Pension Deficits and the Design of Private Debt Contracts

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Abstract

We find a positive relation between the amount of pension deficits and the cost of bank loans. Borrowers with larger pension deficits are also more likely to violate covenants in the future. The effect of pension deficits on the costs of bank loans is driven by financial constraints, information asymmetry problems, and higher pension investment risk. Banks tighten lending terms for firms with larger pension deficits by requiring collateral, increasing the number of loan covenants and shortening loan maturity. Collectively, these findings indicate that pension deficits represent an additional source of risk priced by banks.

JEL Classifications: G3; G32;

Keywords: Defined benefit pensions, cost of bank loans, collateral, covenants, maturity, financial constraints, information asymmetry.

I. Introduction

Recent years have witnessed increasing concerns about the underfunding of defined benefit (DB) corporate pension plans [see for example, Bartram (2016) and Franzoni and Marin (2006)]. Extant research reveals that understanding pension funding level is rather complex due to numerous regulations and actuarial assumptions (Bergstresser, Desai and Rauh, 2006; Cocco and Volpin, 2013; Comprix and Muller, 2011). In addition, simply focusing on the size of pension plan deficits and ignoring the risks of pension assets and liabilities may give an incomplete picture of the risks arising from the pension plan (Cocco, 2014). Indeed, prior empirical studies examine the stock market reaction to pension funding decisions and yield mixed results. Franzoni and Marin (2006) document that stock markets underreact to the level of pension underfunding, suggesting that investors do not fully comprehend the risk of pension liabilities. On the other hand, Jin, Merton and Bodie (2006) find that the risk of the pension plan is incorporated in the systematic risk of the firm.

Our objective in this paper is to understand the implications of pension underfunding for bank lenders. We focus on banks for several reasons. First, the superior information access and processing ability provides banks with an information advantage over other financial market participants (Ertugrul et al., 2017). Given their information advantage, banks might assess the value of the borrower's DB pension plan more accurately. As such, the terms of credit offerings of these informed lenders are more likely to reflect the costs of pension underfunding. Second, given that bank loans are one of the largest source of funds for corporations (Graham, Li and Qiu, 2008; Hasan et al., 2014), and play a crucial role for firms' operating flexibility and financing real investment activities (Valta, 2012), examining the effect of pension funding policies on the costs of bank loans sheds further light into the financing costs of DB pension sponsors.[1]

[1] Graham, Li and Qiu (2008) document $780 billion in net debt security issuances and only $2 billion for equities over the last decade, with bank loans accounting for 54% of total debt issues.

We argue that banks charge higher risk premiums on loan to borrowers with large pension underfunding. A high level of pension underfunding (i.e., pension deficits) increases the likelihood of mandatory pension contributions, which, in turn, impose cash flow constraints on the sponsoring firm (Rauh, 2006). In addition, firms with underfunded pension plans have an incentive to manipulate pension accounting to manage earnings (Bergstresser, Desai and Rauh, 2006), which reduces financial reporting quality. Besides, a DB sponsoring firm facing a large pension deficit might attempt to reduce the deficit by investing in riskier assets in the pension plan (Anantharaman and Lee, 2014). This risk-shifting behavior is costly to the lender because it increases the volatility of pension contributions, hence the volatility of the borrower's cash flows. In anticipation of these issues, banks may charge higher loan premium to borrowers with large pension deficits. Taking altogether, we predict a positive relation between the size of pension deficits and loan costs.

An alternative view is that pension deficits may not have any impact on loan pricing because they may not convey additional information beyond what the bank already possesses. This is because through lending relationship and industry expertise, banks collect soft information about the borrower (Bharath et al., 2011; Dennis and Mullineaux, 2000; Diamond, 1991b; Sufi, 2007), which allows them to better understand the quality of the borrower despite the complex pension reporting and potential manipulation of pension assumptions. Pension contributions also bring tax benefits (Shivdasani and Stefanescu 2010). Larger pension benefits give rise to larger pension contributions, thus larger tax benefits, which increases cash flows and help offset the effect of pension contributions. These conflicting propositions suggest that the overall effect of pension deficits on loan pricing is ambiguous and is thus an empirical question that we attempt to answer.

We investigate the effect of pension deficits on loan costs using a sample of individual loan facilities for US non-financial and non-utility borrowers during the period 1982–2013. We find a positive relation between the amount of pension deficits and the cost of bank loans. A one standard deviation increase in pension deficits leads to an increase of 7.24 basis points (bps) in loan spreads indicating that the effect of pension deficits on loan costs is economically significant.

We use a two-stage self-selection model to address the potential endogeneity concern on how managers decide how much to contribute to the DB pension plan in anticipation of obtaining a new loan. In the first stage, following Shivdasani and Stefanescu (2010), we jointly estimate how firms (1) self-select into becoming pension plan sponsors and (2) determine the size of pension deficits conditional on being a DB sponsor. In the second stage, we examine the impact of the predicted value of pension underfunding obtained in the first stage on bank loan costs. Our results indicate that DB plan sponsoring firms pay lower loan spreads than non-sponsors; yet, conditional on being a DB sponsor, firms with larger pension deficits pay higher loan spreads.

We further perform propensity score matching to address the self-selection bias of pension underfunding. Our goal is to examine whether firms with large pension deficits would have been charged high loan rates if they had not had large deficits. Thus, our treatment firms are firms that have high pension deficits (above industry median) in a certain fiscal year, while our control firms are otherwise comparable firms with low pension deficits (below industry median).[2] Using the nearest neighbor matching and caliper matching methods, we find that on average, treatment firms pay significantly higher loan spreads than control firms.

As loan contract terms are determined jointly, the effect of pension deficits on the cost of bank loans might be biased if we fail to control for the simultaneity of loan contract terms. We address this issue using two approaches. First, we examine the effect of pension deficits on loan spreads across different subsamples stratified based on (a) collateral requirement; (b) covenants; and (c) maturity. We find that the effect of pension deficits on loan spreads remain consistent across these different strata.

[2] We compute the median pension deficit for each two-digit Standard Industrial Classification (SIC) industry in each fiscal year.

Second, we adopt a 2SLS framework similar to Bharath et al. (2011) to adjust for the simultaneous determination of loan price, collateral requirement, covenants and maturity. We find similar results using this 2SLS regression method. Overall, our findings are robust to various methods of addressing the endogeneity problem and the simultaneity of various loan contract terms.

Having established a positive relation between pension deficits and bank loan costs, we then examine the underlying channels driving this relation. We argue that pension underfunding affects loan pricing because it increases the degree of financial constraints, worsens information asymmetry problems, and induces risk-shifting activity in pension investments.

Pension obligations could reduce cash holdings and force firms to use costly external financing. External financing is more costly for firms that face greater financial constraints (Almeida, Campello and Weisbach, 2004; Franzoni, 2009; Rauh, 2006). Therefore, we argue that the effect of pension underfunding on loan costs will be more pronounced for firms with greater financial constraints. We use credit ratings, the Kaplan and Zingales (1997) (KZ) index, and the Hadlock and Pierce (2010) (HP) index as proxies for financial constraints and show that the effect of pension deficits on loan pricing exists only among financially constrained firms.

In addition, we conjecture that information asymmetry plays a crucial role on the effect of DB pension funding on the cost of borrowing. The complexity of pension accounting allows room for management's manipulation of pension items [see for example, Bergstresser, Desai and Rauh (2006)]. The opportunity of manipulating pension accounting is greater under more opaque information environments. Consequently, we show that the effect of pension deficits on loan costs is more pronounced for firms with higher information asymmetry problems. Moreover, we find the effect of pension deficits on loan costs to be stronger when firms adopt a high expected rate of returns or a high discount rate. The DB sponsoring firm might use pension assumed rates of returns as a tool to manipulate earnings (Bergstresser, Desai and Rauh, 2006; Choy, Lin and Officer, 2014). In particular, a higher assumed rate of return reduces the net pension periodic costs. This finding thus indicates that banks charge higher loan rates when there is indication that the borrower manipulates pension assumptions. Our empirical analyses support this information asymmetry hypothesis.

Besides the level of underfunding in the DB pension plan, the sponsoring firm has discretion to determine the plan's investment policy (Rauh, 2009). Cocco (2014) points out that the amount of pension underfunding may not fully reflect the risk of DB pension plans because it does not capture the mismatch between the risk of pension liabilities and that of pension assets. As such, we examine the combined effect of pension underfunding and the risk of pension investment policy on loan costs and find that the effect of pension deficits on loan costs is acutely strong when the borrower adopts a risky investment strategy in the pension plan. In other words, banks take into account the risk of pension underfunding and investment policy in setting loan costs.

In additional tests, we explore whether the effect of pension deficits varies over time due to changes in investors' awareness of the issues underlying DB pension plans. Franzoni and Marin (2006) point out that investment firms started to pay attention to pension funding and reporting in 2003, following poor performance of DB pension funds that led to an overall loss of $400 billion for US DB plans from 2000 to 2002. We examine whether the impact of pension deficit on loan costs is stronger in the post-2003 period, compared to the period before 2003, and find that the effect of pension deficits on loan costs is stronger in the post-2003 period, relative to the pre-2003 period. This indicates that banks pay more attention on pension deficits subsequent to 2003. We further examine whether banks use other features of the loan contract to reduce the risk posed by pension deficits. We find that banks impose more stringent covenants and collateral requirements and shorter loan maturity for borrowers with larger pension deficits. Borrowers with larger pension deficits are also more likely to violate covenants in the future. Collectively, these findings are consistent with our conjecture that banks tighten lending standards when DB pension plans are underfunded.

Our study makes three main contributions to the existing literature. First, we contribute to the recent literature on the costs and design of bank loan contracts. Existing studies emphasize the importance of financial reporting quality (Bharath, Sunder and Sunder, 2008; Ertugrul et al., 2017; Graham, Li and Qiu, 2008); lender protection (Bae and Goyal, 2009; Qian and Strahan, 2007); ownership structure (Lin et al., 2011, 2012); shareholders rights (Chava, Livdan and Purnanandam, 2009); lending relationship (Bharath et al., 2011); lending syndicate-related issues (Ivashina, 2009; Ivashina and Sun, 2011); tax aggressiveness (Hassan et al., 2014); industry risk (James and Kizilaslan, 2014); product market competition (Valta, 2012), social capital (Hasan et al., 2017), among others, in explaining loan contract design. We contribute to this literature by showing that bank impose higher loan costs and stricter loan terms for borrower with larger pension underfunding. The impact of pension underfunding on bank loan costs is more pronounced among firms with higher information asymmetry, firms facing severe financial constraints, and firms with higher pension investment risk.

Second, we extend the literature on the effect of pension obligations on firms' cost of capital. Campbell et al. (2012) show that mandatory pension contributions increases firms' cost of equity and cost of bonds. We document that, pension deficits, rather than mandatory pension contributions, play an important role in explaining the costs of bank loans. The impact of pension deficits on loan costs is predominantly evident in firms with riskier pension asset allocation. Thus, pension underfunding and the risk of plan assets interact closely in determining debt financing costs.

