I=0), & \text{if no investments} \quad (a) \\ E(W-(1+\psi)I;K_{post}), & \text{if cash payment} \quad (b) \\ E(W;K_{post})-(1+\psi+\phi)I, & \text{if stock payment} \quad (c) \end{cases} . \qquad (5)$$

We define $E(W;K_{pre}, I=0)$ in equation (5a) as the benchmark equity value, where no acquisition occurs. The M&A will take place only if it delivers a positive net present value to equity holders, irrespective of the method of payment. That is, $E(W-(1+\psi)I;K_{post}) > E(W;K_{pre}, I=0)$ for a full cash payment acquisition, or $E(W;K_{post})-(1+\psi+\phi)I > E(W;K_{pre}, I=0)$ for a full stock payment acquisition.

Equation (5b) states the condition for all cash payment. The equity value increases from $E(W;K_{pre})$ to $E(W-(1+\psi)I;K_{post})$, after a total cost $(1+\psi)I$ in the form of cash, where ψ is the capital adjustment cost. The acquirer enjoys the capital expansion and synergy gain *G*. It is worth noting that the cash payment decreases the cash holding, *W*, by the amount of $(1+\psi)I$. As we have discussed for equation (2), debt retirement and issuance might cause future rollover loss/gain. The decrease in the cash holding due to cash payment might amplify the rollover loss. Therefore, a low-maturity firm is less likely to choose cash payment to complete the M&A transaction, because it anticipates the rollover risk.

Equation (5c) states the condition for acquisition for all equity payment. The equity value increases from $E(W;K_{pre})$ to $E(W;K_{post})$, after the total payment $(1+\psi+\phi)I$. Different from the cash payment that lowers cash holding, equity payment does not alter the state variable cash holding, W_t. In addition to the adjustment cost, ψ, equity financing incurs additional issuance cost, ϕ, paid to investment banks as underwriting costs. Information asymmetry and adverse information (Akerlof, 1970) implies that equity issuance is generally costlier than debt issuance. Barclay and Clifford (1995) further show that firms issue more short-term debt to mitigate the higher information asymmetry. In this model, we do not model information asymmetry explicitly. Instead, we assume the information symmetry is manifested in the relatively high issuance cost, which impacts the acquirer's preference in the method of payment.

Taken together, if deciding to acquire the target, the firm chooses the method of payment, either cash payment (equation 5b) or stock payment (equation 5c), to maximize its equity value, $E(W;K_s)$, as follows:

$$\max[\underbrace{E(W-(1+\psi)I;K_{post})}_{\text{Cash payment}},\underbrace{E(W;K_{post})-(1+\psi+\phi)I}_{\text{Stock payment}}]. \quad (6)$$

The model is solved by backward induction. In anticipating future rollover-induced default risk after the completion of merger, equity holders of the pre-merger firm choose the method of payment *ex ante.* That is, equity holders maximize the pre-merger value in equation (6), subject to the pre-merger default condition in equations (3) and the post-merger default conditions in equation (A5), listed in the Appendix, as well as other conditions in equations (A7), (A8) and (A9).

In contrast, existing debtholders do not make investment decisions. Because they do not benefit from the expansion investment, the post-merger debt value is the same as the pre-merger value, irrespective to the payment method, as follows:

$$D(W,K_{pre})=\begin{cases} D(W;K_{pre},I=0), & \text{if no investments} \quad (a) \\ D(W-(1+\psi)I;K_{post}), & \text{if cash payment} \quad (b) \\ D(W;K_{post}), & \text{if stock payment} \quad (c) \end{cases}. \quad (7)$$

3. Model implications

In this section, we use model simulations to generate five predictions. The first three predictions investigate the relation between equity/debt-cash sensitivity and debt maturity (the proxy for rollover risk), because their sensitivities have direct implications for the firm's payment choice. The fourth prediction considers the effects from cash reserve and rollover risk on M&A investments and payment methods. Finally, we examine the market response to payment choice.

3.1 Sensitivities of Equity and Debt Values to Cash

The sensitivities (or elasticities) of equity and debt to cash are expressed as follows:

$$Sensitivity_E = \frac{d\log E(W)}{d\log W} = \frac{dE(W)}{dW}\frac{W}{E(W)}, \tag{8a}$$

$$Sensitivity_D = \frac{d\log D(W)}{d\log W} = \frac{dD(W)}{dW}\frac{W}{D(W)}. \tag{8b}$$

The sensitivity of equity in equation (8a) is the marginal value of cash, *dE(W)/dW*, divided by the average value of cash, *E(W)/W*, and analogously for the sensitivity of debt in equation (8b). Our discussions of the equity/debt sensitivities focus on the pre-merger firms, because their sensitivity affects their future M&A decisions.

We mainly follow the literature (e.g., Bolton, Chen and Wang (2011), and Della Seta et al. (2020)) in selecting parameter values. Additionally, we normalize the pre-merger capital K_{pre} to 1. The relative size of the target to the acquirer, or the investment I is 0.1, which is consistent with empirical evidence in Moeller, Schlingemann and Stulz (2004). The proportional transaction cost of the acquisition, ψ, is set to 5%, and the synergy gain, g, is 1% of the combined value, i.e., $G(K_{post}) = 1\% \times K_{post}$. All the parameter values are listed in Table 1.

Figures 1 and 2 plot the relation between debt maturity and the sensitivity of equity/debt value to cash holding across three levels of cash. The solid, dashed, and dotted line are, respectively, for a low level of cash (W = 0.1), a medium level of cash (W = 0.15), and a high level of cash (W = 0.2), in both figures. As cash is the only state variable in our model, we use the level of cash to proxy for a firm's financial status. That is, a low (high) level of cash reserves implies that the firm is distressed (heathy).

3.2. First Prediction

Two observations are worth noting. First, equity-cash sensitivities in Figure 1 are nearly 20 times larger than debt-cash sensitivities in Figure 2. This is not surprising, because bond holders receive fixed income before bankruptcy and the liquidation value of assets during the bankruptcy. Second, both equity- and debt-cash sensitivities are larger among distressed firms with a low level of cash reserve, i.e., $W = 0.1$, than those among healthy firms with a high level of cash reserve, i.e., $W = 0.2$. This contrast is in line with our intuition. When firms are short of cash and close to bankruptcy, both equity and debt holders are concerned about their repayments from the deteriorating firms, and therefore become more sensitive to the level of their firm's cash reserves.

We have the first prediction from the above discussion as follows:

Prediction 1: Equity and debt values of highly distressed firms are more sensitive to cash reserves levels than those of healthy firms.

3.3. Second Prediction

Two additional observations in Figure 1 are worth noting. First, the equity-cash sensitivity decreases monotonically with debt maturity across all the three cash levels. Low maturity debt implies a high rollover risk, which is borne by equity holders, because they have incentives to issue new debt to roll over existing debt to keep their firm afloat and their investment opportunities (e.g., M&A) alive. That is, equity holders transfer wealth to debt holders in the rollover, which in turn makes them more sensitive to corporate cash holdings, particularly when the firm is in distress.

The second prediction summarizes the relation between equity-cash sensitivities and maturity as follows:

Prediction 2: Equity values of firms with lower debt maturity are more sensitive to cash. The negative relation between equity-cash sensitivity and debt maturity is more significant in distressed firms with less cash.

3.4. Third Prediction

The debt-cash sensitivities in Figure 2 differ from those in Figure 1. They increase with the maturity across the three levels of cash reserves. This positive relation between debt-cash sensitivities and maturity is consistent with the intuition that short maturity debt holders are more likely to get paid fully than long maturity debt holders in general. Additionally, this interesting contrast between debt and equity sensitivities. As we have discussed for equation (3), equity holders optimally want to issue new debt to repay retiring debt to keep the distressed firm alive, which implies a wealth transfer to existing debt holders, who will become relatively less sensitive to the level of cash reserves. Notably, this rollover-induced wealth transfer is more severe among low-maturity firms.

Moreover, the positive relation becomes more significant when firms are more distressed or have a lower cash reserve (W = 0.1). The short maturity debt holders in those distressed firms face an increasing likelihood of default risk. Therefore, short maturity debt-cash sensitivity increases when the degree of financial distress become more severe.

However, this increase in the debt-cash sensitivities among firms with more short maturity debt is much smaller than that among firms with more long maturity debt. The reasons for the different increases are as follows. First, as we have discussed for Prediction 2, it is the equity holders who bear the rollover loss, while short maturity debt holders benefit from the wealth transferred from equity holders. Second, long maturity debt holders receive the residual of the wealth after short maturity debt holders. Therefore, the long maturity debt holders are more sensitive to the level of cash reserves, compared with short maturity debt holders, particularly when the firms are close to bankruptcy and short of cash. Therefore, the difference in the debt-cash sensitivities is more significant in distressed firms with less cash than that in healthy firms.

The above discussion can be summarized by the following prediction:

Prediction 3: Market values of debt in firms with lower debt maturity are less sensitive to cash reserve levels. The positive relation between debt-cash sensitivity and maturity is more significant in distressed firms.

3.4 Fourth Prediction

After demonstrating that the negative (positive) relation between equity (debt)-cash sensitivity, we proceed to examine the role played by rollover risk for the method of payment for mergers and acquisitions. To this end, Figure 3 illustrates the relation between debt maturity and M&A decisions. We plot the difference in the gains between cash payment and stock payment against debt maturity. A negative (positive) difference implies cash payment is less (more) preferable than stock payment.

When the acquirer's debt maturity is low, cash payment is less preferable compared with equity payment because the difference in the gains from the two payment methods is negative, i.e., the gain from cash payment is 0.3% lower than that form stock payment, when average maturity is half a year. When debt maturity increases, the difference generated from the two payment methods gradually becomes positive, implying that cash payment becomes a more profitable payment choice than stock payment.

These observations are consistent with our discussion for equations (5) and (6). When choosing cash or stock payment, equity holders consider the future rollover-induced default risk. That is, when their firms have more short maturity debt, equity holders precautionarily choose to issue equity to finance their M&A investments, particularly when their firm's condition is deteriorating.[2]

The above discussion yields the prediction for the payment method as follows:

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[2] An alternative role played by debt maturity is related to signaling a firm's future credit worthiness or profitability (see, e.g., Diamond (1991), and Flannery (1986)). Intuitively, higher quality firms, on the margin, choose shorter maturity debt as a costly signal to distinguish themselves from lower quality firms, which would not be able to bear the larger (rollover) risk. By the same logic, we would expect firms with lower debt maturity to use cash as a method of payment to signal their higher quality in a costly way that lower quality firms cannot easily implement. In contrast to the signaling, our model predicts a new role of debt maturity.

Prediction 4: Firms with low debt maturity prefer equity payment to cash payment in mergers and acquisitions. The preference of equity payment to cash payment in mergers and acquisitions become stronger among distressed firms.

3.5 Fifth Prediction

Consequently, if the cash payment choice indeed maximizes the wealth of equity holders of high-maturity firms as in equation (6), we expect a positive market reaction to their acquisition announcement. As shown in Figure 3, cash payment generates a greater gain than stock payment for high-maturity acquirers. Moreover, we expect a smaller positive market reaction in low-maturity firms, because rollover risk erodes this gain.

The above discussion yields the prediction for market reaction as follows:

Prediction 5: Upon their acquisition announcement, high-maturity firms who choose cash payment receive higher positive equity returns than low-maturity firms.

Note that this prediction assumes that the synergy gain is invariant in this calibration exercise. Given the gain, high-maturity firms choose the costless cash payment, when they face a low rollover risk and are not concerned about their cash reserve.

In summary, the model generates five empirically testable predictions. The first three predictions are on the equity- and debt-cash sensitivities, and the fourth and fifth predictions are related to the payment method of M&A. We emphasize the interaction of cash holding and rollover risk and their implication for M&A payment decisions.

4. Data and Measures

4.1 Data

Our data universe spans from 1990 to 2021. The mergers and acquisitions data are from the Securities Data Company's (SDC) U.S. Mergers and Acquisitions Database. Following Moeller, Schlingemann and Stulz (2004） and Bhagwat, Dam and Harford (2016), we apply filters as follows. (1) transactions are completed, (2) the types of deals exclude buyback, repurchase, self-tender or spinoff, (3) deal values are larger than 1 million dollars and larger than 1% of the book value of the acquirer, (4) acquirers hold less than 50% shares of the target before the deal, and obtains all shares after the deal, and (5) each deal has non-missing information in payment method. Finally, we winsorize all the variables at the top and bottom one percentile to mitigate adverse effects of outliers.

Firm characteristics, returns, and accounting information come from the annual COMPUSTAT and the monthly CRSP tapes. We delete observations with negative sales, book assets less than $1 million, non-positive long-term debt and less than two years in the COMPUSTAT/CRSP universe. Financial firms (SIC from 6000 to 6999) and utility firms (SIC from 4900 to 4999) are excluded.

Our corporate bond data are from TRACE and NAIC. Due to data availability, the corporate bond data ranges from 1994 to 2021. When there are overlapped records in both NAIC and TRACE, we keep those from TRACE because they are transaction-based. We follow Dick-Nielsen (2014) and delete the invalid transaction records in TRACE. Further following Ma (2019) and Chen, Chen and Li (2022), we impose more filters to ensure that bonds in the sample are liquid enough and their prices establish their market values.[3]

4.2. Variables

To proxy for debt maturity, we follow Harford, Klasa and Maxwell (2014) and calculate the fraction of short maturity debt. That is, we divide long-term debt due in one, three and five years by total long-term debt. The total long-term debt includes the current portion of long-term debt and debt due in more than one year.

[3] Our bond filters build on Dick-Nielsen (2014), Ma (2019) and Chen, Chen and Li (2022). Our filters include the following steps: (1) remove the transactions of reversal, cancellation and correction. (2) Remove bonds that are not issued or traded in the U.S. market. (3) Remove Yankee bonds and bonds that are issued by Canadian companies. (4). Remove bonds that are asset-backed. (5). Remove convertible bonds since the option makes them have the properties of equity. (6) Remove puttable bonds (7) Remove defaulted bonds (8). Remove bond transactions that are labeled as when-issued or lock-in.

We use the probability of failure (Campbell, Hilscher and Szilagyi (2008)) to proxy for distress severity for three reasons as follows. First, the failure probability is negatively related to cash， but does not reflect debt maturity which intensifies the effects that we want to examine in this paper.[4] Second, the failure probability, constructed with firm characteristics, covers more firms and allows us to mitigate sample selection bias, compared with credit ratings that do not cover many small and growth firms which are effectively more vulnerable. Third, the failure probability incorporates credit ratings when available. Specifically, a firm with a rating of D ("default") is considered as a "failure" in the estimation of the failure probability.[5]

We follow the literature and construct control variables for our estimates of equity- and debt-cash sensitivities and tests of M&A behaviors. The definitions of all other variables can be found in Table 2.

Table 3 reports summary statistics for firm and bond characteristics as well as deal information, respectively. We start with firm characteristics in Panel A. The average fraction of long-term debt due within three years is more than 40 percent, and its median is over 30 percent. An alternative measure, debt due within five years as short maturity debt, has an average fraction of 59 percent and median fraction of 63 percent respectively. We observe similar patterns in our bond sample in Panel B. The median years-to-maturity is less than five years and nearly 25 percent of bonds have a year-to-maturity less than 2.5 years. Thus, we find that most of firms have a large fraction of low-maturity debt.

Panel C presents summary statistics of our M&A sample. After applying the filters, we have a final sample of 9281 deals. The median ratio of deal size relative to acquirer size is about 13 percent. the average fraction of cash payments is about 60 percent, which is 20 percentage points more than stock payments in our sample.

5. Empirical Analysis

[4] Recall that the failure probability assumes a one-year horizon and uses short-term plus one half long-term book debt to proxy for the face value of debt.

[5] Specifically, in Table III of Campbell, Hilscher and Szilagyi (2008), the estimated coefficient of cash is -2.40, with a t-statistic of 8.64, from a logit regression.

We first examine the sensitivity of equity and debt to cash holding for firms with different debt maturities and financial conditions in Sections 5.1 to 5.3, and then investigate the impact of debt maturity and financial distress on the method of payment and market reaction in mergers and acquisitions in Sections 5.4 to 5.5.

5.1. Financial Distress and Sensitivity of equity and debt

We start with estimating equity- and debt-cash sensitivities for firms in different financial conditions. We sort firms each year into two groups based on failure probability, and classify firms in the top group as distressed and those in the bottom group as healthy.

To estimate the sensitivity, we closely follow the definition of the sensitivity in equations (8a) and (8b), and regress the logarithm of equity and debt values on the logarithm of cash as follow:

$$Log\,equity\,or\,debt\,value_{it} = a + b\,Log\,cash_{it} + c\,Controls_{it} + e_{it} \tag{9}$$

where *cash* is the logarithm of cash holdings. We are interested in the estimated coefficient of *b*, which is the first differentiation of *log asset value* with respect to *log cash*. We include standard control variables, such as *leverage*, *log sale*, *tangibility*, *profitability*, *market-to-book ratio*, *capital expenditure* and *dividend*. We control for year and firm fixed effects in all regressions.

We are mainly interested in the estimated coefficient, *b,* of *Log cash,* which is our estimated equity-cash sensitivity in columns (1) and (2) or debt-cash sensitivity in columns (3) and (4). As shown in Table 4, the estimated equity-cash sensitivities are much larger than the debt-cash sensitivities, which is in line with the fact that debt is less risky than equity due to its priority over cash flows and liquidation.

When the dependent variable is *Log equity value* in columns (1) and (2), the estimated coefficient of *Log cash* is 0.178 (t-statistic = 28.997) for distressed firms and 0.097 (t-statistic = 21.704) for healthy firms, implying that their equity value increases by 0.178% and 0.097% when their cash holding increases by 1%. The decrease in the equity-cash sensitivities between distressed and healthy firms is 0.081, confirming our first prediction that equity values are more sensitive to cash when firms are in distress.

We estimate the debt-cash sensitivity in columns (3) and (4) where the dependent variable is *Log Debt Value*. The estimated coefficient of *Log Debt Value* in column (3) for distressed firms is 0.007 (t-statistic = 4.619), which implies that the debt value of distressed firms increases by 0.07% if cash holding increases by 1%. In column (4) for healthy firms, the debt-cash sensitivity is 0.03, which is much smaller. This smaller estimate is consistent with our intuition that debt holders are less concerned about a healthy firm where they likely get full repayment. Therefore, the debt-cash sensitivity in distressed firms is greater than that in healthy firms by 0.04, adding support for our first prediction that, like equity values, debt values are more sensitive to cash in distressed firms than in healthy firms as well.

In short, we find consistent evidence that both equity and debt in distressed firms are more sensitive to cash than those in healthy firms.

5.2. Debt Maturity and the Equity-Cash Sensitivity

To test our second prediction, we estimate equation (9) within a subsample of firms with different debt maturities. We use long-term debt due in one, three, and five years to proxy for short maturity debt and calculate the *short maturity debt fraction*. For each proxy, we split firms into low- and high-maturity subsamples based on the median of *short maturity debt fraction*.

In Table 5, we investigate the empirical relation between equity-cash sensitivity and debt maturity. In columns (1) and (2) where we use debt due in one year to proxy for short maturity debt, the coefficient of *Log cash* is 0.241 for low-maturity firms in column (1) and 0.136 for high-maturity firms in column (2), respectively. Their difference is 0.105, with p-value less than 0.001, indicating that they are statistically different. We find similar but slightly weaker results when we use debt maturing in three years in columns (3) and (4) and in five years in columns (5) and (6).

Observing the significant effects of financial distress on equity- and debt-cash sensitivities in Table 4, we extend our analysis by considering the interplay of financial distress and debt maturity. We use the same procedure to classify firms into distressed and healthy firms as we do in Table 4, and further sort them into low- and high-maturity groups based on the median of short maturity debt fraction.

As shown in Table 6, among distressed firms, the estimated equity-cash sensitivity is 0.213 for low-maturity firms, and 0.132 for high-maturity firms, respectively. Moreover, the difference between high- and low-maturity groups among distressed firms is 0.081 with a p-value less than 0.001, which is greater than 0.058 (0.132 – 0.074) among healthy firms. Therefore, the greater difference in the distressed firms demonstrates how default risk exacerbates the effect of rollover risk, which provides further support for our second prediction.

5.3. Debt Maturity and the Debt-Cash Sensitivity

We study Prediction 3 on the positive relation between debt maturity and the debt-cash sensitivity.

We utilize bond transaction prices to calculate the firm-level market value of debt by aggregating the market value of all the bonds within the same firm. In the same manner, we use value-weighted years-to-maturity to proxy for the firm-level bond maturity. Then, we split firms into two subsamples based on the median of the firm-level bond maturity and estimate the debt-cash sensitivity within each subsample.

We present the empirical relation between debt-cash sensitivity and debt maturity in Table 7. In columns (1) and (2) where we split the sample into low- and high-maturity firms, the debt-cash sensitivity of high-maturity firms is 0.049 with a t-statistic of 3.531, which is economically and statistically significant. In contrast, the estimated sensitivity for low-maturity firms is 0.021 and is statistically insignificant. This contrast supports Prediction 3 that the debt-cash sensitivity increases with debt maturity. Our results remain similar when we sort firms into terciles in columns (3) and (4).

Then, we further examine the relation between debt-cash sensitivity and debt maturity, conditional on the firm's financial condition in Table 8. Using the same procedure in Table 6, we sort firms into halves based on their failure probability and on their bond maturities respectively. This double-sort procedure yields four subsamples.

Three observations emerge from Table 8. First, the market values of debt are not sensitive to cash when firms are healthy (columns (3) and (4)), which is echoing our evidence in Table 7. Second, when firms are distressed (columns (1) and (2)), the debt-cash sensitivity increases substantially from 0.039 (t-statistic = 2.119) for low-maturity firms to 0.085 (t-statistic = 3.989) for high-maturity firms. Third, interestingly, among all the regressions, long maturity debt in distressed firms is the most sensitive to cash holding, indicating that how the interplay between financial distress and debt maturity determines the debt-cash sensitivities.

Taken together, we find supportive evidence for our third prediction: the positive relation between debt-cash sensitivity and debt maturity, particularly in distressed firms.

5.4. Debt Maturity and the Method of Payment

Given our previous evidence on the impacts of debt maturity and financial distress on the equity- and debt-cash sensitivities, we proceed to examine how the interplay between debt maturity and financial distress affects the method of payment in mergers and acquisitions.

We use the fraction of cash payment in total transaction amount, *Cash payment fraction*, to measure the payment preference. A larger fraction indicates the greater preference of cash over equity payment. We then run panel regressions as follows:

$$Cash\ payment\ fraction = a + b\,Short\ maturity\ debt\ fraction + c\,Controls_{it} + e_{it} \qquad (10)$$

where *Short maturity debt fraction* is the long-term debt due in one, three, and five years, divided by total long-term debt. We follow Harford, Klasa and Walcott (2009) and De Bodt, Cousinand, and Roll (2018) and include mainly characteristics of acquirer as our control variables, such as acquirers' size, leverage, market-to-book ratio, tangibility, dividend, R&D expenses and one-year before announcement return. Moreover, we include an indicator for targets that are public firms, and the relative ratio of deal size to the acquirer's size. We include year and industry fixed effects in all the regressions. Industries are classified using the two-digit SIC numbers, and standard errors are clustered at the firm (acquirer) level.