Our results also shed new lights on how market participants process pension underfunding information. Franzoni and Marin (2006) document that share market participants do not fully understand the extent of pension deficits, hence underestimating the risk of pension deficits. We find that this is not the case for banks, since bank lenders charge higher cost for borrowers with larger pension deficits. Our results are consistent with the notion that banks are more informed about the borrower than the public as they acquire proprietary information in due diligence and monitoring activities (Bharath et al., 2011; Dennis and Mullineaux, 2000; Diamond, 1991b; Sufi, 2007). Given that bank credit is the most common source of funds for US corporations (Bharath, Sunder and Sunder, 2008), our findings indicate that the economic consequences of mismanaging DB pension plans have significant implications for lenders and pension plan sponsors.

The remainder of this paper proceeds as follows. Section II presents the hypothesis development. Section III describes the data collection, and the regression method. We present our main results on the effect of pension deficits on loan costs and the empirical analyses that address endogeneity in Section IV. In Section V, we discuss the economic mechanisms through which pension deficits influence loan pricing. We then discuss the effects of pension deficits on various non-price loan terms in Section VI. We document additional tests and robustness checks in Section VII. Section VIII concludes.

II. Significance of Pension Deficits and Hypothesis Development

This section discusses the rationale on the impact of deficits on bank loan costs and highlights our expectation regarding the relation between DB pension deficits and loan costs. DB pension plans are retirement income schemes in which employers specify the payment amount made to the employees upon retirement. The DB pension sponsor is liable for the present value of the employee's future benefits, including expected salary increases. Moreover, the employer is required to pay insurance premiums on insufficient DB funds. Therefore, the balance of a DB pension plan has significant implications for the sponsoring firm's economic value.[3]

We argue that the effects of pension deficits on firm value and corporate decisions are rather complex compared to other types of debt. First, it is relatively difficult to estimate the true liabilities under a DB pension plans, because contributions are amortized over a number of years. Second, as management has considerable discretion over pension actuarial assumptions, pension obligations are more prone to accounting manipulation (Bergstresser, Desai and Rauh, 2006; Choy, Lin and Officer, 2014; Comprix and Muller, 2011). This practice potentially obscures the true costs of the DB plan. Third,

[3] We provide detailed discussion of DB pension plan regulations and accounting rule changes affecting pension reporting in Section A of the internet appendix.

besides pension liabilities, the *net* pension obligations are determined by the value of pension assets. The value and volatility of pension assets therefore could influence the value and volatility of pension obligations. Anantharaman and Lee (2014) find evidence that risk shifting through investing pension plan funds in risky asset classes is stronger when top managers have high wealth-risk sensitivity (vega). This finding shows that management could affect the net pension liabilities not only through the manipulation of pension accounting but also through excessive risk-taking in pension asset allocation.

Fourth, pension obligations are distinct from other debt obligations in terms of tax treatment. Specifically, additional contributions beyond the minimum requirement is tax-deductible, whereas prepayment of debt does not provide additional tax benefits (Shivdasani and Stefanescu, 2010). Finally, pension obligations are protected by the Pension Benefit Guaranty Corporation (PBGC).[4] In most cases, the minimum funding requirements take priority over other types of debt. This implies that when the sponsoring firm goes bankrupt, banks' claims are likely to rank behind pension obligations.[5] In comparison, the literature suggests that other types of debt tend to rank behind bank debt (Diamond, 1993; Rajan and Winton, 1995). These issues highlight the unique features of pension obligations, as opposed to other types of debt. More importantly, in our context, we argue that pension obligations are acutely important for bank lenders, as pension regulations imply that the PBCG may override bank's seniority during bankruptcy proceedings.

The funding status of DB pension plans might increase the cost of borrowing because of the following reasons. First, when a company's DB pension liabilities exceed its DB pension assets by a predetermined threshold, the firm is required to make mandatory contributions to cover the accrued

[4] The PBGC is a government-owned entity managed by the US Department of Labor that is responsible for making pension payments to employees of defaulted companies.

[5] If the PBCG files for bankruptcy when the sponsor does not meet the minimum contributions, its claim has the most senior status. In other cases, while the PBCG generally has the most senior claim, some proportions of the funding shortfall might be treated as unsecured debt, or the court might reduce the size of the claim. See Shivdasani and Stefanescu (2010) for further details.

benefits over the year, as well as a part of its current deficit. Therefore, pension underfunding increases the pension insurance premium and the risk of making mandatory contributions, which, in turn, increases the chances of experiencing a cash shortfall. Prior research shows that firms reduce their capital investments due to significant financial constraints (Campello, Graham and Harvey, 2010). This issue is particularly severe for firms making mandatory contributions to their DB pension plans (Rauh, 2006, 2009). Alternatively, firms with severely underfunded DB plans may raise funds from external markets to finance new investments. However, market frictions such as information asymmetry and agency problems make external financing more expensive than internal funds, leading to an increase in the overall cost of capital (Campbell, Dhaliwal and Schwartz, 2012).

Second, we argue that banks increase interest premiums to borrowers with large pension deficits because the latter has an incentive to manipulate pension actuarial assumptions. Bergstresser, Desai and Rauh (2006) find that firms with large pension deficits attempt to boost earnings by adjusting the assumption of the long-term rate of return for pension assets. Firms also manage/manipulate actuarial assumptions to compute a firm's pension liability to increase reported earnings to meet/exceed analyst forecasts (An, Lee and Zhang, 2014) or to decreases pension liabilities and perceived underfunding (Asthana, 1999). For example, Comprix and Muller (2011) show that DB plan sponsors assume downward biased pension assumptions to make their plans appear more costly in the year they decide to ‘‘hard’’ freeze their defined benefit pension plans. Moreover, Cocco and Volpin (2013) report that firms with underfunded pensions are less likely to be a target of mergers and acquisitions, since acquirers find that it is difficult to value the pension obligations due to the complexity of estimating the amount of pension contributions and their tax treatments. The prior literature on bank loan contracting reveals that banks charge higher loan rates when information asymmetry is higher. For example, Bharath, Sunder and Sunder (2008) and Ertugrul et al. (2017) report that accounting information quality, as well as the readability of annual reports, has a significant impact on loan costs. In a similar vein, Graham, Li and Qiu (2008) document that banks charge higher interest rates following financial report restatements. We thus argue that firms with higher pension deficits will experience information asymmetry problems, which increase the costs of borrowing.

Besides the size of pension deficits, managers in the DB sponsoring firm has discretion over the investment of pension assets. For example, Anantharaman and Lee (2014) find evidence that allocation to risky assets in pension plans increases with managers' risk-taking incentive, as proxied by managers' wealth-risk sensitivity. Thus, when facing with a large deficit, the sponsoring firm may engage in risk-shifting through the pension plan in order to reduce the deficit. Excessive risk-taking in pension plans may cause significant losses, which, in turn, leads to lost investment opportunities or financial distress (Rauh, 2006, 2009). Given that this increases the borrower's risk of financial distress, bank lenders should charge higher risk premiums.

On the other hand, banks have proprietary access to the borrower's information through maintaining a long-term relationship with the borrower and through monitoring activities (Bharath et al., 2011; Boot and Thakor, 2000; Diamond, 1984; Fama, 1985). Such information advantage implies that banks may be able to assess the riskiness of the borrower's pension plan. This suggests that the size of pension deficits may not convey additional information beyond what the bank already possesses, hence are not related to the costs of borrowing. In addition, since pension contributions are tax deductible (Campbell, Dhaliwal and Schwartz, 2012; Shivdasani and Stefanescu, 2010), larger contributions carry larger tax savings. Shivdasani and Stefanescu (2010) find that on average, the tax benefits from pension plans are approximately 1.5% of firm value. The tax shields from pension contributions are also substantial, amounting to a third of interest tax shields. The tax benefits of pension contributions could therefore increase cash flows and reduce firms' incentive to increase debt for tax reduction purposes. The tax benefits associated with pension contributions could offset the negative effect of pension contributions. These offsetting effects imply that pension deficits might not have a significant impact on loan pricing. These conflicting propositions suggest that the overall effect of pension deficits on loan pricing is ambiguous and is thus an empirical question that we attempt to answer.

III. Data and Research Design

We discuss the computation of the pension underfunding ratio in Section III.A and present the sample selection procedure in the Section III.B. We present our baseline regression model in Section III.C.

A. Measuring Pension Deficits

Following Franzoni and Marin (2006), we measure the extent of pension deficits using the ratio of the difference between pension liabilities and pension assets to the sponsoring firm's market capitalization. We obtain the DB pension data from Compustat Pension Annual Files.[6] The fair value of pension assets (*FVPA*) is the sum of employer contributions and the market value of the plan's investments, minus benefits paid. The value of pension liabilities is equal to the actuarial present value of employee benefits, plus expected benefits due to salary increase (*PBO*). The pension deficit ratio is the ratio of *PBO* minus *FVPA* to the market value of the firm's equity:

(1) $DEFICIT = (PBO - FVPA)/MARKET\_CAP$,

where, *PBO* denotes the projected value of pension benefits; *FVPA* denotes the fair value of pension assets; *MARKET_CAP* denotes the market capitalization of the firm's equity. For ease of interpretation, we take the difference between the projected pension obligations and the fair value of pension assets—as opposed to the difference between *FVPA* and *PBO* used by Franzoni and Marin (2006)—so that the ratio in Equation (1) reflects the amount of *underfunding* (or deficit) of the pension plan. The denominator is the sponsor's market capitalization, which equals the total number of common shares outstanding multiplied by the share price reported for the same fiscal year. If the pension plan is underfunded (hence $FVPA < PBO$), the pension funding ratio is positive. If the pension plan is overfunded ($FVPA > PBO$), this ratio becomes negative.

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[6] Over the sample period, pension reporting was subject to several rule changes. These changes lead to changes in pension data reported in Compustat. We follow the procedure outlined in Franzoni and Marin (2006) to account for these changes.

B. Loan Sample

After obtaining the funding ratio for firms with DB plan and other firm characteristics from the Compustat, we match these attributes to the DealScan database using the linking table provided by Chava and Roberts (2008).[7] Our sample starts in 1982, the first year DealScan reports loan data. Following (Bharath et al., 2011; Bharath, Sunder and Sunder, 2008; Chava, Livdan and Purnanandam, 2009) , we treat each loan facility as an individual loan. We exclude financial and utilities firms (SIC code falls between 6000 and 6999, and 4900 and 4999) and firms with missing or negative assets and sales. Similar to Kahle and Stulz (2013), we further remove firms whose share price is less than US $1. Our final sample includes 10,298 loan facilities granted to DB sponsoring firms from 1982 to 2013. There are 6,353 firm-year observations from 1,670 unique firms.

Table 1 shows the summary statistics of our sample. On average, DB pension deficits amount to about 4% of the sponsor's market capitalization. The average size of the sample firms is US$ 6.042 billion. The average total leverage ratio is 0.291 and the average ratio of tangible assets to total assets (*PPE*) is 0.325.[8] Our sample firms, on average, hold 7% of assets in cash and other liquid assets. The average firm's profitability (*ROA*) is 13.7%. The market-to-book ratio (*MTB*) is 1.279. The average Z-score and earnings volatility are 1.876 and 0.781, respectively. In addition, the statistics of the rating number (*RATING*) indicate that a large proportion of our sample firms in our sample are either not rated or below investment grade. This is consistent with Diamond (1991b)'s argument that lower graded firms tend to rely on banks, whereas higher graded firms are more likely to tap the public bond markets. Bharath et al. (2011) also report that a large proportion of borrowers in their sample is not rated. Overall, these statistics show that our sample firms have similar characteristics relative to those reported in previous

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[7] We thank Michael Roberts for providing the linking table. The file is accessible at http://finance.wharton.upenn.edu/~mrrobert/styled-9/styled-12/index.html.

[8] We measure the total financial leverage as the ratio of total debt to total assets. Total debt does not include non-debt liabilities. As a result, pension liabilities are not part of the leverage ratio.

studies (Anantharaman and Lee, 2014; Hasan et al., 2014; Lin, Ma and Xuan, 2011; Valta, 2012). With respect to loan characteristics, the average spread is 178 bps over the LIBOR (or LIBOR-equivalent) rate. The average size of these loans is US$ 469 million and the average maturity is about four years. Furthermore, over 90% of our sample loans are syndicated loans. This is consistent with the sample of Hasan et al. (2014) who also report a higher percentage of syndicated loans (approximately 81%).

[Insert Table 1 here]

C. Research Design: Effect of Pension Deficits on Loan Costs

We examine the relation between DB pension deficits and the costs of bank borrowing based on the following equation:

(2) $SPREAD_{j,i,t} = f(DEFICIT_{i,t-1}, FIRMCHAR_{i,t-1}, LOANCHAR_{j,i,t}, MACRO_{t-1}, FIXED\ EFFECTS)$,

where $SPREAD_{j,i,t}$ is the natural logarithm of the *all-in spread drawn* item from DealScan database for loan facility *j* obtained in year *t* by firm *i*. $DEFICIT_{i,t-1}$ is the ratio of the difference between pension liabilities and the pension asset value of firm *i*, scaled by market capitalization, as of year $t-1$. Following Hasan et al. (2014) and Valta (2012), we control for firm characteristics that influence the pricing of bank loans: firm size (*LOGASSETS*), leverage ratio (*LEVERAGE*), asset tangibility (*PPE*), cash holdings (*CASH*), profitability (*ROA*), the market-to-book ratio (*MTB*), earnings volatility (*EARNVOL*), and the Z-score (*Z_SCORE*). We further control for loan-specific attributes, namely, the natural logs of loan maturity (*LNMATURITY*) and loan size (*LNSIZE*), an indicator variable for whether the loan is syndicated loan or bilateral loan (*SYNDICATION*), and loan type and loan purpose fixed effects. Other control variables are macroeconomic conditions (*MACRO*) using the term structure of interest rates and the credit default spread (Valta, 2012). The term structure of interest rates (*TERMSTR*) is the yield spread between 10-year government bonds and three-month Treasury bills. We measure the credit spread (*CRSPREAD*) as the difference in yield between AAA and BAA corporate bonds. We also control for credit rating fixed effects. Finally, we include year and industry fixed effects to control for time- and industry-invariant factors. Further details on these variables are available in Appendix. All continuous variables are winsorized at the 1st and 99th percentiles to account for outliers.

IV. Pension Deficits and the Costs of Bank Loans

This section presents our main findings on the effect of pension deficits on the costs of bank loans. We discuss our baseline results in Section IV.A. We discuss the results addressing endogeneity issues in Section IV.B and the results addressing the joint determination of loan terms in Section IV.C.

A. Baseline Regression Results

We report our baseline results for the impact of the pension deficits on the cost of bank loans in Table 2. Model 1 in Table 2 presents the impact of pension deficits on the cost of bank loans without controlling for any other factors besides year and industry fixed effects. Model 2 accounts for firm-level control variables. Model 3 augments Model 2 with loan-level control variables. Model 4 includes firm- and loan-level controls, as well as the term structure of interest rates and the credit spread. All models include year and industry fixed effects. In all models, the coefficients of the pension deficit ratio are positive and significant at the 1% level, suggesting that banks charge premiums when the DB plan becomes more underfunded. This effect is both statistically and economically significant. As the dependent variable is a logarithm, the coefficient of *DEFICIT* in the full model (Model 4) indicates that a one unit increase in DB pension deficit is associated with a 25.22% change in the loan spread. Thus, a one standard deviation increase in *DEFICIT* leads to an increase of 4.06% in the loan spread (16.1%×25.22%=4.06%). Given the average loan spread is 178.224 bps, a one standard deviation increase in the deficit ratio leads to an increase of 7.24 bps (4.06%×178.224 bps) in interest charged on the loan.

The coefficient of total financial leverage in the full Model 4 is statistically and significantly positive indicating that leverage also has significant impact of bank loan costs. With respect to economic significance, a one standard deviation increase in total leverage leads to an increase of 20.91 bps in loan spreads. Given that pension deficits are not part of the leverage ratio, pension deficits have incremental impact on loan pricing in addition to the effect of financial leverage. For comparison, a one standard deviation increase in tax aggressiveness leads to an increase of 4.87 bps in loan spreads (Hasan et al., 2014). To ensure that the effect of pension deficits document in Model 4 is robust to alternative measures of financial leverage, we also employ the following measures of financial leverage: the ratio of long-term debt to total assets, the ratio of total debt to market capitalization and the ratio of long-term debt to market capitalization. We replace our original leverage measure (total debt to total assets) with the ratio of long-term debt to total assets, the ratio of total debt to market capitalization and the ratio of long-term debt to market capitalization in Models 5, 6 and 7 respectively. We find that the pension deficit ratio (*DEFICIT*) is positive and significant in all these additional models.[9] Overall, our analyses here show that the effect of pension deficits on loan spreads remains economically significant and have incremental impact on loan pricing in addition to the effect of financial leverage.

The estimated coefficient of the log of total assets is significantly negative in all models, suggesting that larger firms pay lower loan costs because they are safer firms. Moreover, they tend to have more bargaining power, since they are likely to have access to multiple financial markets (Billett, King and Mauer, 2007; Diamond, 1991b). The estimated coefficients of *ROA* and *MTB* are significantly negative, indicating that profitable firms (with a higher *ROA*) and firms with higher growth opportunity can borrow loans at lower costs. On the other hand, riskier borrowers—those with a higher leverage ratio, a lower Z-score, or more volatile earnings—pay a higher loan spread, consistent with Hasan et al. (2014) and Valta (2012). Overall, the results documented in Table 2 support our main hypothesis that higher pension deficits are associated with higher costs of borrowing.

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[9] In untabulated results we find that the estimated coefficient of *DEFICIT* is significantly positive when we exclude LEVERAGE in model 4. Similarly we find that the estimated coefficient of leverages is significantly positive when we exclude DEFICIT in models 5-7.

[Insert Table 2 here]

B. Endogeneity between Pension Deficits and Loan Spreads

We show in our baseline regression results that the pension deficit ratio has a significant and positive relation with loan costs. There is a possibility that managers decide how much to contribute to the DB pension plan in anticipation of obtaining a new loan. In other words, firms can self-select (1) into being a DB sponsor or not being a DB sponsor and (2) the extent to which the DB plan is underfunded (i.e., the size of the deficit).

We address this issue using a two-staged least squares (2SLS) model with an adjustment for self-selection bias and size of the pension deficits conditional on sponsoring DB pension [see Shivdasani and Stefanescu (2010) and Chang, Kang and Zhang (2012)]. In the first stage, we estimate the following equations simultaneously:

(3) $DBDUMMY_{i,t} = f(TENURE_{k,t-1}, UNION_{k,t-1}, CONTROLS_{i,t-1}, YEAR\ AND\ INDUSTRY\ FIXED\ EFFECTS)$,

(4) $DEFICIT_{i,t} = f(TENURE_{k,t-1}, PLAN\_AGE_{i,t-1}, CONTROLS_{i,t-1}, YEAR\ FIXED\ EFFECTS)$.

Equation (3) is a probit regression that models the choice between being a DB sponsor and not being a DB sponsor ($DBDUMMY_{i,t}$). The dependent variable is a binary variable that equals one if the firm has a DB pension plan and zero otherwise. We classify firm *i* as a DB sponsor in year *t* if information about firm *i*'s pension assets is available in Compustat for the fiscal year *t*. Following Shivdasani and Stefanescu (2010), our instruments for the pension choice include the industry median employee tenure ($TENURE_{k,t-1}$,) and the industry union rate ($UNION_{k,t-1}$). We collect industry median employee tenure data from the US Bureau of Labor Statistics. We measure the degree of unionization at the industry level, as the proportion of workers covered by a union within an industry. Industry unionization data are collected from the Union Membership and Coverage Database by Hirsch and Macpherson (2003).

Ippolito (1985) argues that DB pension plans induce employees to stay with the sponsor longer, thus increasing employee tenure. Therefore, employee tenure has a positive relation with the decision to sponsor DB plans. On the other hand, there should be no direct link between industry median employee tenure and individual firms' costs of borrowing. The degree of industry unionization reflects the collective bargaining power of workers in an industry, which can influence the adoption of DB pension plans by firms within the industry. The unionization rate should be uncorrelated with the funding status of DB pension plans (Shivdasani and Stefanescu, 2010).

Equation (4) estimates the size of the pension deficit ratio. The instrumental variables for the size of pension deficits include the DB plan's age ($PLAN\_AGE_{i,t-1}$,) and the industry median employee tenure ($TENURE_{k,t-1}$,). Atanasova and Gatev (2013) find a positive relation between plan age and pension investment returns. Therefore, the DB plan's age is expected to have a negative effect on pension deficits (Chang, Kang and Zhang, 2012). In addition, employee tenure could influence the size of pension deficits due to human capital needs (Shivdasani and Stefanescu, 2010). Firms operating in industries with strong human capital investment needs have an incentive to minimize the extent of pension underfunding to reduce employee turnover. We include all control variables used by Shivdasani and Stefanescu (2010) in the simultaneous Equations (3) and (4). In Equation (3), the control variables include the natural logarithm of firm assets (*LOGASSETS*); the market-to-book ratio (*MTB*); earnings volatility (*EARNVOL*); profitability (*ROA*); the ratio of plant, property, and equipment to total assets (*PPE*), industry and year fixed effects. In Equation (4), besides the variables mentioned above, we also include the Z-score to control for the borrower's default risk (*Z_SCORE*), a dummy variable indicating the firm has negative equity (*NEG_EQUITY*), and year fixed effects. As we employ a 2SLS procedure, we use bootstrapped standard errors with 500 replications to correct for any potential correlation of residuals across firms and across time.