We highlight two observations in Table 9. First, when we use debt due in one year in the first column, the estimated coefficient is -12.96 (t-statistic of -5.014), which is economically and statistically significant. Given the standard deviation of 0.26 for *Short maturity debt fraction*, an increase in one standard deviation in *Short maturity debt fraction* implies a decrease of 3.37% (12.96 x 0.26) in cash payment fraction on average. Second, the coefficients of *Short maturity debt fraction* become less negative when we use debt due in three and five years in columns (2) and (3). The decreasing negative effects are also consistent with our intuition that the longer debt maturity exerts less repayment pressure on acquirers, which allows them to use cash payments.

Our estimates for control variables are consistent with the literature. For example, large acquirers are likely to have enough cash reserves to cover all or most of the purchase price, and therefore use cash payment. Acquirers with high equity valuation (or market-to-book ratio) prefer equity payment (Shleifer and Vishny (2003)). The preference of cash payment to acquire private targets is also consistent with Harford, Klasa and Walcott (2009) and De Bodt, Cousin, and Roll (2018). Interestingly, in contrast to the significantly negative effect from short maturity debt, the total leverage has weakly positive effect on cash payment. This contrast highlights the new role of short maturity in determining the payment method in M&A.

Overall, we find supportive evidence for our Prediction 4 that firms with higher fraction of short maturity debt use less cash payment in mergers and acquisitions because of the precautionary motive. Hence one novel result is that debt maturity intensifies the precautionary behavior for the choice of method of payment.

To better understand the driving force behind the impact of debt maturity on payment method, we also examine the relation between debt maturity and the method of payment, conditional on the acquirer's financial status. This test allows us to distinguish our rollover risk channel from the signaling theory (see, e.g., Diamond (1991), and Flannery (1986)), which states that short-maturity firms use cash payment to signal their high quality in a costly way that lower quality firms cannot easily mimic. Specifically, we run panel regressions as follows:

$$\begin{aligned} Cash\ payment\ fraction &= a + b_1\,Distress + b_2\,Short\,maturity\,debt\ fraction \\ &+ b_3\,Distress \times Short\,maturity\,debt\ fraction + c\,Controls + e \end{aligned} \tag{11}$$

where *Distress* is an indicator variable that equals one if the acquirer is in the distressed group and zero otherwise. As before, we sort acquirers each year into two groups based on their failure probability and divide them into distressed firms (in the top group) and healthy firms (in the bottom group) in the sample.

We are mainly interested in the estimated coefficient, b_3, of the interaction term *Distress**Short maturity debt fraction* because it demonstrates the effect from financial distress on the method of payment, in addition to the rollover risk.

As shown in Table 10, we use the fraction of long-term debt due within one, three, and five years to proxy for *Short maturity debt*. First of all, as expected, distressed firms have fewer cash acquisitions in general, as indicated by the negative coefficients on *Distress* across all the regressions. Second, compared with those in Table 9, the coefficients on *Short maturity debt fraction* becomes insignificant after we introduce the interaction variable, *Short maturity debt fraction *Distress*. Thus, the substantial decline in the coefficient on *Short maturity debt fraction* indicates that debt maturity influences the payment choice mainly via the rollover-induced default risk, instead of the information channel, because firms suffer from rollover loss/risk when they are distressed. Third, the estimated coefficient for the interaction term is -13.91 (t-statistic = -3.177) in the first column where we use debt due in one year to proxy for the short maturity debt. This estimate substantially declines to -3.915 (*t-statistic* = -1.486) in the third column where we use debt due in five years for short maturity debt. This substantial decline suggests that a longer maturity decreases the rollover risk, mitigating the pressure on the already distressed firms in choosing their method of payment.

Taken together, we find strong evidence for the model's predictions. Particularly, the preference for equity payment to cash payment becomes stronger among distressed acquirers, because of the rollover-induced default risk, providing further support for Prediction 4. [6]

5.5. Debt Maturity and Market Reaction

Early evidence, such as Travlos (1987) and Fuller et al. (2002), shows that cash payment typically generates higher abnormal return than stock payment. We further examine whether the positive relation between cash payment and market reaction depends on the acquirer's debt maturity. That is, we test our fifth prediction on the relation between debt maturity and market reaction as follows:

$$Announcement\,Return = a + b\,Cash\;payment\;\;fraction + c\,Controls + e \qquad (12)$$

where *Announcement Return* is 3-day cumulative abnormal returns (CARs) centered on the announcement date for acquirers. Following Loughran and Vijh (1997) and Rau and Vermaelen (1998), we adjust for size and book-to-market ratio by using the 25 Fama and French portfolios formed on size and book-to-market as our benchmark portfolios. *Cash payment fraction* is the fraction of cash payment in total transaction amount. We include the same set of control variables as those in equations (10) and (11). Again, we split firms into low- and high-maturity subsamples based on the median of *short maturity debt fraction*.

We are interested in the coefficient, *b*, on the *Cash payment fraction*, and expect it to be more positive in high-maturity subsamples according to our Prediction 5. The results are shown in Table 11. In column (1) and (2), we first use debt due within one year to proxy for short maturity debt. The coefficient on *Cash Payment Fraction* is -0.002, which is statistically insignificant for low-maturity firms in column (1). Thus, for low-maturity firms, cash payment will not generate higher abnormal announcement return than stock payment like in the general situation. In contrast, the coefficient becomes 0.017 with a statistic of 3.674 in high-maturity firms, so high-

[6] As mentioned earlier, a costly signaling model suggests that firms with lower debt maturity use cash as a method of payment to signal their higher quality relative to lower quality firms that cannot likely withstand the implication of such a choice. Hence, a conventional information model predicts higher returns for low-maturity firms using cash, which is different from the role played by debt maturity in our setting.

maturity firms earn higher announcement return from cash payment than stock payment. Given the standard deviation of 0.45 for *Cash payment fraction*, an increase of one standard deviation in *Cash payment fraction* will result in 0.765% (1.7% x 0.45) higher excess return in the three days around the announcement. The difference is 0.019 (0.017 + 0.002), confirming the additional effect from rollover risk in our Prediction 5. From columns (3) to (6), we use the debt due within three years and five years to proxy short maturity debt, the difference decreases to 0.013 (0.014 - 0.001) and 0.007 (0.010 – 0.003), respectively. The decline in the difference as debt maturity increases further highlights the important role of managing rollover risk in maximizing equity wealth.

Therefore, cash payment generates higher abnormal returns for shareholders of high-maturity firms not low-maturity firms, confirming our Prediction 5.

6. Conclusion

In this paper, we develop a dynamic model to explain the financing decision in mergers and acquisitions through the channel of sensitivity to cash. In the model, we assume that the firm commits to the initial debt structure and continuously rolls over the debt at future market prices. Intuitively, distressed firms short of cash reserves are more likely to go bankrupt when failing to repay. Therefore, equity and debt values of distressed firm have higher sensitivity to cash than those of healthy firms.

Our model also predicts a negative (positive) relation between debt maturity and equity (debt)-cash sensitivities. The interesting contrast in the sensitivity between equity and debt arises because of wealth transfers from rollovers. Intuitively, low-maturity firms face high rollover-induced default risk. It is equity holders, instead of debt holders, who bear the rollover risk, because they issue new debt to refinance existing debt to keep their firm afloat and their investment opportunities alive. That is, rollovers effectively transfer equity holders' wealth to debt holders, which makes equity value more sensitive to cash holdings. In contrast, debt holders are less sensitive to rollover risk, because they benefit from the wealth transferred from equity holders before bankruptcy. In other words, because short maturity implies more frequent rollovers, equity (debt) value is more (less) sensitive to cash in firms with short debt maturity.

Moreover, the more distressed, the greater the rollover loss (gain) to equity (debt) holders. Therefore, the negative (positive) relation between debt maturity and equity (debt)-cash sensitivities are more pronounced in distressed firms.

A series of empirical tests provides strong support for our model's predictions about the relation between equity-cash sensitivity, cash holdings, debt rollover risk, and financial distress. Using bond transaction data from TRACE and NAIC, we construct firm-level market values of debt and confirm our novel prediction on the positive relation between debt maturity and on debt-cash sensitivity. Moreover, we also find evidence consistent with our model for the market response to payment choices in mergers and acquisitions.

Consequently, this relation between the equity/debt-cash sensitivity, debt maturity and financial distress impacts corporate investment decisions, namely, mergers and acquisitions. Given the high equity-cash sensitivity in low debt maturity firms, acquirers with low debt maturity prefer stock payment to cash payment in mergers and acquisitions, because cash is highly valuable to equity holders. This preference becomes stronger when acquirers become distressed. Using merger and acquisition data from the SDC, we also find empirical evidence that low-maturity firms prefer stock payment especially when they are financially distressed. Also, our model predicts that cash payment generates abnormal returns only among high-maturity firms. The related empirical results are also consistent with the model prediction.

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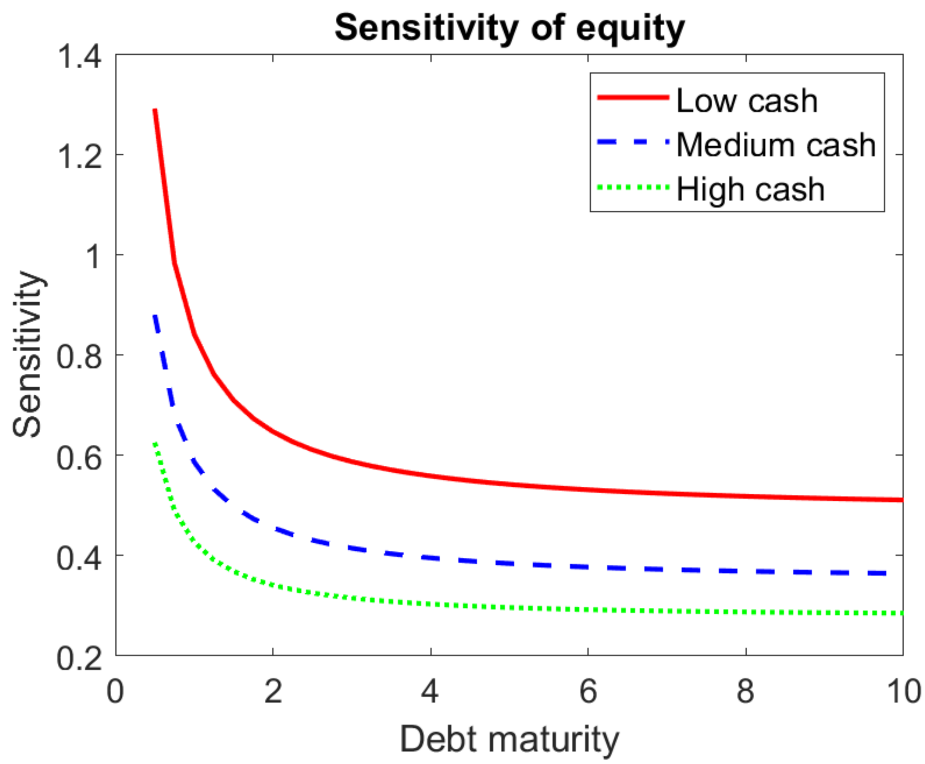

Figure 1: Sensitivity of equity to cash
This figure plots the relation between debt maturity and the sensitivity of equity value to cash holding across three levels of cash. The solid, dashed, and dotted line are, respectively, for a low level of cash is low (0.1), a medium level of cash (0.15), and a high level of cash (0.2).