The results of the simultaneous equations in the first stage are reported in Models 1 and 2 in Panel A of Table 3. We also present the first-staged diagnostic tests statistics in Panel A. Model 1 reports the results of the pension choice equation and Model 2 shows the results of the pension deficit equation. We find that more profitable firms and firms with more tangible assets (*PPE*) are most likely to sponsor DB pension plans. Employee tenure (*TENURE*) is negatively correlated with the choice of DB pension plan, similar to the results in Chang, Kang and Zhang (2012). The estimated coefficient of the ratio of unionization (*UNION*) is positive and significant, indicating that stronger employee bargaining power induces the DB sponsor decision. As can be seen in Model 2, we show that smaller, less profitable firms with a lower Z-score or negative book equity tend to be more underfunded. Young pension plans are more underfunded, consistent with the findings of Atanasova and Gatev (2013). The Wald F statistic is 27.03, and is significant at 1%. Thus, we reject the null hypothesis that all coefficients in our first-staged model is zero. The test of independent equations is significant, indicating that there is a selection bias. In addition, the signs of lambda and rho are negative, suggesting that the unobservable factors determining pension plan choice are negatively correlated with pension funding size. Overall, our coefficient estimates in Panel A are consistent with those of Chang, Kang and Zhang (2012) and Shivdasani and Stefanescu (2010).

We obtain the predicted values of the pension deficit ratio for firm *i* for each fiscal year using the simultaneous Equations (3) and (4), which we then use as the input in the following model:

(5) $SPREAD_{j,i,t} = f(DBDUMMY_{i,t-1}, EDEFICIT_{i,t-1} \times DBDUMMY_{i,t-1}, LOANCHAR_{j,t}, FIRMCHAR_{i,t-1}, MACRO_{t-1}, FIXED\ EFFECTS)$.

Equation (5) is identical to the baseline model, Equation (2), except that we replace the pension deficit ratio with the DB pension dummy variable ($DBDUMMY_{i,t-1}$) and the predicted value of the pension deficit ratio interacted with the DB dummy variable ($EDEFICIT_{i,t-1} \times DBDUMMY_{i,t-1}$). We are interested in whether our baseline results remain robust after controlling for the self-selection issues of pension plan choice and pension underfunding. We report the results of the Equation (5) in Model 3 of

Panel A of Table 3.[10] We also present the second-stage diagnostic tests statistics. The Durbin-Wu-Hausman test of endogeneity produces a χ^2 of 8.005 and is significant at the 5% level, indicating that loan spreads and pension deficits have an endogenous relation. The χ^2 obtained from the Anderson canonical correlations test is 71.878 and is significant at the 1% level; thus, we reject the null hypothesis that the model is under-identified. The Cragg-Donald Wald F statistic also shows that the instruments used in the first stage are valid instruments, under the Stock and Yogo (2005) critical values.

The negative coefficient of the sponsor dummy variable indicates that DB plan sponsoring firms pay a lower loan spread. This is consistent with Edmans and Liu (2011), who find that debt-like compensation (such as DB pensions) aligns the CEO's interest with debtholders' interest, hence reducing the firm's risk taking. Similarly, Choy, Lin and Officer (2014) show that firms take on more risk following the freezing of DB pension plans. This includes increasing leverage and investment in risky assets (i.e., R&D investment). Conditioned on being a DB sponsor ($DBDUMMY_{i,t-1}$=1), however, deficit firms pay higher loan spreads. This is consistent with our baseline results and suggests that banks charge higher risk premiums when pension deficits increase.

Falato and Liang (2016) find that union elections that increase employee bargaining power also increase loan spreads. Moreover, Matsa (2010) finds that firms with excess cash increase leverage to discourage workers from demanding higher wages. This incentive is stronger in the presence of organized labor unions. As an increase in leverage increases the costs of new loans (Bharath, Sunder and Sunder, 2008; Valta, 2012), the costs of bank loans may also be correlated with the level of unionization. However, when we examine the relation between loan costs and unionization using the baseline model [we replace the deficit ratio by the unionization rate and re-estimate Equation (2)], we find that the unionization rate has no significant relation with the loan spread.

[10] The sample for this test includes loans obtained by both DB and non-DB sponsors. Consequently, the number of observations is 29,046 loans, larger than the main sample of 10,298, which include only loans from DB-sponsoring firms. When the borrower is a non-DB sponsor, we assign the value of zero to its pension deficit ratio.

Nevertheless, to circumvent the sensitivity of our results to the selected instruments, we attempt to address the self-selection bias concern using propensity score matching. The goal is to compare the costs of loans extended to borrowers with large pension deficits and those to borrowers with small pension deficits. We use the yearly two-digit SIC industry median of the pension deficit ratio as the cut-off value and define firms with large (small) pension deficits as those with above (below) median pension deficits. Firms with large pension deficits are our treatment firms, so that our treatment group includes loans granted to these firms. Similarly, firms with small pension deficits are our control firms, and our control group is comprised of loans to these firms. We estimate the probability of being assigned to the treatment or control group using a logit regression with all firm-level, loan-level and macroeconomic-level control variables as specified in the baseline regression [Equation (2)]. We then use the propensity score to perform one-to-one nearest neighbor matching without replacement. One limitation of the nearest neighbor matching method is that it might generate bad matches if the propensity score of the treated observation is far away from the propensity score of the best matched control observation. To avoid this issue, we also perform caliper matching with a caliper of 10%. This algorithm imposes a maximum propensity score distance of 10%, thus excluding all matches where the distance is above 10%. We report the average treatment effect estimates in Panel B. We find that the loan spread is higher for firms in the treatment group, relative to firms in the control group. Taken together with the results of the 2SLS regressions presented above, these findings shows that our main findings remain robust to controlling for self-selection bias.

[Insert Table 3 here]

C. Joint Determination of Loan Contract Terms

In our baseline model, we study the effect of pension deficits on interest costs, while controlling for other loan characteristics. As loan contract terms are determined jointly, we examine the effect of pension deficits on the cost of bank loans addressing issue of simultaneity of loan contract terms in this section. We perform two tests to address this issue. First, following Hollander and Verriest (2016), we estimate the baseline model [Equation (2)] across loan observations with different maturity, covenant intensity and collateral requirement. In particular, we stratify the sample based on (1) collateral requirement (into firms with collateral and no collateral); (2) covenants (into firms with below median and equal to or above median covenants); and (3) maturity (into less 24 months, equal to or greater than 24 months but less than or equal to 60 months, and greater than 60 months). If the effect of pension deficit on loan spread is affected by the interdependencies of loan contract terms, we should observe a significant positive coefficient for pension deficits in one sample and possibly an insignificant coefficient for pension deficits in the other. We report the results on the impact of pension deficits on loan costs for these subsamples in Table 4. The estimated coefficients of the pension deficit ratio are significantly positive across all subsamples (Models 1 to 7), indicating that the effect of pension deficits on loan costs is not affected by the joint determination of loan contract terms.

Second, we use the 2SLS method to address the joint determination of loan terms, following prior literature (Bharath et al., 2011; Dennis, Nandy and Sharpe, 2000; Hollander and Verriest, 2016). We provide detailed discussion of this method in Section B of the internet appendix and report the results of the second-stage regression in Model 8. The estimated coefficient of *DEFCIT* is significantly positive, indicating that the effect of pension deficit on loan costs is not driven by the joint determination of loan contract features. The coefficient of *DEFICIT* is 0.2452. The standard deviation of *DEFICIT* in this sample is 0.169, and the average loan spread is 154 bps. This indicates that a one standard deviation increase in the deficit ratio leads to a 4.15% increase in loan spreads, or 6.39 bps. We also conduct a number of instrument validity tests. First, we test whether loan maturity, loan security and covenant intensity are indeed endogenous with the Durbin-Wu-Hausman test. The Durbin-Wu-Hausman χ^2 statistic is 88.71, highlighting that loan spread and other non-price loan terms are endogenous, and thus supporting the use of instrumental variables for the non-price loan features in the second-staged regression. Second, we report the Anderson-Rubin Wald χ^2 statistic from testing whether the instruments are jointly zero, and thus are not valid instruments. The Anderson-Rubin Wald χ^2 is 7.5 and is significant at the 1% level. We thus reject the hypothesis that all instruments are jointly zero.

Next, we control for both the simultaneity bias of loan terms and the self-selection bias of pension sponsoring. Specifically, we use the predicted deficit ratio adjusted for self-selection bias (*EDEFICIT*) obtained from Equation (4) and re-estimate the second-staged regression. We present the results in Model 9 of Table 4. We find that the estimated coefficient of the predicted deficit ratio on loan spread significantly positive at the 5% level, indicating that our main result is robust to both the simultaneity bias and the self-selection bias. The coefficient of *EDEFICIT* is 0.5992. The standard deviation of *EDEFICIT* is 0.056. Thus, a one standard deviation increase of pension deficits leads to a 3.33% increase in loan costs, or 5.13 bps. Overall, the tests reported in Table 4 show that the effect of pension deficits on loan costs remain statistically and economically significant after we control for the joint determination of various loan terms.

[Insert Table 4 here]

V. Economic Mechanisms

In the preceding discussion, we demonstrate that banks impose higher loan costs to firms with higher pension deficits. In this section, we examine the role of (1) financial constraints, (2) information asymmetry problems, (3) risk-shifting through pension asset allocation, on the effect of pension deficit on cost of bank loans. We explore each of these channels in the following sections.

A. Financial Constraints and DB Pension Risk

Firms facing greater financial constraints incur larger deadweight loss due to financial frictions, such as higher adverse selection costs and more severe credit rationing (Campbell, Dhaliwal and Schwartz, 2012). Consequently, cash holdings play a crucial role in financing profitable investments, especially among financially constrained firms. For example, Sufi (2009) documents that firms with low levels of cash flows rely on internal liquidity (cash holdings) rather than external liquidity provided by bank lines of credit. Furthermore, financially constrained firms systematically attempt to save more cash out of cash flows (Almeida, Campello and Weisbach, 2004) and reduce their capital investments and forgo growth opportunities (Campello, Graham and Harvey, 2010; Rauh, 2006). Cash holdings are more valuable to these firms than to firms with easy access to financial markets (Faulkender and Wang, 2006). Larger pension deficits increase the risk of cash shortfalls because larger pension deficits require larger mandatory contributions (Cocco, 2014). Since the cash shortfalls will have a more severe impact on financially constrained firms, we argue that the effect of pension underfunding on the cost of bank loans should increase with the degree of financial constraints.

We use the firm's long-term issuer credit rating, the Kaplan and Zingales (2000) (KZ) index, and the Hadlock and Pierce (2010) (HP) index as proxies for the degree of financial constraints a borrower faces. With respect to credit ratings, we classify firms as financially constrained if their Standard & Poor's (S&P) long-term issue rating (Compustat item *splticrm*) is below investment grade (below BBB) and as financially unconstrained if the credit rating is investment grade (BBB or above). Following Becker and Ivashina (2014), we also use S&P's definition of investment grade (BBB- and above) and below investment grade (below BBB-) to classify firms into financially unconstrained and financially constrained firms as a robustness test. Our results (untabulated) remain unchanged using this definition of investment grade. With respect to the KZ and HP indices, for each fiscal year, we sort firms into terciles based on their degree of financial constraint. Similar to Kim et al. (2016), we define a borrower as being financially constrained (unconstrained) when its financial constraint index belongs to the top (bottom) tercile. We exclude firms in the middle tercile from our analysis.

We re-estimate our baseline regression [Equation (2)] on the two subsamples of financially constrained and unconstrained firms and report the findings in Panel A of Table 5. Models 1, 3 and 5 document the results for the constrained groups (FC). We document the findings for the unconstrained groups (UC) in Models 2, 4 and 6. We find that the positive effect of pension deficits on loan spreads is strong and statistically significant for financially constrained firms, irrespective of the financial constraints proxy used. In contrast, the coefficients of *DEFICIT* obtained from the unconstrained subsample are not statistically significant using credit ratings and the KZ index as proxies for financial constraints, while marginally significant at the 10% level using the HP index. These findings indicate that DB pension deficits increase the degree of financial constraints faced by the sponsoring firm, which in turn, makes the financially constrained firm's cash flows riskier, hence increasing its cost of borrowing.

[Insert Table 5 here]

B. Information Asymmetry

The bank loan contracting literature reveals that banks charge higher loan rates when the borrower faces severe information asymmetry (Armstrong, Guay and Weber, 2010; Bharath, Sunder and Sunder, 2008; Ertugrul et al., 2017; Graham, Li and Qiu, 2008). When a DB pension becomes underfunded, the sponsoring firm has an incentive to manipulate earnings (Asthana, 1999; Bergstresser, Desai and Rauh, 2006; Bodie, Light and Morck, 1987) resulting in lower disclosure quality. In anticipation of this tendency, banks charge higher loan rates for borrowers with larger pension deficits. Prior research shows that the opportunity to manipulate accounting numbers is greater for firms with a more opaque information environment. For example, Yu (2008) finds that firms followed by more analysts are less likely to engage in earnings management. If opaque information environment makes it easier to manipulate accounting figures and if pension underfunding induces such behavior, we expect lenders to be more sensitive to pension deficits as the degree of information asymmetry increases. In other words, the effect of pension underfunding on borrowing costs should be stronger when the degree of information asymmetry is higher.

To investigate the information asymmetry channel, we perform the following tests. First, we examine how the effect of pension deficits on loan costs varies among firms with different levels of information asymmetry. We use the number of analysts following the borrowing firm and the probability of informed trading (PIN) developed by Easley et al. (1996) and Easley, Kiefer and O'Hara (1997) as proxies for information asymmetry. These proxies are commonly used in the literature (Brown and Hillegeist, 2007; Kim et al., 2016). A larger number of analysts following the borrowing firm indicates greater transparency (hence lower information asymmetry). We compute the analyst coverage using data from the I/B/E/S database. The annual PIN score measure is provided by Brown and Hillegeist (2007).[11] The PIN score measures the probability of an informed trader submitting a certain order. The probability of informed trading has a positive relation with the degree of information asymmetry. When a firm operates in a transparent information environment, uninformed investors are more likely to trade, thus reducing the probability of informed trades relative to uninformed trades. In contrast, when information is not readily available, uninformed investors avoid trading due to higher adverse selection costs, leading to a higher PIN score.

For each fiscal year, we sort firms into terciles based on the value of analyst coverage. We define firms in the bottom (top) tercile of analyst coverage as having higher (lower) information asymmetry. Similarly, we group firms into terciles based on the PIN scores at the beginning of each fiscal year. We define firms in the top (bottom) tercile of the PIN score as having high (low) information asymmetry. We then estimate the baseline model [Equation (2)] on the subsamples of firms with high and low information asymmetry and compare the coefficients of *DEFICIT* obtained from these subsamples. Panel A of Table 6 reports the results.

Models 1 and 3 of Panel A report the results for the subsamples with high information asymmetry and Models 2 and 4 show the results of the tests for the subsamples with low information asymmetry. The table shows that the estimated coefficient of pension deficits is significantly positive only when the firm suffers severe information asymmetry. Overall, we find supportive evidence for our conjecture that the positive relation between pension deficits and cost of bank loan becomes stronger for firms facing higher opacity.

[11] We thank Stephen Brown for making the PIN score publicly available at http://scholar.rhsmith.umd.edu/sbrown/pin-data.

[Insert Table 6 here]

Second, we examine whether firms with large pension deficits indeed attempt to manipulate pension rate assumptions. Under Accounting Standards Codification (ASC) 715, the DB sponsor makes three assumptions in calculating the net pension obligation and net periodic pension costs, including the expected rate of return (ERR), the salary inflation rate (SIR), and the discount rate (DR). Firms are reluctant to increase the SIR because they would then need to increase wages accordingly (Comprix and Muller, 2011). Likewise, we argue that it is difficult to adjust the SIR downwards, as this might be faced with resistance from the workers' union. As a result, we focus on the expected rate of return assumption (item *pbarr* in Compustat) and the discount rate assumption (item *ppror*). An increase in the expected rate of return assumption reduces the net periodic pension costs and increases the expected returns on pension assets, whereas an increase in the discount rate assumption results in a lower projected benefit obligations (Bergstresser, Desai and Rauh, 2006; Comprix and Muller, 2011). This implies that DB sponsors with large deficits might attempt to reduce the size of the deficit by increasing the assumed expected rate of return and the assumed discount rate. Therefore, a large pension deficit, together with a high expected rate of return assumption and/or a high discount rate assumption, indicates management's manipulation of pension rates. Consequently, the bank will increase the risk premium on loans to DB sponsors whose pension plans are invested in risky assets.

To test the effect of pension rate assumptions on the relation between pension deficits and loan cost, we first sort firms into terciles based on the assumed ERR in each fiscal year. We then re-estimate the baseline model [Equation (2)] on the subsamples of high and low ERR (the top and bottom terciles, respectively). We repeat this test for the assumed DR and document the results in Panel B of Table 6. The results indicate that the effect of pension deficit on loan costs is strong when ERR and DR are high. In contrast, when ERR and DR are low (Models 2 and 4), the coefficient of *DEFICIT* is insignificant. This finding provides further support for our argument that pension deficits influence borrowing costs through information asymmetry problems, which in turn are caused by pension rate manipulation practices.

C. Risk-Shifting in Pension Investment Policy

When the pension plan is in deficit, the sponsoring firm might select riskier investments in the pension plan, hoping to improve the funding status of the plan (Anantharaman and Lee, 2014). If the investment pays off, the sponsoring firm makes smaller pension contributions (Love, Smith and Wilcox, 2011). If the investment fails and the firm files for bankruptcy, the creditors bear the costs. Therefore, banks should be averse to the borrower's pension investment risk, especially when the pension plan is in deficit.

Following prior literature (Anantharaman and Lee, 2014; Rauh, 2006, 2009), we measure pension investment risk with the proportion of pension assets allocated to equity investments. We obtain the allocation to equity investment (in percentage) (item *pnate*) in DB pension plans from Compustat Pension Annual Files. This item includes investments in domestic and international equity securities and venture capital. Since SFAS 132(R) requires asset allocation disclosure only from fiscal years ending December 2003 and onward, our sample for this test is limited to loans obtained from 2004 to 2013. We match the equity allocation variable with our baseline loan sample using the firm's GVKEY and financial year, and obtain 3,634 loan observations with non-missing equity allocation data. For each fiscal year, we categorize firms as having high (low) pension investment risk if the proportion of equity investment in their DB plans is in the top (bottom) tercile of equity allocation. We then investigate the effect of pension deficits on loan spreads for the subsamples of firms with high and low pension investment risk. We report the results of this analysis in Table 7.

Model 1 (Model 2) presents the results of the effect of pension deficits on loan spreads for the high (low) risk subsample. We highlight that pension deficits have significant implications for bank lenders only when the borrower follows a risky pension investment policy. This evidence indicates that banks are concerned with both risk shifting through the level of pension underfunding and risk shifting through pension asset allocation, consistent with the findings of Anantharaman and Lee (2014).

[Insert Table 7 here]

Overall, we demonstrate that the impact of pension deficits on the cost of bank loans is stronger for firms with (1) severe financial constraints, (2) a high level of information asymmetry, (3) more allocation to risky assets in their pension plans.

VI. Pension Deficits and Non-Price Loan Terms

Besides loan costs, banks impose restriction on various features of the loan contracts to monitor their borrowers. In this section, we study the effect of pension deficits on non-price loan terms. We focus on covenant intensity, loan security (collateral requirement), and loan maturity, as they reflect the lender's monitoring effort. Diamond (1984), Jensen and Meckling (1976), and Myers (1977), among others, highlight the important role of collateral requirements and covenant restrictions as monitoring mechanisms. Debt covenants help to reduce the agency costs of debt by aligning shareholder and debtholder interests (Bradley and Roberts, 2015; Smith and Warner, 1979). Violation of a debt covenant triggers a transfer of control to the lenders, which typically enable them to reassess the loan through renegotiations (Armstrong, Guay and Weber, 2010; Dichev and Skinner, 2002). Similarly, Rajan and Winton (1995) posit that collateralization incentivizes bank monitoring because it ensures the bank's claim in the event of bankruptcy. In addition to covenant restrictions and collateral requirement, lenders also impose monitoring by shortening the loan's maturity. Short-term debt provides an alternative monitoring mechanism because it results in management's loss of control when the lenders refuse to roll over the debt under adverse circumstances (Diamond, 1991a). Consistent with this argument, Bharath et al. (2011) find that bank loans for firms with lower credit quality have shorter maturity. Short-term debt also requires more frequent information disclosure, thereby reducing information asymmetry problems (Graham, Li and Qiu, 2008).

Since firms with underfunded pension plans tend to manipulate accounting information (Bergstresser, Desai and Rauh, 2006), and pension deficits represent unsecured claims by the borrower's employees, banks are likely to impose collateral requirement, restrictive covenants and shorter maturity on loans for firms with higher pension deficits to ensure that their claims are ahead of pension liabilities. Moreover, although bank debt tends to take seniority over other creditors, the minimum pension contributions are statutory debt, which ranks ahead of all creditors, including banks (Chen et al., 2014). This suggests that in the event of bankruptcy, a part of pension liabilities ranks ahead of all debt, including bank loans. As a result, banks have an incentive to set stringent covenants and collateral requirements. Overall, we expect that borrowers with more underfunded DB plan will have a higher likelihood of collateral requirements, larger number of covenant restrictions and shorter maturity.