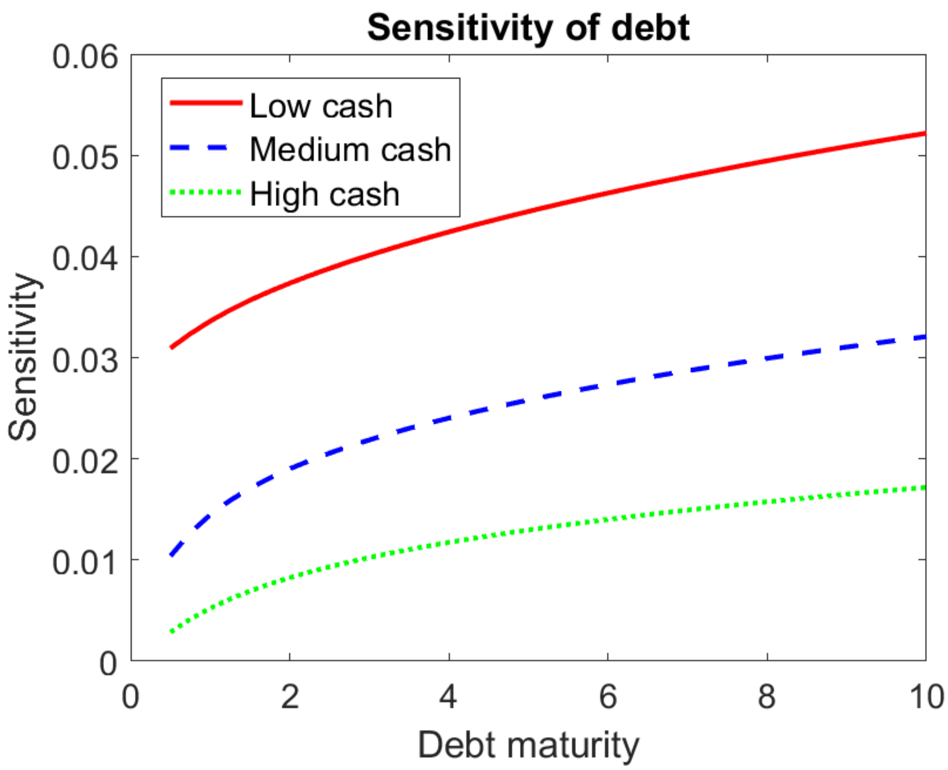

Figure 2: Sensitivity of debt to cash

This figure plots the relation between debt maturity and the sensitivity of debt value to cash holding across three levels of cash. The solid, dashed, and dotted line are, respectively, for a low level of cash is low (0.1), a medium level of cash (0.15), and a high level of cash (0.2).

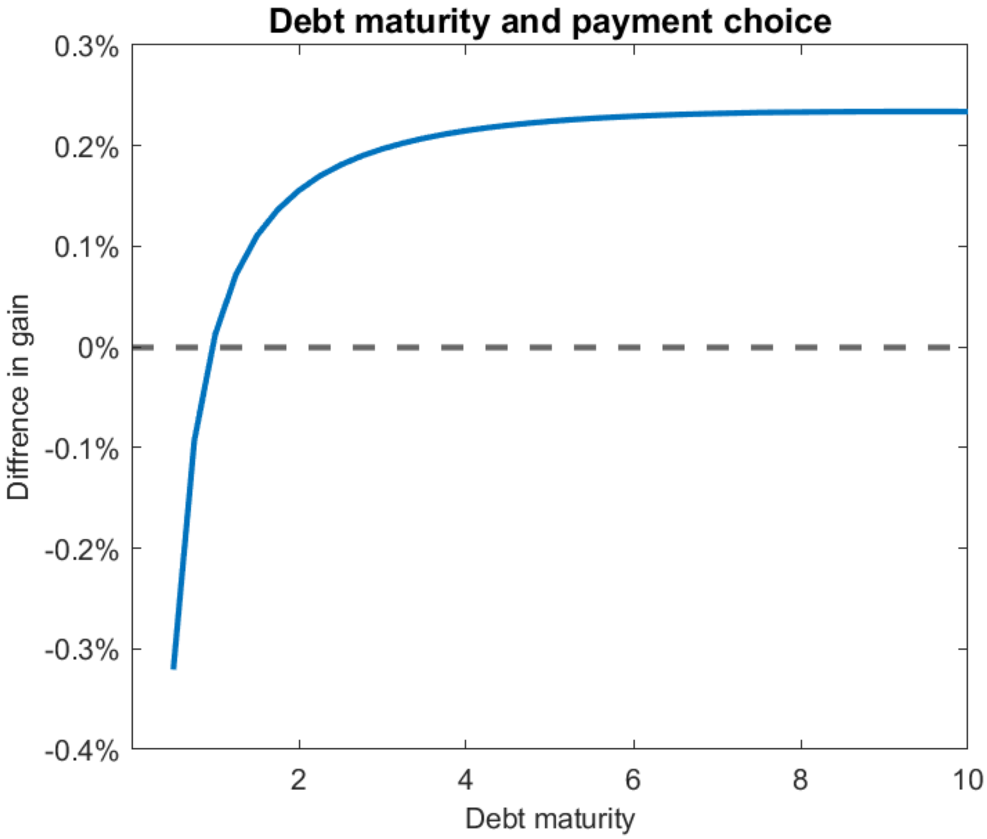

Figure 3: Debt maturity and merger and acquisition policy.

This figure illustrates how debt maturity affects the mergers and acquisitions. We assume the M&A investment opportunity arrives when the acquirer's cash holing W= 0.38, and plot the difference between the gain from cash payment and stock payment. A negative (positive) difference indicates the stock (cash) payment is preferable.

Table 1: Parameter values

We list parameter values for model calibration.

Parameter	Symbol	Value
Mean cash flow rate	μ	0.09
Cash flow volatility	σ	0.1
Risk-free rate	r	0.04
Carry cost of cash	λ	0.01
Liquidation cost	φ	0.33
Tax rate	θ	0.20
Coupon on debt	C	0.036
Principal on debt	P	0.75
Average debt maturity	M	0.5-10
Debt issuance cost	κ	0.01
Production scale	α	0.7
Transaction cost	ψ	0.05
Equity issuance cost	ϕ	0.06
Initial capital	K_{pre}	1
Target size	I	0.1
After-transaction capital	K_{post}	1.1
Synergy gain	g	1%

Table 2: Empirical variable definitions

Variable	Definition
	Panel A: firm characteristics
Fraction of long-term debt due within one year	DD1/(DD1+DLTT) (Source: Compustat)
Fraction of long-term debt due within three years	(DD1+DD2+DD3)/(DD1+DLTT) (Source: Compustat)
Fraction of long-term debt due within five years	(DD1+DD2+DD3+DD4+DD5)/(DD1+DLTT) (Source: Compustat)
Log equity value	log(PRCC_F*CSHO) (Source: Compustat)
Log cash	log(CHE) (Source: Compustat)
Book leverage	(DLTT+DLC)/ (PRCC_F*CSHO + DLC + DLTT)/ (Source: Compustat)
Log sale	log(SALE) (Source: Compustat)
Tangibility	PPENT/AT (Source: Compustat)
Profit	OIBDP/AT (Source: Compustat)
Log bond value	Aggregate the market value of bonds by firm level and take log (Source: NAIC and TRACE)
Average bond maturity	Value-weighted bond maturity by firm level (Source: NAIC and TRACE)
Market-to-book ratio	(PRCC_F*CSHO + DLC + DLTT)/AT (Source: Compustat)
Cash scaled by asset	CHE/AT (Source: Compustat)
Capital expenditures	CAPX/AT (Source: Compustat)
R&D expenses	In process research and development expenses, RDIP/AT (Source: SDC MA and Compustat)
Dividend ratio	DVC/AT (Source: Compustat)

Panel B: bond characteristics	
Outstanding volume	The outstanding amount of the bond (Source: FISD)
Years to maturity	The time length between maturity date and transaction date (Source: TRACE and FISD)
Panel C: deal characteristics	
Cash payment fraction (%)	The percentage of cash payment in the total transaction value (Source: SDC MA)
Transaction value	The total value of the acquisition deal
Relative size	deal valuation/book value of acquirer (Source: SDC MA)
Completion time	The time to complete the acquisition (Source: SDC MA)
Horizontal	A dummy equal to one if the acquirer and the target are in the same industry (the same first-two digit SIC) (Source: SDC MA)

Table 3: Summary statistics

This table reports the summary statistics of our firm, bond and acquisition samples. Panel A reports the summary statistics of our firm-year sample from CRSP/COMPUSTAT from 1990 to 2021. Long-term debt is defined as the debt maturing in more than one year and the current portion of long-term debt (Compustat variables DLTT + DD1). Panel B reports the summary statistics of our bond-year sample from NAIC and TRACE from year 1994 to 2021. Panel C reports the summary statistics of our acquisition deal sample from the SDC Mergers and Acquisitions database from year 1990 to 2021.

Panel A: Summary statistics of firm characteristics

Variable	N	Mean	SD	P25	Median	P75
Fraction of long-term debt due within one year	110767	0.188	0.26	0.009	0.076	0.252
Fraction of long-term debt due within three years	110767	0.419	0.367	0.078	0.316	0.772
Fraction of long-term debt due within five years	110767	0.585	0.378	0.227	0.625	1
Cash	110738	0.147	0.184	0.024	0.074	0.192
Book asset	110767	4115.546	14368.016	77.042	400.443	1942.316
Market-to-book ratio	110767	1.558	1.48	0.755	1.106	1.783
Book leverage	110767	0.282	0.244	0.078	0.218	0.435
Tangibility	110767	0.289	0.244	0.091	0.215	0.433
Profit	110479	0.058	0.203	0.026	0.101	0.157
Dividend ratio	110767	0.008	0.018	0	0	0.008
Capital expenditure	110767	0.056	0.065	0.016	0.036	0.072

Panel B: Summary statistics of bond characteristics

Variable	N	Mean	SD	P25	Median	P75
Coupon	309452	4.427	2.946	2.25	4.875	6.5
Years to maturity	327769	7.597	9.772	1.726	4.463	9.422
Outstanding volume (in million)	326653	250.851	498.927	2.509	20.41	305.113

Panel C: Summary statistics of deal characteristics

Variable	N	Mean	SD	P25	Median	P75
Transaction value	9281	619.173	3768.033	15	54	245
Acquirer size	9281	3621.149	14475.773	113.431	467.628	1810.2
Relative size	9281	0.46	2.081	0.045	0.125	0.36
Completion time (day)	9281	73.958	113.245	9	47	105
Cash payment fraction (%)	9281	60.752	45.538	0	100	100

Table 4. Financial distress and sensitivity of market value of assets to cash

This table reports the relation between financial distress and sensitivity of asset value to cash. We estimate the sensitivity of equity/debt to cash by regressing the logarithm of equity/debt value on the logarithm of cash and control variables within the subsample of firms with different degrees of financial severity. The sample includes firms in CRSP and Compustat from 1990 to 2021, excluding financial and utility firms. We use failure probability (Campbell, Hilscher and Szilagyi (2008)) to proxy for the severity of financial distress, sort firms each year into two groups based on the median of failure probabilities, and classify firms in the top group as distressed and those in the bottom group as healthy. The dependent variable is logarithm of equity value in column (1) and (2) and logarithm of debt value in column (3) and (4). We calculate the market value of debt by aggregating the market value of all the bonds of each firm, where the market value of bond is the product of bond price and the amount of bond outstanding. We include control variables, defined in the appendix, firm-and year-fixed effects, and cluster standard errors at the firm level. * p<0.10 ** p<0.05 *** p<0.01.