We examine the effects of DB pension deficits on loan collateral requirements using a probit regression with all control variable specified in Equation (2). For the covenant restriction test, we use a Poisson regression. We use the covenant intensity index developed by Bradley and Roberts (2015). The index is obtained by counting the number of the following groups of covenants in the loan contract: 1) security, 2) dividend restrictions, 3) whether the loan has more than two financial covenants, 4) asset sweep, 5) equity sweep, and 6) debt sweep. Other variables are analogous to those described in Equation (2).

We present the results of these tests in Models 1 and 2 Table 8. We find that loans to borrowers with larger pension deficits are more likely to have collateral, and more covenant restrictions. The marginal effect of *DEFICIT* is 0.056, suggesting that a one unit increase in the deficit ratio leads to an increase of 0.056 in the likelihood of the loan being secured. Thus, a one standard deviation increase in *DEFICIT* leads to an increase of 0.00964 in the probability of the loan being secured. Similarly, we estimate the marginal effect of *DEFICIT* in Model 2, as we use the Poisson regression. The result shows that a one standard deviation increase in the deficit ratio leads to an increase of 0.031 in the number of covenants. Overall, these results support our argument that pension deficits pose an additional source of risk and that banks consider this risk when designing loan contracts to DB-sponsoring firms.

We further examine the effect of pension deficits on loan maturity and report the results in Model 3. The dependent variable is the log of loan maturity. The control variables are identical to Equation (2), except for loan maturity. We find a negative relation between pension deficits and loan maturity. Given an average of 46.601 months in loan maturity, this suggests that a one standard deviation increase in *DEFICIT* leads to a decrease of 1.224 month in loan maturity. This shows that banks shorten the loan maturity on bank loans for firms with higher pension deficits.

Finally, we examine the effect of pension underfunding on the expected probability of covenant violation. Chava and Roberts (2008) report that most financial covenants are tied to cash flows from operations. These include the maximum debt to EBITDA requirement and the minimum interest coverage ratio requirement, among others. Since firms with an underfunded pension plans are required to make additional contributions that reduce their cash flows, we argue that firms with large pension deficits face higher risk of covenant violation.

We use the probability of covenant violation measures developed by Demerjian and Owens (2016).[12] Three measures of the probability of covenant violation are associated with three types of covenants. The main proxy measures the probability of any covenant provision of loan package *i* being breached within a certain fiscal year. The two other proxies relate to two specific groups of covenant provisions, following the definitions of Christensen and Nikolaev (2012), namely, capital covenants and performance covenants. Capital covenants impose restriction on capital structure, whereas performance covenants tied with borrower's periodic performance ("tripwire" covenants).

Since covenants are determined at the loan package level but not at the facility level, there is no variation in loan covenants across different loan facilities within the same package. Thus, to avoid

[12] The data are available at http://faculty.washington.edu/pdemerj/data.html.

correlations between loan facilities within the same package, we follow Anantharaman, Fang and Gong (2013) and conduct our analysis using only the largest facility of each loan package.[13] We merge these loans with the covenant violation probability data provided by Demerjian and Owens (2016) and obtain a sample of 3,489 loan facilities. We then examine the effect of pension underfunding on the probability of covenant violations using the OLS regression method. We use three covenant violation measures used by Demerjian and Owens (2016). The independent variables are analogous to those described in Equation (2).

We present the results of these tests in Models 4 to 6 of Table 8, using the overall covenants violation probability (*PVIOL*), the performance covenants violation probability (*PVIOLPERF*), and the capital covenants violation probability (*PVIOLCAP*), respectively. We note that the extent of pension underfunding is associated with a higher probability of violating any of the loan's covenant restrictions in the future. When decomposing covenants into performance and capital covenants, we find that firms with greater pension underfunding are likely to violate both types of covenants. The coefficients of *DEFICIT* are 0.1739, 0.1543 and 0.0725, respectively. The standard deviation of *DEFICIT* in this sample is 0.176, suggesting that a standard deviation increase in pension deficits leads to an increase of 3.07%, 2.72% and 1.28% in the probability of violating any covenant, violating a performance-based covenant, or violating a capital-based covenant in the next fiscal year. Taken together with the results for loan pricing reported in Tables 2 and 3, these findings suggest that the pension deficit ratio has a significant impact on various loan terms, although its impact is stronger for loan costs compared to other non-price loan terms.

[Insert Table 8 here]

[13] As a robustness check, we estimate Equation (9) at the facility level and find similar results to those reported in Table 8.

VII. Further Analyses

This section reports further analyses to enhance our understanding of the implications of DB pension deficits for the sponsoring firms. First, we explore the role of pension size in determining loan costs. If DB pension obligations are important to bank lenders, the size of the DB plan should be positively associated with the costs of borrowing, as the net pension liabilities could be larger relative to the firm's profitability. We measure the size of the DB plan using two proxies. First, we estimate the ratio of pension liabilities to market capitalization. Although the pension liability ratio captures directly the value of pension obligations, its effect could be offset by the value of pension assets. As such, we employ a second measure of DB pension size, namely the ratio of the number of DB plan participants to market capitalization.[14] We estimate the effect of pension size on the cost of bank loans using these proxies and report the results in Models 1 and 2 of Table 9. In Model 1, we observe a significantly positive relation between pension liabilities and loan costs. The estimated coefficient of the pension liability ratio is smaller than that of the pension deficit ratio. This result is expected, because DB sponsors only face the risk of making additional contributions when the plan is underfunded (when the value of pension liabilities exceeds the value of pension assets). Similarly, in Model 2, the coefficient of the ratio of the number of DB participants to market capitalization (*EMP*) is positive and significant, indicating that loan interest premiums increase when the number of employees covered by DB pensions increases. These results thus highlight the economic significance of pension plan decisions.

Second, the ERISA requires severely underfunded firms to make mandatory contributions to reduce pension deficits. Thus, the amount of pension underfunding may have a high correlation with mandatory contributions. Campbell, Dhaliwal and Schwartz (2012) find that the cost of capital increases

[14] For each fiscal year, we collect the number of plan participants from firms' filings of the Internal Revenue Service's (IRS) Form 5500. Form 5500 data are available from 1990 to 1999 from the website of the Center for Retirement Research at Boston College. We match the number of employees under DB pension plans to our sample firms using the Employer Identification Number (EIN).

following mandatory contributions to DB plans. In order to ensure that our results do not merely capture the effect of mandatory contributions on loan costs, we control for mandatory contributions by including the measure of mandatory contributions (*MC*) in the baseline model [Equation (2)] as an additional control variable. We argue that the extent of pension deficits provides important information for bank lenders as pension underfunding signals to the market that the borrowers are likely to make mandatory pension contributions in the future. If that is the case, we should still observe a positive relation between the pension deficits and loan spreads after controlling for mandatory contributions. We compute the amount of mandatory contributions following Campbell, Dhaliwal and Schwartz (2012)'s method. Model 3 of Table 9 reports the results of estimating Equation (2) with mandatory contributions (*MC*) as an additional control variable. We observe that the coefficient of *MC* is insignificant, while the pension deficit ratio (*DEFICIT*) remains positive and significant. These findings indicate that the amount of mandatory pension contributions does not affect the relation between pension deficits and loan costs.

Finally, we explore whether the effect of pension deficits changes over time. Franzoni and Marin (2006) document that in 2003, investment firms began to pay attention to pension funding and reporting issues, following a sharp reduction of $400 billion in DB pension funding in the United States from 2000 to 2002. Thus, it is reasonable to expect the effect of pension deficits on the cost of borrowing to vary over time, as investors became more aware of the issues of DB pension plans. To investigate whether the effect of pension deficits on loan pricing changes over time due to changes in investor awareness, we follow Franzoni and Marin (2006) and compare the effect of pension deficits on loan pricing in the period 1998-2002 with the effect of pension deficits in the period 2004-2008.[15] We document the results in Models 4 and 5. The coefficient of *DEFICIT* is 0.1685 in Model 4 and 0.4091 in Model 5, suggesting

[15] The choice of five years before and after 2003 is arbitrary. As such, we also perform the same test for two- and three-year windows to ensure our results are not driven by the choice of sample period. In addition, we split the sample into two periods, 1982 – 2002 and 2004 – 2013 and repeat the test. In all these tests, we find that the effect of pension deficit on loan costs is stronger after 2003, similar to the results reported in Model 5.

that the effect of pension deficits on loan pricing becomes stronger after 2003. This is consistent with Franzoni and Marin (2006)'s conjecture that investors become more aware of the implication of DB pension plans for firm value after 2003. We also show that our results are robust to addressing extreme observations, multiple loan facilities of the same loan package, the interdependency of loans initiated by the same lender, alternative measure of total borrowing costs and firm age in the Section C of the internet appendix.

[Insert Table 9 here]

VIII. Conclusions

We find a positive association between pension deficits and loan costs, indicating that banks charge high risk premiums on loans to borrowers with large DB pension deficits. Further analyses reveal that the positive association between pension deficits and loan costs is stronger for firms facing severe financial constraints, higher information asymmetry, and more pension investment risk. These findings indicate that pension deficits influence loan pricing via increasing cash flow constraints, exacerbating information asymmetry problems and risk-shifting in pension investment. In addition, banks tighten lending terms for firms with larger pension deficits by requiring collateral, increasing the number of loan covenants and shortening loan maturity. These findings imply that banks perceive DB pension underfunding as engendering significant risks and adjust loan contract terms to better monitor these borrowers. The probability of covenant violation is also significantly higher for firms with larger pension deficits.

Overall, we provide new evidence on the importance of DB pension underfunding in determining loan costs and non-price loan terms. Since bank credit is the most common and largest source of funds for corporations (Bharath et al., 2008; Graham et al., 2008), our findings highlight that DB pension funding status influences firm value and investment by increasing the cost of external debt financing.