Column	(1)	(2)	(3)	(4)
Dependent variable	Log equity value		Log debt value	
Distress status	Distressed	Healthy	Distressed	Healthy
Log cash	0.178***	0.097***	0.070***	0.030**
(t)	(28.997)	(21.704)	(4.619)	(2.079)
Leverage	-1.500***	-1.071***	-0.097	1.490***
(t)	(-38.554)	(-28.714)	(-0.679)	(9.191)
Log sale	0.395***	0.644***	0.421***	0.607***
(t)	(29.775)	(51.385)	(8.684)	(11.293)
Tangibility	-0.072	-0.283***	-0.144	-0.308
(t)	(-1.043)	(-4.009)	(-0.567)	(-1.033)
Profit	0.112***	-0.634***	-0.039	-0.895***
(t)	(2.753)	(-9.609)	(-0.235)	(-3.300)
Market-to-book ratio	0.140***	0.215***	0.049*	0.002
(t)	(29.115)	(32.603)	(1.872)	(0.060)
Capital expenditures	0.325***	0.432***	0.367	0.163
(t)	(3.303)	(4.596)	(1.202)	(0.383)
Dividend	1.224***	-0.345	1.827**	2.329*
(t)	(3.468)	(-1.436)	(2.023)	(1.923)
Constant	2.510***	2.223***	2.828***	1.286***
(t)	(38.891)	(28.974)	(7.352)	(2.795)
Observations	39567	40384	5306	8699
Adjusted R-squared	0.905	0.960	0.799	0.836
Firm fixed effect	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y

Table 5: Sensitivity of equity value to cash and debt maturity

This table reports the relation between debt maturity and sensitivity of equity to cash. We estimate the sensitivity of equity to cash by regressing the logarithm of equity value on the logarithm of cash and control variables within the subsample of firms with different fractions of short maturity debt. The sample includes firms in CRSP and Compustat from 1990 to 2021, excluding financial and utility firms. The short maturity debt fraction is short maturity debt divided by total long-term debt (Compustat DLTT + DD1), where the short maturity debt is long-term debt due within one year (DD1) in columns (1) and (2), long-term debt due within three years (DD1 to DD3) in columns (3) and (4) and long-term debt due within five years (DD1 to DD5) in columns (5) and (6). We sort firms into low- and high-maturity groups, based on the median of debt maturity measures, respectively. We include control variables, defined in the appendix, firm-and year-fixed effects, and cluster standard errors at the firm level. * p<0.10 ** p<0.05 *** p<0.01.

Column	(1)	(2)	(3)	(4)	(5)	(6)
Short maturity debt	One year		Three years		Five years	
Debt maturity group	Low maturity	High maturity	Low maturity	High maturity	Low maturity	High maturity
Log cash	0.241***	0.136***	0.218***	0.142***	0.211***	0.149***
(t)	(41.621)	(26.942)	(40.747)	(27.138)	(38.912)	(28.287)
Market leverage	-1.406***	-1.724***	-1.495***	-1.643***	-1.536***	-1.555***
(t)	(-36.793)	(-43.485)	(-39.732)	(-41.568)	(-41.076)	(-38.142)
Log sale	0.404***	0.511***	0.429***	0.504***	0.446***	0.487***
(t)	(33.705)	(39.127)	(35.605)	(39.762)	(36.243)	(39.728)
Tangibility	0.019	-0.162**	-0.028	-0.143**	-0.067	-0.091
(t)	(0.278)	(-2.357)	(-0.427)	(-2.137)	(-0.988)	(-1.341)
Profit	0.193***	0.068	0.216***	0.035	0.192***	0.097
(t)	(4.792)	(1.184)	(5.436)	(0.588)	(4.648)	(1.643)
Market-to-book ratio	0.143***	0.155***	0.144***	0.158***	0.148***	0.154***
(t)	(30.845)	(25.152)	(31.276)	(26.942)	(31.968)	(26.196)
Capital expenditures	0.424***	0.147*	0.418***	0.180*	0.322***	0.221**
(t)	(4.595)	(1.664)	(4.678)	(1.932)	(3.606)	(2.300)
Dividend	1.065***	0.446*	1.229***	0.451*	0.973***	0.719***
(t)	(3.860)	(1.808)	(4.114)	(1.846)	(3.488)	(2.820)
Constant	2.538***	2.938***	2.477***	2.966***	2.432***	3.017***
(t)	(42.353)	(36.906)	(41.051)	(38.800)	(39.652)	(40.023)
Observations	51967	52196	51897	52249	52026	52138
Adjusted R-squared	0.940	0.934	0.935	0.939	0.923	0.947
Firm fixed effect	Y	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y	Y

Table 6: Sensitivity of equity value to cash, financial distress, and debt maturity

This table reports the relation between financial distress, debt maturity and sensitivity of equity to cash. We estimate the sensitivity of equity to cash by regressing the logarithm of equity value on the logarithm of cash and control variables within the subsample of firms with different fractions of short maturity debt and degrees of financial severity. The sample includes firms in CRSP and Compustat from 1990 to 2021, excluding financial and utility firms. We use failure probability (Campbell, Hilscher and Szilagyi (2008)) to proxy for the severity of financial distress, sort firms each year into two groups based on the median of failure probabilities, and classify firms in the top group as distressed and those in the bottom group as healthy. We further sort firms into low- and high-maturity groups based on the median of short maturity debt fraction, which is long-term debt due within one year (DD1) divided by total long-term debt (Compustat DLTT + DD1). We include control variables, defined in the appendix, firm-and year-fixed effects, and cluster standard errors at the firm level. * p<0.10 ** p<0.05 *** p<0.01.

Column	(1)	(2)	(3)	4)
Distress status	Distressed		Healthy	
Debt maturity group	Low maturity	High maturity	Low maturity	High maturity
Log cash	0.213***	0.132***	0.132***	0.074***
(t)	(25.516)	(14.732)	(19.020)	(14.092)
Leverage	-1.180***	-1.696***	-0.969***	-1.186***
(t)	(-21.637)	(-31.198)	(-17.926)	(-23.606)
Log sale	0.306***	0.456***	0.602***	0.659***
(t)	(18.219)	(22.454)	(37.743)	(36.156)
Tangibility	-0.022	-0.098	-0.295***	-0.269***
(t)	(-0.230)	(-0.984)	(-3.148)	(-2.918)
Profit	0.129***	0.084	-0.608***	-0.747***
(t)	(2.649)	(1.094)	(-7.034)	(-7.026)
Market-to-book ratio	0.128***	0.143***	0.204***	0.214***
(t)	(20.844)	(15.577)	(27.653)	(18.867)
Capital expenditures	0.403***	0.293**	0.630***	0.204*
(t)	(2.881)	(2.134)	(4.258)	(1.695)
Dividend	1.193*	0.896**	-0.312	-0.466
(t)	(1.775)	(2.112)	(-1.022)	(-1.407)
Constant	2.373***	2.768***	2.153***	2.433***
(t)	(32.947)	(24.205)	(24.127)	(19.799)
Observations	19011	18234	17766	21141
Adjusted R-squared	0.887	0.910	0.961	0.958
Firm fixed effect	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y

Table 7: Sensitivity of market value of debt to cash and bond maturity

This table reports the relation between bond maturity and the sensitivity of debt to cash. We estimate the sensitivity of debt value to cash by regressing the logarithm of bond value on the logarithm of cash and control variables within the subsample of firms with different bond maturity. The sample includes firms in CRSP and Compustat from 1994 to 2021, excluding financial and utility firms, which have observations in TRACE and NAIC. We calculate the market value of debt by aggregating the market value of all the bonds of each firm, where the market value of bond is the product of bond price and the amount of bond outstanding. We construct the firm-level bond maturity, which is value-weighted with a weight of bond size. Then, we sort firms into halves each year based on the median of the maturity in columns (1) and (2) and into terciles in columns (3) and (4). We include control variables, defined in the appendix, firm-and year-fixed effects, and cluster standard errors at the firm level. * $p<0.10$ ** $p<0.05$ *** $p<0.01$.

Column	(1)	(2)	(3)	(4)
Bond maturity group	Below median	Above median	Bottom tercile	Top tercile
Log cash	0.021	0.049***	0.020	0.062***
(t)	(1.373)	(3.531)	(1.003)	(3.334)
Leverage	0.244*	0.504***	0.248	0.715***
(t)	(1.732)	(3.347)	(1.313)	(3.584)
Log sale	0.523***	0.472***	0.504***	0.514***
(t)	(10.093)	(9.621)	(6.980)	(8.091)
Tangibility	-0.421	-0.272	-0.073	-0.075
(t)	(-1.614)	(-0.841)	(-0.208)	(-0.193)
Profit	-0.345**	-0.517*	-0.193	-0.231
(t)	(-1.975)	(-1.924)	(-0.871)	(-0.674)
Market-to-book ratio	0.061***	-0.031	0.053*	-0.051
(t)	(2.600)	(-1.056)	(1.761)	(-1.581)
Capital expenditures	-0.194	0.334	-0.823*	-0.570
(t)	(-0.556)	(0.801)	(-1.651)	(-1.067)
Dividend	1.945	2.132*	2.673*	2.344
(t)	(1.553)	(1.767)	(1.659)	(1.504)
Constant	1.994***	2.786***	1.922***	2.369***
(t)	(4.775)	(6.760)	(3.240)	(4.394)
Observations	7246	7234	4696	4794
Adjusted R-squared	0.759	0.857	0.751	0.873
Firm fixed effect	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y

Table 8: Sensitivity of market value of debt to cash, financial distress, and bond maturity

This table reports the relation between financial distress, bond maturity and sensitivity of market value of debt to cash. We estimate the sensitivity of debt to cash by regressing the logarithm of bond value on the logarithm of cash and control variables within the subsample of firms with different bond maturity and degrees of financial severity. The sample includes firms in CRSP and Compustat from 1994 to 2021, excluding financial and utility firms, which have observations in TRACE and NAIC. We calculate the market value of debt by aggregating the market value of all the bonds of each firm, where the market value of bond is the product of bond price and the amount of bond outstanding. We use failure probability (Campbell, Hilscher and Szilagyi (2008)) to proxy for the severity of financial distress, sort firms each year into two groups based on the median of failure probabilities, and classify firms in the top group as distressed and those in the bottom group as healthy. We construct the firm-level bond maturity, which is value-weighted with a weight of bond size. Then, we sort firms into low- and high-maturity groups every year based on the median of the maturity. We include control variables, defined in the appendix, firm-and year-fixed effects, and cluster standard errors at the firm level. * p<0.10 ** p<0.05 *** p<0.01.