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Appendix: Variable Descriptions

Variable	Description
Bank loan characteristics obtained from DealScan	
COVENANTS	A categorical variable ranging from zero to six, with six being the most restrictive. We estimate this by counting the number of the following groups of covenants in the loan contract: (1) security, (2) dividend restrictions, (3) whether the loan has more than two financial covenants, (4) asset sweep, (5) equity sweep, (6) debt sweep.
LNMATURITY	The natural log of the number of months until maturity (item *maturity*).
LNSIZE	The natural log of the size of the loan facility (item *facility amt*).
LOAN_PURPOSE	A categorical variable representing different loan purposes, including corporate purposes, debt repayment, working capital, acquisitions, backup loans, and others (item *primary purpose*).
LOAN_TYPE	A categorical variable representing different loan types, including term loans, revolver less than one year, revolver greater than one year, 364-day facility, bridge loans, and others (item *type*).
SECURITY	A dummy variable that equals one if the loan is secured, and zero otherwise.
SPREAD	The log of the difference (in bps) between the interest charged on the loan facility and LIBOR or LIBOR-equivalent rate (item *all-in-drawn spread*).
SYNDICATION	A dummy variable that equals one if the loan involves more than one lender, and zero otherwise.
Bank loan characteristics obtained from Demerjian and Owens (2016)	
PVIOL	Probability of any financial covenant in the loan package being breached.
PVIOLCAP	Probability of any capital covenant in the loan package being breached. Capital covenants include (1) quick ratio, (2) current ratio, (3) debt-to-equity ratio, (4) loan-to-value ratio, (5) ratio of debt to tangible net worth, (6) leverage ratio, (7) senior leverage ratio, (8) net worth and (9) tangible net worth (Christensen and Nikolaev, 2012).
PVIOLPERF	Probability of any performance-related covenant in the loan package being breached. Performance covenants are any of the following provisions: (1) cash interest coverage ratio, (2) debt service coverage ratio, (3) level of EBITDA, (4) fixed-charge coverage ratio, (5) interest coverage ratio, (6) ratio of debt to EBITDA and ratio of senior debt to EBITDA.
Firm characteristics obtained from Compustat	
CASH	*Cash = che/ at*
ΔCRISK	We assign a number value for each credit rating category, with the AAA rating having a value of one, and the SD or D rating having a value of 21. We measure the change in the firm's credit risk as the yearly average of the monthly change in the credit rating number. A larger number indicates an increase in credit risk (or a decrease in the credit rating).
DEFICIT	Pension deficit: From 1982 to 1986: *Deficit = (pbnvv – pbnaa)/ (prcc_f *csho);* From 1987 to 1997: *Deficit = [(pbpro + pbpru) – (pplao + pplau)]/ (prcc_f *csho;* From 1998 to 2013: *Deficit = (pbpro – pplao) / (prcc_f *csho)*
EARNVOL	Standard deviation of quarterly earnings (*epspiy*) in the previous four years
EMP	The ratio of the number of DB participants over market capitalization
HP INDEX	$HP = -0.737*\log(\text{adjusted } at) - 0.043*[\log(\text{adjusted } at)]^2 - 0.040*Age$,

	where *at* is adjusted for inflation (to 2004 dollars) and *age* is the number of years with non-missing Compustat data. Total assets (*at*) are capped at $4.5 billion and firm age is capped at 37 years.
IG_DUMMY	Investment-grade dummy variable: equals one if the company has an S&P long-term credit rating (*splticrm*) of BBB or above, and zero otherwise. Company-year observations with an “N.D” or “D” rating are excluded.
KZ INDEX	KZ = –1.002[(ib + dp)/lagged ppent] +0.283[(at + prcc_f*csho - ceq - txdb)/at] + 3.139[(dltt + dlc)/ (dltt + dlc + seq)] – 39.368[(dvc + dvp)/ lagged ppent] – 1.315[che/lagged ppent]
LEVERAGE	We use the ratio of total debt to total assets as a main proxy for leverage while we use ratios of long-term debt to total assets, total debt to market capitalization and the long-term debt to market capitalization as alternative proxies for robustness checks.
LIABILITIES	Pension liabilities: From 1982 to 1986: Liabilities = pbnvv/ (prcc_f *csho); From 1987 to 1997: Liabilities = (pbpro + pbpru)/ (prcc_f *csho; From 1998 to 2013: Liabilities = pbpro / (prcc_f *csho)
LOANCON	LOANCON = Loan amount / (Loan amount + dltt + dlc)
LOGASSETS	Log assets = log(at)
MC	Mandatory contributions: For fiscal years before 2008: MC = [Service cost + (ABO – FVPA)/30]/at, if PBO>FVPA; otherwise zero; For fiscal years beginning in 2008 or later: MC = [Service cost + (ABO – FVPA)/7]/at, if PBO>FVPA; otherwise zero.
MTB	MTB=(prcc_f*csho+dltt+dlc)/at
NEG_EQUITY	Dummy variable that equals one if the firm’s total equity (item ceq) is negative, and zero otherwise.
PLAN_AGE	Number of years from the first fiscal year the firm reports pension assets and liabilities to the current fiscal year
POST2006	Dummy variable that equals one if the fiscal year is after December 31, 2006, and zero otherwise.
PPE	PPE = ppent/ at
RATING	Categorical variable indicating the company’s S&P long-term credit rating (*splticrm*). We assign the value of 21 for the highest rating – AAA – and a value of two for the lowest rating – CC. We assign a value of one for firms with missing rating information.
RETVOL	Annualized standard deviation of daily stock return
ROA	ROA = oibdp/ at
Z_SCORE	Z= [(3.3*pi + sale + 1.4*re + 1.2*(act – lct)]/at
Macroeconomic characteristics collected from DataStream	
CRSPREAD	The difference between the ten-year AAA corporate bond yield and ten-year BAA corporate bond yield
TERMSTR	The difference between the ten-year government bond yield and three-month T-bill yield
Other data	
TENURE	Industry median employee tenure, collected from the Bureau of Labor Statistics of the United States of America
UNION	Industry median unionization rate, collected from the Union Membership and Coverage Database (http://www.unionstats.com/)

TABLE 1
Descriptive Statistics

This table reports the descriptive statistics for the sample of 10,298 loan facilities obtained by US non-financial non-utility firms that sponsor DB pensions from 1982 to 2013. There are 6,353 firm-year observations from 1,670 unique firms in our sample. We collect the loan data from the Loan Connector's DealScan database, whereas accounting information is from the Compustat Industrial Annual Files. We collect the pension data from the Compustat Pension Annual Files. All variables are winsorized at 1% and 99% level. The Appendix provides a detailed description of the variables.

Variable	N	Mean	Std Dev	25th Pctl	50th Pctl	75th Pctl
			Firm characteristics			
DEFICIT	6,353	0.040	0.161	0.000	0.010	0.042
TOTAL ASSETS (US$ MIL)	6,353	6,042.7	15,332.1	459.9	1,553.3	4,812.0
LEVERAGE	6,353	0.291	0.181	0.169	0.271	0.386
PPE	6,353	0.325	0.203	0.169	0.282	0.439
CASH	6,353	0.070	0.080	0.014	0.040	0.097
ROA	6,353	0.137	0.070	0.095	0.133	0.177
MTB	6,353	1.279	0.771	0.784	1.044	1.523
Z_SCORE	6,353	1.876	1.064	1.206	1.866	2.493
EARNVOL	6,353	0.781	1.183	0.222	0.417	0.824
RATING	6,353	8.088	6.143	1.000	9.000	13.000
			Loan characteristics			
SPREAD (BPS)	10,298	178.119	144.609	62.500	150.000	255.000
MATURITY (MONTHS)	10,298	46.601	25.055	24.000	58.000	60.000
SIZE (US$ MIL)	10,298	469.113	1,036.872	70.000	200.000	500.000
SYNDICATION	10,298	0.916	0.277	1.000	1.000	1.000
SECURITY	10,298	0.427	0.495	0.000	0.000	1.000
COVENANTS	10,298	1.926	2.138	0.000	1.000	4.000
			Macroeconomic variables			
TERMSTR	10,298	1.406	1.088	0.513	1.117	2.593
CRSPREAD	10,298	1.052	7.634	-4.148	-1.320	4.687

TABLE 2
Effect of Defined Benefit Pension Funding on the Cost of Bank Loans

This table reports the results on the impact of pension deficit on the cost of bank loans using the log of the *all-in-drawn spread* variable as a proxy for the cost of bank loans. We cluster the standard errors at the firm level. We use the ratio of total debt to total assets as a proxy for leverage in models 2-4, whereas we use ratios of long-term debt to total assets, total debt to market capitalization and the long-term debt to market capitalization in Models 5, 6 and 7 respectively. We present *t* statistics in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. We provide detailed description of the variables in Appendix.

	Models						
	1	2	3	4	5	6	7
DEFICIT	0.9853	0.2445	0.2503	0.2522	0.257	0.1234	0.1408
	(12.66)***	(4.09)***	(4.62)***	(4.66)***	(4.77)***	(2.16)**	(2.47)**
LOGASSETS		-0.1692	-0.101	-0.1012	-0.1065	-0.1101	-0.1118
		(-15.51)***	(-7.18)***	(-7.20)***	(-7.36)***	(-7.55)***	(-7.61)***
LEVERAGE		0.6806	0.6161	0.6169	0.4511	0.0625	0.0669
		(9.04)***	(9.66)***	(9.66)***	(7.77)***	(9.26)***	(8.48)***
PPE		-0.1465	-0.0177	-0.0171	-0.0436	-0.05	-0.0577
		(-1.86)*	(-0.27)	(-0.26)	(-0.65)	(-0.75)	(-0.86)
CASH		0.2948	0.1193	0.123	0.0012	-0.1219	-0.1268
		(2.28)**	(1.07)	(1.11)	(0.01)	(-1.12)	(-1.17)
ROA		-1.5559	-1.7651	-1.7615	-1.7015	-1.4749	-1.4808
		(-7.66)***	(-9.84)***	(-9.81)***	(-9.39)***	(-8.28)***	(-8.29)***
MTB		-0.1257	-0.0824	-0.0832	-0.0786	-0.061	-0.0636
		(-5.88)***	(-4.62)***	(-4.67)***	(-4.45)***	(-3.55)***	(-3.68)***
Z_SCORE		-0.0303	-0.0152	-0.0152	-0.0384	-0.0538	-0.0593
		(-2.21)**	(-1.34)	(-1.33)	(-3.47)***	(-4.84)***	(-5.39)***
EARNVOL		0.0177	0.0181	0.0181	0.0182	0.0148	0.0144
		(2.27)**	(2.80)***	(2.80)***	(2.84)***	(2.22)**	(2.16)**
LNSIZE			-0.0684	-0.0686	-0.0671	-0.0651	-0.0644
			(-5.92)***	(-5.92)***	(-5.71)***	(-5.49)***	(-5.41)***
LNMATURITY			-0.0567	-0.0569	-0.06	-0.0379	-0.0427
			(-2.72)***	(-2.73)***	(-2.85)***	(-1.81)*	(-2.03)**
TERMSTR				-0.0355	-0.0316	-0.0322	-0.0289
				(-1.22)	(-1.08)	(-1.11)	(-0.99)
CRSPREAD				0.0092	0.0089	0.0082	0.0086
				(1.36)	(1.32)	(1.22)	(1.28)
Constant	5.4005	6.6424	7.6083	7.5102	7.6686	7.572	7.6156
	(26.84)***	(13.27)***	(15.63)***	(15.12)***	(15.70)***	(16.33)***	(16.35)***
Loan type, syndication and purpose fixed effects	No	No	Yes	Yes	Yes	Yes	Yes
Credit ratings, year and industry fixed effects	No	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.1792	0.6314	0.7057	0.7058	0.7022	0.7037	0.7025
Number of observations	10,298	10,298	10,298	10,298	10,298	10,298	10,298

TABLE 3

Endogeneity Tests of the Effect of Pension Funding on the Cost of Bank Loans

This table report the results of estimate the effect of pension underfunding on loan pricing using the 2SLS regression method and the PSM method. Panel A reports the results of the 2SLS regression method. Standard errors are bootstrapped with 500 replications. Panel B shows the average treatment effects obtained from propensity score matching. Our treatment (control) group is loans extended to firms with large (small) pension deficits. We present *t* statistics in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. We provide detailed description of the variables in the Appendix.