Column	(1)	(2)	(3)	(4)
Distress status	Distressed		Healthy	
Bond maturity group	Low maturity	High maturity	Low maturity	High maturity
Log cash	0.039**	0.085***	0.021	0.036*
(t)	(2.119)	(3.989)	(1.118)	(1.916)
Leverage	-0.237	0.280	1.526***	1.425***
(t)	(-1.311)	(1.105)	(7.551)	(7.219)
Log sale	0.472***	0.465***	0.650***	0.532***
(t)	(5.935)	(8.097)	(9.947)	(7.207)
Tangibility	0.169	-0.839	-0.672	0.237
(t)	(0.561)	(-1.428)	(-1.336)	(0.669)
Profit	-0.211	0.456	-0.608	-0.865***
(t)	(-1.278)	(0.949)	(-1.607)	(-2.751)
Market-to-book ratio	0.060**	0.044	0.071**	-0.003
(t)	(1.973)	(0.790)	(2.058)	(-0.088)
Capital expenditures	-0.282	1.210*	-0.160	-0.191
(t)	(-0.728)	(1.929)	(-0.269)	(-0.374)
Dividend	2.042	1.073	1.174	2.562
(t)	(1.396)	(1.093)	(0.676)	(1.564)
Constant	2.443***	2.674***	0.631	2.022***
(t)	(3.932)	(5.420)	(1.219)	(3.118)
Observations	3087	1837	3557	4862
Adjusted R-squared	0.755	0.853	0.802	0.870
Firm fixed effect	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y

Table 9: Payment method and debt maturity

This table reports the relation between debt maturity and payment method in mergers and acquisitions. The dependent variable is cash payment fraction in acquisitions. The sample includes completed deals in SDC from 1990 to 2021. The dependent variable is the percentage of cash payment. *Short maturity debt fraction* is short maturity debt divided by total long-term debt (Compustat DLTT + DD1), where the short maturity debt is long-term debt due within one year (DD1) in column (1), three years (DD1 to DD3) in column (2) and long-term debt due within five years (DD1 to DD5) in columns (3). We include control variables of acquirers' characteristics, defined in the appendix, industry-and year-fixed effects, and cluster standard errors at the firm level. * p<0.10 ** p<0.05 *** p<0.01.

Column	(1)	(2)	(3)
Dependent variable	Percentage of cash payment		
Short maturity debt	One year	Three years	Five years
Short maturity debt fraction	-12.956***	-6.223***	-1.889
(t)	(-5.014)	(-3.912)	(-1.231)
Cash	-9.336***	-10.545***	-10.546***
(t)	(-2.649)	(-2.991)	(-2.968)
Log sale	3.714***	3.768***	4.055***
(t)	(10.204)	(10.145)	(10.851)
Leverage	2.993	3.574	5.780
(t)	(0.844)	(0.996)	(1.597)
Market-to-book ratio	-2.188***	-2.245***	-2.240***
(t)	(-7.502)	(-7.693)	(-7.683)
Tangibility	2.007	2.519	2.702
(t)	(0.511)	(0.640)	(0.681)
Dividend	98.191***	97.806***	95.030***
(t)	(3.423)	(3.394)	(3.288)
R&D expenses	83.282*	85.533*	89.232*
(t)	(1.750)	(1.789)	(1.888)
Relative size of target to bidder	-0.967**	-0.975**	-0.981**
(t)	(-2.551)	(-2.535)	(-2.515)
Horizontal	0.578	0.669	0.790
(t)	(0.533)	(0.615)	(0.724)
Public target	-26.549***	-26.547***	-26.561***
(t)	(-20.794)	(-20.653)	(-20.639)
10-year interest rate	-1.181	-1.139	-1.031
(t)	(-0.947)	(-0.911)	(-0.824)
One-year pre-announcement bidder return	-2.960***	-2.927***	-2.919***
(t)	(-6.551)	(-6.492)	(-6.492)
Constant	61.105***	60.909***	56.773***
(t)	(8.979)	(8.861)	(8.139)
Observations	7669	7669	7669
Adjusted R-squared	0.307	0.305	0.304
Industry fixed effect	Y	Y	Y
Year fixed effect	Y	Y	Y

Table 10: Payment method, debt maturity and failure probability

This table reports the relation between debt maturity, financial distress and payment method in mergers and acquisitions. The dependent variable is percentage of cash payment in acquisitions. The sample includes completed deals in SDC from 1990 to 2021. *Short maturity debt fraction* is short maturity debt divided by total long-term debt (Compustat DLTT + DD1), where the short maturity debt is long-term debt due within one year (DD1) in column (1), three years (DD1 to DD3) in column (2) and long-term debt due within five years (DD1 to DD5) in columns (3). Distress is an indicator variable equal to one if the acquirer is in the distress group. We use failure probability (Campbell, Hilscher and Szilagyi (2008)) to proxy for the severity of financial distress, sort firms each year into two groups based on the median of failure probabilities, and classify firms in the top group as distressed and those in the bottom group as healthy. We include control variables of acquirers' characteristics, defined in the appendix, industry- and year-fixed effects, and cluster standard errors at the firm level. * p<0.10 ** p<0.05 *** p<0.01.

Column	(1)	(2)	(3)
Dependent variable	Percentage of cash payment		
Short maturity debt	One year	Three years	Five years
Distress	-5.178***	-4.573***	-5.126***
(t)	(-3.973)	(-3.000)	(-2.663)
Short maturity debt fraction	-4.699	-1.535	0.516
(t)	(-1.409)	(-0.749)	(0.255)
Short maturity debt fraction* Distress	-13.909***	-7.413***	-3.915
(t)	(-3.177)	(-2.705)	(-1.480)
Cash	-11.374***	-12.759***	-12.943***
(t)	(-3.020)	(-3.389)	(-3.422)
Log sale	2.988***	3.087***	3.379***
(t)	(7.565)	(7.668)	(8.328)
Market-to-book ratio	-2.560***	-2.580***	-2.600***
(t)	(-7.656)	(-7.734)	(-7.778)
Tangibility	3.171	3.715	4.240
(t)	(0.781)	(0.913)	(1.033)
Dividend	82.725***	78.950**	72.894**
(t)	(2.694)	(2.574)	(2.368)
R&D expenses	66.476	69.438	73.798
(t)	(1.314)	(1.360)	(1.472)
Relative size of target to bidder	-1.052**	-1.057**	-1.055**
(t)	(-2.194)	(-2.178)	(-2.159)
Horizontal	0.268	0.426	0.560
(t)	(0.238)	(0.379)	(0.496)
Public target	-26.266***	-26.334***	-26.373***
(t)	(-19.579)	(-19.588)	(-19.590)
10-year interest rate	-0.860	-0.833	-0.738
(t)	(-0.666)	(-0.644)	(-0.570)
One-year pre-announcement bidder return	-2.955***	-2.917***	-2.925***
(t)	(-5.971)	(-5.916)	(-5.930)
Constant	69.243***	68.436***	65.156***
(t)	(9.957)	(9.738)	(9.102)
Observations	6822	6822	6822
Adjusted R-squared	0.302	0.300	0.298
Industry fixed effect	Y	Y	Y
Year fixed effect	Y	Y	Y

Table 11: Payment method, debt maturity and market reaction

This table reports the relation between debt maturity, payment method and market reaction in mergers and acquisitions. The dependent variable is 3-day cumulative abnormal returns (CARs) centered on the announcement date for acquirers. The baseline return is from 25 size and book-to-market ratio portfolios. The sample includes completed deals in SDC from 1990 to 2021. The short maturity debt fraction is short maturity debt divided by total long-term debt (Compustat DLTT + DD1), where the short maturity debt is long-term debt due within one year (DD1) in columns (1) and (2), long-term debt due within three years (DD1 to DD3) in columns (3) and (4) and long-term debt due within five years (DD1 to DD5) in columns (5) and (6). We sort acquirers into low- and high-maturity groups based on the median of the debt maturity measures, respectively. We include control variables, defined in the appendix, firm-and year-fixed effects, and cluster standard errors at the firm level. * p<0.10 ** p<0.05 *** p<0.01.

Column	(1)	(2)	(3)	(4)	(5)	(6)
Short maturity debt	One year		Three years		Five years	
Debt maturity group	Low maturity	High maturity	Low maturity	High maturity	Low maturity	High maturity
Cash payment fraction	-0.002	0.017***	0.001	0.014***	0.003	0.010**
(t)	(-0.303)	(4.208)	(0.115)	(3.369)	(0.499)	(2.137)
Cash	-0.002	-0.012	0.003	-0.020	0.004	-0.023*
(t)	(-0.134)	(-1.126)	(0.257)	(-1.625)	(0.305)	(-1.713)
Log sale	-0.010***	-0.003**	-0.009***	-0.004***	-0.007***	-0.007***
(t)	(-6.044)	(-2.379)	(-5.655)	(-3.348)	(-4.662)	(-5.160)
Leverage	0.081**	0.029***	0.072**	0.034***	0.067**	0.026**
(t)	(2.338)	(2.771)	(2.181)	(3.187)	(2.328)	(2.339)
Market-to-book ratio	-0.002*	-0.002	-0.003***	0.001	-0.003***	0.001
(t)	(-1.812)	(-1.450)	(-2.599)	(0.408)	(-2.784)	(0.625)
Tangibility	0.009	-0.002	0.017	-0.009	0.010	0.002
(t)	(0.347)	(-0.237)	(0.707)	(-1.065)	(0.404)	(0.216)
Dividend	0.118	0.014	0.100	0.019	0.166	0.003
(t)	(1.094)	(0.161)	(0.875)	(0.225)	(1.462)	(0.031)
R&D expenses	-0.061	0.276	-0.006	0.001	0.102	-0.424
(t)	(-0.396)	(1.099)	(-0.037)	(0.006)	(0.785)	(-1.202)
Relative size	0.002	0.005**	0.002	0.005*	0.002	0.002
(t)	(1.229)	(2.083)	(1.211)	(1.767)	(1.275)	(0.811)
Horizontal	-0.006	-0.002	-0.003	-0.006*	-0.004	-0.006*
(t)	(-1.188)	(-0.838)	(-0.625)	(-1.906)	(-0.785)	(-1.868)
Public target	-0.033***	-0.019***	-0.030***	-0.021***	-0.033***	-0.018***
(t)	(-6.237)	(-4.856)	(-5.762)	(-5.529)	(-6.262)	(-4.577)
GS10	-0.003	-0.002	-0.001	-0.005	-0.003	-0.003
(t)	(-0.625)	(-0.633)	(-0.274)	(-1.222)	(-0.556)	(-0.832)
Constant	0.096***	0.034*	0.078***	0.055**	0.075***	0.073***
(t)	(3.207)	(1.711)	(2.736)	(2.491)	(2.703)	(2.930)
Observations	3651	3521	3743	3427	3871	3298
Adjusted R-squared	0.043	0.053	0.037	0.047	0.042	0.044

Appendix

A. Model and boundary conditions

A1. Ordinary differentiation equations

A2. Boundary conditions

B. Robustness tests

B1. Alternative distress proxy for Prediction 1

B2. Alternative tests for Prediction 2 on the equity-cash sensitivity

B3. Alternative tests for Predictions 3 on the debt-cash sensitivity

B4. Alternative test method for Predictions 4 on the payment method

A. Model Solution

Our model builds on Bolton Chen and Wang (2011) and Della Seta, Morellec and Zucchi (2020). We first provide ordinary differentiation equations (ODE) and then list boundary conditions for the post-merger firm.

A.1. ODEs

Under the risk neutral measure, *Q*, the Bellman equation of equity value function satisfies.

$$E(W_t) = (1+rdt)^{-1} \mathrm{E}^Q[E(W_t + dW_t) \mid W_t]. \tag{A1}$$

Applying *Ito*'s lemma, we obtain the ODE of the equity value as follows:

$$\begin{aligned} rE(W_t) = &\left[(1-\theta)\left((r-\lambda)W_t + K_s^{\alpha}\mu - C + G(K_s)\right) + \frac{1}{M}\left((1-\kappa)D(W_t) - P\right) \right] E'(W_t) \\ &+ \frac{\left((1-\theta)\sigma K_s\right)^2}{2} E''(W_t). \end{aligned} \tag{A2}$$

Different from equity holders, debt holders receive coupon and part of principal value over time. Thus, the value function of debt with a maturity *M* satisfies:

$$D(W_t) = (1+rdt)^{-1} \mathrm{E}^Q[Cdt + \frac{Pdt}{M} + (1-\frac{dt}{M})D(W_t + dW_t) \mid W_t]. \tag{A3}$$

Similarly, we obtain the ODE of the debt value function, $D(W_t)$, as follows:

$$\begin{aligned} (r+\frac{1}{M})D(W_t) = &\begin{bmatrix} (1-\theta)\left((r-\lambda)W_t + K_s^{\alpha}\mu - C + G(K_s)\right) \\ +\frac{1}{M}\left((1-\kappa)D(W_t) - P\right) \end{bmatrix} D'(W_t) \\ &+ \frac{\left((1-\theta)\sigma K_s\right)^2}{2} D''(W_t) + C + \frac{P}{M}. \end{aligned} \tag{A4}$$

A.2. Boundary conditions for the post-merger firm

The post-merger firm defaults when it is out of cash, i.e., *W=0*. Similar to equations (3) and (4), we have

$$E(W=0;K_{post})=\max(\iota K_{post}-P,0)\,, \tag{A5}$$

$$D(W=0;K_{post})=\min(\iota K_{post},P)\,. \tag{A6}$$

Equations (A5) and (A6) state the equity and debt value of the post-merger firm at bankruptcy. After the acquisition, the collateral value increases from ιK_{pre} to ιK_{post}. It is worth noting that if the firm choose to pay with cash as in equation (5b), the level of cash reserve is reduced by the amount of $(1+\psi)I$,becoming closer to the default threshold of *W=0*.

We assume that the post-merger firm does not have additional acquisition opportunities. When cash reserve approaches infinity, equity holders benefit from every unit increase in cash reserve. Thus, we have the boundary condition as follows:

$$E'(\infty;K_{post})=1. \tag{A7}$$

Because debt holders do not enjoy the upside benefits when cash holding is sufficiently large, the marginal value of cash to debt holders equals zero as follows:

$$D'(\infty;K_{post})=0\,. \tag{A8}$$

B. Robustness

In this section, we include the results of robustness tests.

B.1. Alternative distress proxy for Prediction 1

We use an alternative proxy for financial distress, i.e., credit rating. Firms with a non-investment grade are considered as distressed and those with an investment grade as healthy. We refer to the rating schedule by Standard & Poor, i.e., a rating above BBB- as investment grade and non-investment grade otherwise. Table B1 confirms that our results in Table 4 that equity and debt values are more sensitive to cash holdings in non-investment grade firms than those in investment grade firms.

B.2. Alternative tests for Prediction 2 on the equity-cash sensitivity

Not all the firms issue public bonds. In testing the sensitivity of the market value of debt to cash holding, we use bond maturity from TRACE as the proxy for debt maturity, instead of debt maturity from Compustat. The bond maturity of a firm is the value-weighted maturity across all the bonds. Using a similar procedure we adapt in the main text, we sort firms into halves each year based on the median of their bond maturity. Firms with a bond maturity above median are in the high-maturity group and the rest in the low-maturity group. Table B2 shows that the debt value of firms with low bond maturity are more sensitive to cash than those of high-maturity firms, confirming our results observed in Table 2.

To ensure our results are robust to financial status classification, we also adopt bond maturity to proxy for debt maturity. As in the main text, we first sort firms into halves each year based on their failure probability in this alternative test. Firms above median are considered distressed and those below median as healthy, respectively. Next, we further sort firms into two groups based on their bond maturity and classify firms above median into the high-maturity group and the rest into the low-maturity group. Table B3 shows that results are similar to those in the main text that equity value is more sensitive to cash among distressed and low-maturity firms, confirming the interaction effect in Table 6.

B3. Alternative tests for Predictions 3 on the debt-cash sensitivity

We use bond maturity in the main text because we use the market value of all the bonds of the same firm, and its bonds issued publicly are a subset of their total debt, which might include private loans. Although the total debt could be slightly different total public traded bonds, we use short debt maturity fraction as the proxy for debt maturity. Using a similar procedure in Table 7, we sort firms into halves each year, based on the median of their short debt maturity fraction. Table B4 shows that our results are largely the same as those in the main text that the sensitivity of bond to cash are only economically and statistically significant in firms with high-maturity debt.

In the double-sort exercise, we still use short maturity debt fraction. That is, we first sort firms into distressed and healthy groups based on the median of their failure probability. Next, we further sort firms into the low- and high-maturity group based on the median of their short maturity debt fraction. The results in Table B5 are similar to those in the main text that distressed and high-maturity firms have higher sensitivity of debt value to cash.

B4. Alternative test method for Predictions 4 on the payment method

While we use linear regressions in the main text, we use probit regressions in testing the payment choice in Tables B6 and B7. The dependent variable is an indicator for cash only payments. We observe results and patterns similar to those in Tables 9 and 10. That is, firms with more short maturity debt are less likely to use cash as their payment in Table B6. The reluctance becomes stronger among distressed firm in Table B7. For example, in column (1) where short maturity debt is debt due in one year, the coefficient of *short maturity debt fraction* is -0.505 (-0.228 – 0.277), which is more than double -0.228 for healthy firms. In the second column (2) where we use the debt due in three years, the negative effect in distressed firm becomes weaker with an estimate of -0.232 (-0.117-0.115), which is almost as double as -0.117 in health firms. We observe further decline in column (3).

Table B1. Financial distress and sensitivity of market value of assets to cash

This table reports the relation between financial distress and sensitivity of asset value to cash. We estimate the sensitivity of equity/debt to cash by regressing the logarithm of equity/debt value on the logarithm of cash and control variables within the subsample of firms with different degrees of financial severity. The sample includes firms in CRSP and Compustat from 1990 to 2021, excluding financial and utility firms. We use credit ratings from Standard & Poor to proxy for the severity of financial distress, and classify firms into two groups. Firms with a rating below the investment grade is considered distressed and the rest considered healthy. The dependent variable is the logarithm of equity value in column (1) and (2) and the logarithm of debt value in column (3) and (4). We calculate the market value of debt by aggregating the market value of all the bonds of each firm, where the market value of bond is the product of bond price and the amount of bond outstanding. We include control variables, defined in the appendix, firm-and year-fixed effects, and cluster standard errors at the firm level. * p<0.10 ** p<0.05 *** p<0.01.

Column	(1)	(2)	(3)	(4)
Dependent variable	Log equity value		Log debt value	
Distress status	Distressed	Healthy	Distressed	Healthy
Log cash	0.110***	0.072***	0.049***	0.010
(t)	(8.287)	(8.103)	(3.344)	(0.608)
Leverage	-2.188***	-1.645***	0.091	1.952***
(t)	(-19.253)	(-14.044)	(0.655)	(11.489)
Log sale	0.389***	0.589***	0.434***	0.645***
(t)	(9.256)	(19.913)	(10.228)	(12.395)
Tangibility	-0.460**	-0.543***	-0.222	0.084
(t)	(-2.482)	(-3.313)	(-0.900)	(0.268)
Profit	0.002	-0.965***	-0.192	-0.937***
(t)	(0.010)	(-4.870)	(-1.109)	(-2.954)
Market-to-book ratio	0.121***	0.177***	0.091**	0.017
(t)	(3.937)	(9.568)	(2.208)	(0.621)
Capital expenditures	-0.605**	-0.537*	0.572**	-0.348
(t)	(-2.341)	(-1.727)	(2.099)	(-0.712)
Dividend	0.438	-1.132*	1.355	1.315
(t)	(0.561)	(-1.662)	(1.591)	(1.011)
Constant	4.671***	3.925***	2.574***	0.991**
(t)	(14.992)	(15.159)	(7.590)	(2.269)
Observations	7563	7248	7562	7247
Adjusted R-squared	0.863	0.949	0.737	0.876
Firm fixed effect	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y

Table B2: Cash sensitivity of equity value and bond maturity

This table reports the relation between bond maturity and the sensitivity of equity to cash. We estimate the sensitivity of equity to cash by regressing the logarithm of equity value on the logarithm of cash and control variables within the subsample of firms with different bond maturity. The sample includes firms in CRSP and Compustat from 1994 to 2021, excluding financial and utility firms, which have observations in TRACE and NAIC. We construct the firm-level bond maturity, which is value-weighted with a weight of bond size. Then, we sort firms into three groups each year. The top tercile is the high-maturity group and the bottom tercile is the low-maturity group. We include control variables, defined in the appendix, firm-and year-fixed effects, and cluster standard errors at the firm level. * p<0.10 ** p<0.05 *** p<0.01.

Column	(1)	(2)
Bond maturity group	Below tercile	Above tercile
Log cash	0.115***	0.073***
(t)	(8.105)	(5.393)
Leverage	-2.221***	-1.980***
(t)	(-15.170)	(-14.287)
Log sale	0.537***	0.511***
(t)	(10.361)	(12.049)
Tangibility	-0.387*	-0.483**
(t)	(-1.710)	(-1.989)
Profit	-0.263	-0.315
(t)	(-1.297)	(-0.947)
Market-to-book ratio	0.186***	0.133***
(t)	(7.502)	(6.378)
Capital expenditures	-0.632*	-0.289
(t)	(-1.741)	(-0.748)
Dividend	0.817	-0.236
(t)	(0.651)	(-0.263)
Constant	3.503***	4.658***
(t)	(8.639)	(12.854)
Observations	4696	4794
Adjusted R-squared	0.919	0.944
Firm fixed effect	Y	Y
Year fixed effect	Y	Y

Table B3. Sensitivity of equity value to cash, financial distress, and bond maturity

This table reports the relation between financial distress, bond maturity and sensitivity of equity to cash. We estimate the sensitivity of equity to cash by regressing the logarithm of equity value on the logarithm of cash and control variables within the subsample of firms with different fractions of short maturity debt and degrees of financial severity. The sample includes firms in CRSP and Compustat from 1990 to 2021, excluding financial and utility firms. We use failure probability (Campbell, Hilscher and Szilagyi (2008)) to proxy for the severity of financial distress, sort firms each year into two groups based on the median of failure probabilities, and classify firms in the top group as distressed and those in the bottom group as healthy. We further sort firms into two groups based on the median of bond maturity every year. We include control variables, defined in the appendix, firm-and year-fixed effects, and cluster standard errors at the firm level. * p<0.10 ** p<0.05 *** p<0.01.

Column	(1)	(2)	(3)	4)
Distress status	Distressed		Healthy	
Bond maturity group	Low maturity	High maturity	Low maturity	High maturity
Log cash	0.089***	0.074***	0.056***	0.053***
(t)	(5.582)	(3.132)	(4.880)	(5.321)
Leverage	-2.226***	-1.651***	-1.389***	-1.463***
(t)	(-15.943)	(-9.093)	(-10.183)	(-13.094)
Log sale	0.555***	0.525***	0.623***	0.555***
(t)	(8.907)	(8.914)	(10.344)	(10.870)
Tangibility	-0.461*	-0.591*	-0.605***	-0.391**
(t)	(-1.711)	(-1.696)	(-3.157)	(-2.210)
Profit	-0.192	0.166	-1.119***	-0.825***
(t)	(-1.048)	(0.337)	(-4.509)	(-3.216)
Market-to-book ratio	0.180***	0.244***	0.239***	0.160***
(t)	(5.345)	(5.201)	(9.567)	(7.464)
Capital expenditures	-0.347	0.040	-0.475	0.220
(t)	(-0.779)	(0.071)	(-1.578)	(0.683)
Dividend	-0.972	0.059	-0.196	-0.418
(t)	(-0.775)	(0.056)	(-0.248)	(-0.474)
Constant	3.266***	3.588***	3.346***	4.302***
(t)	(6.901)	(8.015)	(6.901)	(9.488)
Observations	3087	1837	3557	4862
Adjusted R-squared	0.876	0.918	0.955	0.961
Firm fixed effect	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y

Table B4. Cash sensitivity of bond value and debt maturity

This table reports the relation between debt maturity and sensitivity of debt to cash. We estimate the sensitivity of debt to cash by regressing the logarithm of bond value on the logarithm of cash and control variables within the subsample of firms with different fractions of short maturity debt. The sample includes firms in CRSP and Compustat from 1990 to 2021, excluding financial and utility firms. We calculate the market value of debt by aggregating the market value of all the bonds of each firm, where the market value of bond is the product of bond price and the amount of bond outstanding. The short maturity debt fraction is short maturity debt divided by total long-term debt (Compustat DLTT + DD1), where the short maturity debt is long-term debt due within one year (DD1) in columns (1) and (2), long-term debt due within three years (DD1 to DD3) in columns (3) and (4) and long-term debt due within five years (DD1 to DD5) in columns (5) and (6). We sort firms into low- and high-maturity groups, based on the median of the debt maturity measures, respectively. We include control variables, defined in the appendix, firm-and year-fixed effects, and cluster standard errors at the firm level. * p<0.10 ** p<0.05 *** p<0.01.

Column	(1)	(2)	(3)	(4)	(5)	(6)
Short maturity debt	One year		Three years		Five years	
Debt maturity group	Low maturity	High maturity	Low maturity	High maturity	Low maturity	High maturity
Log cash	0.029	0.050***	0.005	0.052***	0.002	0.055***
(t)	(1.038)	(4.210)	(0.216)	(4.489)	(0.068)	(5.123)
Leverage	0.641**	0.287***	0.655**	0.267**	0.423**	0.340***
(t)	(2.090)	(2.678)	(2.388)	(2.541)	(1.967)	(2.899)
Log sale	0.766***	0.478***	0.852***	0.473***	0.537***	0.491***
(t)	(9.836)	(12.953)	(10.735)	(12.630)	(5.945)	(13.157)
Tangibility	-0.237	-0.480**	-0.154	-0.558**	-0.087	-0.401*
(t)	(-0.554)	(-2.184)	(-0.358)	(-2.380)	(-0.211)	(-1.770)
Profit	-0.780*	-0.415**	-0.576	-0.510***	-0.022	-0.629***
(t)	(-1.777)	(-2.496)	(-1.354)	(-3.030)	(-0.069)	(-3.432)
Market-to-book ratio	-0.042	-0.016	-0.040	-0.010	0.008	-0.016
(t)	(-0.929)	(-0.654)	(-0.848)	(-0.364)	(0.169)	(-0.597)
Capital expenditures	0.484	0.291	-0.031	0.248	-0.417	0.480*
(t)	(0.435)	(1.137)	(-0.035)	(0.915)	(-0.639)	(1.842)
Dividend	3.944**	2.156**	4.851***	1.786*	4.245**	1.532*
(t)	(2.387)	(2.391)	(2.839)	(1.855)	(2.282)	(1.686)
Constant	0.168	2.493***	-0.585	2.631***	1.749**	2.494***
(t)	(0.235)	(8.367)	(-0.832)	(8.516)	(2.281)	(7.997)
Observations	3581	10981	3861	10664	3159	11389
Adjusted R-squared	0.862	0.777	0.853	0.804	0.815	0.830
Firm fixed effect	Y	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y	Y

Table B5. Sensitivity of market value of debt to cash, financial distress, and debt maturity

This table reports the relation between financial distress, debt maturity and sensitivity of market value of debt to cash. We estimate the sensitivity of debt to cash by regressing the logarithm of bond value on the logarithm of cash and control variables within the subsample of firms with different bond maturity and degrees of financial severity. The sample includes firms in CRSP and Compustat from 1994 to 2021, excluding financial and utility firms, which have observations in TRACE and NAIC. We calculate the market value of debt by aggregating the market value of all the bonds of each firm, where the market value of bond is the product of bond price and the amount of bond outstanding. We use failure probability (Campbell, Hilscher and Szilagyi (2008)) to proxy for the severity of financial distress, sort firms each year into two groups based on the median of failure probabilities, and classify firms in the top group as distressed and those in the bottom group as healthy. We further sort firms into two groups based on *short maturity debt fraction*, which is long-term debt due within five years (DD1 to DD5) divided by total long-term debt (Compustat DLTT + DD1). We include control variables, defined in the appendix, firm-and year-fixed effects, and cluster standard errors at the firm level. * p<0.10 ** p<0.05 *** p<0.01.

Column	(1)	(2)	(3)	(4)
Distress status	Distressed		Healthy	
Debt maturity group	Low maturity	High maturity	Low maturity	High maturity
Log cash	0.011	0.077***	0.001	0.048***
(t)	(0.325)	(5.344)	(0.040)	(3.536)
Leverage	-0.207	-0.030	1.482***	1.362***
(t)	(-0.808)	(-0.202)	(3.856)	(8.083)
Log sale	0.457***	0.429***	0.619***	0.581***
(t)	(3.263)	(9.344)	(4.689)	(11.212)
Tangibility	1.576***	-0.233	-0.297	-0.075
(t)	(3.106)	(-0.872)	(-0.558)	(-0.238)
Profit	0.126	-0.088	-1.448**	-0.859***
(t)	(0.396)	(-0.568)	(-2.426)	(-3.202)
Market-to-book ratio	0.082	0.041	0.012	0.002
(t)	(1.215)	(1.437)	(0.221)	(0.053)
Capital expenditures	-0.457	0.416	-0.637	0.049
(t)	(-0.664)	(1.217)	(-0.560)	(0.124)
Dividend	2.163	1.180	2.950	1.104
(t)	(0.602)	(1.310)	(1.414)	(0.839)
Constant	1.981*	2.847***	1.103	1.476***
(t)	(1.743)	(7.982)	(1.002)	(3.323)
Observations	1180	3808	1648	6790
Adjusted R-squared	0.832	0.806	0.840	0.864
Firm fixed effect	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y

Table B6. Payment method and debt maturity

This table reports results from probit regressions for the relation between debt maturity and payment method in mergers and acquisitions. The dependent variable is an indicator for cash only payment. The sample includes completed deals in SDC from 1990 to 2021. Short debt maturity fraction is short maturity debt divided by total long-term debt (Compustat DLTT + DD1), where the short maturity debt is long-term debt due within one year (DD1) in column (1), three years (DD1 to DD3) in column (2) and long-term debt due within five years (DD1 to DD5) in columns (3). We include control variables of acquirers' characteristics, defined in the appendix, industry-and year-fixed effects, and standard errors are robust. * p<0.10 ** p<0.05 *** p<0.01.

Column	(1)	(2)	(3)
Dependent variable	Indicator of cash only payment		
Short maturity debt	One year	Three years	Five years
Short maturity debt fraction	-0.405***	-0.212***	-0.089*
(t)	(-5.301)	(-4.247)	(-1.947)
Cash	-0.365***	-0.411***	-0.412***
(t)	(-3.285)	(-3.694)	(-3.705)
Log sale	0.147***	0.147***	0.156***
(t)	(12.940)	(12.765)	(13.635)
Leverage	-0.136	-0.122	-0.053
(t)	(-1.149)	(-1.025)	(-0.451)
Market-to-book ratio	-0.056***	-0.057***	-0.056***
(t)	(-4.400)	(-4.554)	(-4.519)
Tangibility	0.015	0.026	0.033
(t)	(0.127)	(0.222)	(0.279)
Dividend	3.427***	3.447***	3.327***
(t)	(2.849)	(2.871)	(2.768)
R&D expenses	2.698	2.695	2.835
(t)	(1.292)	(1.287)	(1.352)
Relative size of target to bidder	-0.342***	-0.341***	-0.341***
(t)	(-5.985)	(-5.957)	(-5.919)
Horizontal	0.018	0.021	0.025
(t)	(0.530)	(0.603)	(0.722)
Public target	-0.746***	-0.746***	-0.746***
(t)	(-17.040)	(-17.031)	(-16.983)
10-year interest rate	-0.057	-0.055	-0.051
(t)	(-1.347)	(-1.299)	(-1.213)
One-year pre-announcement bidder return	-0.127***	-0.125***	-0.125***
(t)	(-5.919)	(-5.915)	(-5.943)
Constant	0.482	0.508	0.394
(t)	(0.851)	(0.907)	(0.697)
Observations	7667	7667	7667
Industry fixed effect	Y	Y	Y
Year fixed effect	Y	Y	Y

Table B7. Payment method, debt maturity and failure probability

This table reports results from probit regressions for the relation between debt maturity, financial distress and payment. The sample includes completed deals in SDC from 1990 to 2021. The dependent variable is an indicator for cash only payment. *Short maturity debt fraction* is short maturity debt divided by total long-term debt (Compustat DLTT + DD1), where the short maturity debt is long-term debt due within one year (DD1) in column (1), three years (DD1 to DD3) in column (2) and long-term debt due within five years (DD1 to DD5) in columns (3). Distress is an indicator variable equal to one if the acquirer is in the distress group. We use failure probability (Campbell, Hilscher and Szilagyi (2008)) to proxy for the severity of financial distress, sort firms each year into two groups based on the median of failure probabilities, and classify firms in the top group as distressed and those in the bottom group as healthy. We include control variables of acquirers' characteristics, defined in the appendix, industry- and year-fixed effects, and cluster standard errors at the firm level. * p<0.10 ** p<0.05 *** p<0.01.

Column	(1)	(2)	(3)
Dependent variable	Indicator of cash only payment		
Short maturity debt	One year	Three years	Five years
Distress	-0.216***	-0.216***	-0.248***
(t)	(-4.894)	(-4.091)	(-3.825)
Short maturity debt fraction	-0.228**	-0.117*	-0.049
(t)	(-2.112)	(-1.652)	(-0.749)
Short maturity debt fraction* Distress	-0.277*	-0.115	-0.021
(t)	(-1.867)	(-1.201)	(-0.237)
Cash	-0.409***	-0.452***	-0.460***
(t)	(-3.372)	(-3.749)	(-3.809)
Log sale	0.120***	0.122***	0.131***
(t)	(9.475)	(9.561)	(10.279)
Market-to-book ratio	-0.062***	-0.063***	-0.064***
(t)	(-4.433)	(-4.577)	(-4.650)
Tangibility	0.007	0.022	0.040
(t)	(0.056)	(0.177)	(0.319)
Dividend	3.004**	2.918**	2.669**
(t)	(2.190)	(2.143)	(1.967)
R&D expenses	2.222	2.231	2.397
(t)	(1.058)	(1.063)	(1.145)
Relative size of target to bidder	-0.362***	-0.361***	-0.363***
(t)	(-5.610)	(-5.603)	(-5.555)
Horizontal	-0.001	0.003	0.007
(t)	(-0.038)	(0.069)	(0.193)
Public target	-0.737***	-0.739***	-0.740***
(t)	(-15.995)	(-16.014)	(-15.983)
10-year interest rate	-0.056	-0.054	-0.050
(t)	(-1.244)	(-1.212)	(-1.129)
One-year pre-announcement bidder return	-0.151***	-0.148***	-0.149***
(t)	(-6.368)	(-6.330)	(-6.360)
Constant	0.420	0.437	0.352
(t)	(0.754)	(0.795)	(0.634)
Observations	6817	6817	6817
Industry fixed effect	Y	Y	Y
Year fixed effect	Y	Y	Y