Panel A: 2SLS regression

	First-staged regressions		Second-staged regression
	Pension choice	Deficit size	
	1	2	3
DBDUMMY			-0.0444
			(-2.44)**
EDEFICIT*DBDUMMY			0.6681
			(3.38)***
LOGASSETS	0.2368	-0.0055	-0.1192
	(28.76)***	(-4.56)***	(-15.23)***
ROA	0.4873	-0.0714	-0.8947
	(5.65)***	(-3.39)***	(-12.43)***
EARNVOL	-0.0002	0.0001	0.0297
	(-1.53)	(1.90)*	(6.03)***
PPE	0.4064	0.0097	-0.0838
	(9.73)***	(2.21)**	(-2.46)**
MTB	-0.1083	-0.0119	-0.0681
	(-9.26)***	(-9.00)***	(-10.10)***
TENURE	-0.016	0.0014	
	(-2.00)**	(1.79)*	
Z_SCORE		-0.0042	-0.0485
		(-2.70)***	(-9.36)***
NEG_EQUITY		0.1332	
		(8.35)***	
UNION	0.0046		
	(3.55)***		
PLAN_AGE		0.001	
		(3.56)***	
Industry fixed effects	Yes	No	Yes
Year fixed effects	Yes	Yes	Yes
All other baseline controls	No	No	Yes
First-staged diagnostic test statistics			
Wald test: all coef.=0	27.03***		
Heckman's l	-0.027***		
Test of independent eqns (rho=0)	-0.205**		
Wald test: all coef.=0	27.03***		
Second-staged diagnostic test statistics			
Durbin-Wu-Hausman (χ^2)			8.005**
Under-identification test (χ^2)			71.878***
Cragg-Donald Wald F statistic			23.851
N	105,977		29,001

Panel B: Propensity score matching

	Nearest neighbour matching	Caliper matching
High vs. low	0.2363	0.0546
	(12.37)***	(2.75)***
Number of loans in the treatment group	4,180	3,677

TABLE 4

Simultaneity of Loan Terms, Pension Deficits and Cost of Bank Loans

This table reports the results of addressing the joint determination of non-price loan contract terms. Models 1 to 7 show the effect of pension deficits on loan spreads in different sub-samples grouped by non-price loan terms. All models include all control variables outlined in the baseline model [Equation (2)]. Standard errors are clustered at the borrowing firm level. Model 8 reports the results of Equation (10) using the fitted values obtained for non-price loan terms using the systems of Equations (7) to (9). Model 9 presents the results of Equation (10) with the predicted values of the deficit ratio (*EDEFICIT*) obtained from Equation (4). We use the log of the average maturity in the previous three months as the instrument for loan maturity; loan concentration and industry median tangibility as the instruments for collateral requirement; and the size of defaulted loans experienced by the lead lender in the previous 360 days as the instrument for covenant intensity. We scale the size of defaulted loans in the previous 360 days by the size of the lead lender's total defaulted loans in the previous four years to account for the differences in size of lead lenders. These variables are discussed in detail in the Appendix. The symbols ***, **, and * denote statistical significance at the 1%, 5% and 10% level, respectively.

	Security		Covenant intensity		Maturity (in months)			2SLS	
	Yes	No	Above median	Below median	Mat<24	24<=Mat <=60	Mat>60		
	1	2	3	4	5	6	7	8	9
DEFICIT	0.1615	0.3213	0.2194	0.2283	0.1946	0.2048	0.4123	0.2452	
	(3.63)***	(3.60)***	(4.08)***	(3.26)***	(2.24)**	(3.21)***	(3.96)***	(4.83)***	
EDEFICIT									0.5992
									(1.99)**
ELNMATURITY								-1.602	-1.8004
								(-2.57)**	(-2.90)***
ESECURITY								0.7381	0.7622
								(5.99)***	(6.19)***
ECOVENANTS								-0.0113	-0.0129
								(-0.65)	(-0.74)
Durbin-Wu-Hausman Chi2								88.71	88.22
Anderson-Rubin Wald Chi2								7.5	7.63
Loan syndication dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Loan type and loan purpose fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
All other control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Credit ratings fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year and industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.4315	0.7101	0.6123	0.7191	0.7745	0.727	0.4918	0.7463	0.7442
N	4,396	5,902	4,294	6,004	2,407	6,120	1,771	6,100	6,080

TABLE 5
Financial Constraints

This table reports the results of the effect of financial constraints on the relation between pension deficits and the cost of bank loans. We use KZ index (Models 1 and 2), the HP index (Models 3 and 4) and a dummy variable indicating whether the borrower is an investment-graded or non-investment-graded firm (Models 5 and 6) as proxies for financial constraints. For the KZ and HP indices, we rank firms into terciles based on the value of each index. We consider firms belonging to the top (bottom) tercile as financially constrained (unconstrained) firms. In the case of investment grade dummy, we define firms as being financially constrained (unconstrained) if they are below (above) investment grade "BBB". Models 1, 3 and 5 show the results for the "constrained" (FC) subsample, whereas models 2, 4 and 6 show the result for the "unconstrained" (UC) sample. The dependent variable in all analyses is the log of the *all-in-drawn spread* variable obtained from Dealscan. We cluster the standard errors at the firm level. We present *t* statistics in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. We provide detailed description of the variables in the Appendix.

	KZ Index		HP Index		Credit Ratings	
	FC	UC	FC	UC	FC	UC
	1	2	3	4	5	6
DEFICIT	0.1451	0.0127	0.2651	0.1273	0.2449	0.0505
	(2.77)***	(0.09)	(2.65)***	(1.71)*	(4.51)***	(0.24)
Constant & other control variables	Yes	Yes	Yes	Yes	Yes	Yes
Loan syndication dummy	Yes	Yes	Yes	Yes	Yes	Yes
Loan type and loan purpose fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Credit ratings fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year and industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.6732	0.7282	0.725	0.5084	0.5284	0.6233
N	3,362	3,020	3,564	3,334	7,200	3,098

TABLE 6
Information Asymmetry

This table shows the results of testing the role of information asymmetry in explaining the effect of pension deficit on the cost of borrowing. In Panel A, we use analyst coverage and the probability of insider trading (PIN) as proxies for information asymmetry. For each fiscal year in the sample period, we sort firms into terciles based on the value of each information asymmetry measure. Models 1 and 3 present the results for the subsamples with high information asymmetry, and Models 2 and 4 show the result for the subsamples with low information asymmetry. For the PIN measure, we define firms as having a high (low) level of information asymmetry if they belong to the top (bottom) tercile of the information asymmetry (PIN) measure. For the analyst coverage measure, we define firms as having a high (low) level of information asymmetry if they belong to the bottom (top) tercile of analyst coverage.

Panel B reports the results of testing the impact of pension deficits on the loan spreads for subsamples of firms with high and low pension rate of return assumptions. Models 1 and 2 show the results for the expected rate of returns (ER), whereas Models 3 and 4 show the results for the discount rate (DR). We classify firms as having high (low) rate of return assumptions if they belong to the top (bottom) tercile of the rate of returns. The dependent variable in all analyses is the log of the *all-in-drawn spread* variable obtained from Dealscan. We cluster the standard errors at the firm level. We present t statistics in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. We provide detailed description of the variables in the Appendix.

Panel A: Information environment

	Analyst Coverage		PIN	
	1	2	3	4
DEFICIT	0.2128	0.1867	0.1628	0.1063
	(3.81)***	(0.77)	(2.75)***	(0.80)
Constant and other control variables	Yes	Yes	Yes	Yes
Loan syndication dummy	Yes	Yes	Yes	Yes
Loan type and loan purpose fixed effects	Yes	Yes	Yes	Yes
Credit ratings fixed effects	Yes	Yes	Yes	Yes
Year and industry fixed effects	Yes	Yes	Yes	Yes
R^2	0.5754	0.7062	0.6081	0.7382
N	3,106	3,107	2,899	2,712

Panel B: Pension accounting manipulation

	High ER	Low ER	High DR	Low DR
	1	2	3	4
DEFICIT	0.4463	-0.0412	0.2774	0.0351
	(5.46)***	(-0.36)	(3.89)***	(0.42)
Constant and other control variables	Yes	Yes	Yes	Yes
Loan syndication dummy	Yes	Yes	Yes	Yes
Loan type and loan purpose fixed effects	Yes	Yes	Yes	Yes
Credit ratings fixed effects	Yes	Yes	Yes	Yes
Year and industry fixed effects	Yes	Yes	Yes	Yes
R^2	0.7702	0.7437	0.7739	0.7576
N	2,380	2,289	2,520	2,250

TABLE 7

Risk-Shifting Activity in Pension Investment

This table shows the results on the impact of pension deficit on loan spread for subsamples of firms with high risk and low risk pension investment strategies. For each fiscal year, we sort into terciles based on the proportion of equity investment in their DB pension plan. We classify the firms as having high (low) pension investment risk if they belong to the top (bottom) tercile of equity allocation. The sample period for this analysis spans from 2004 to 2013, due to the limitation on data availability on the pension investment allocation. The dependent variable in all analyses is the log of the *all-in-drawn spread* variable obtained from Dealscan. We cluster the standard errors at the firm level. We present t statistics in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. We provide detailed description of the variables in the Appendix.

	High risk	Low risk
	1	2
DEFICIT	0.4617	-0.0347
	(4.54)***	(-0.35)
Constant and other control variables	Yes	Yes
Loan syndication dummy	Yes	Yes
Loan type and loan purpose fixed effects	Yes	Yes
Credit ratings fixed effects	Yes	Yes
Year and industry fixed effects	Yes	Yes
R^2	0.7822	0.7523
N	1,954	1,949

TABLE 8

Effect of Pension Deficits on Non-Price Loan Terms

This table reports the results of the impact of pension deficits on loan collateral requirements and covenant restrictions. In Model 1, we show the effect of pension deficits on the probability of having a collateral requirement in the loan contract. In Model 2, we report the findings of the impact of pension deficits on the intensity of covenant provisions. We measure covenant intensity with Bradley and Roberts (2015) covenant index measure. In Model 3, we present the results of estimating the effect of pension deficits on loan maturity. In Models 4 to 6, we present the results of the impact of DB pension deficit on covenant violation using the three probability of covenant violation measures (PVIOL, PVIOLPERF and PVIOLCAP) used by Demerjian and Owens (2016). We cluster the standard errors at the firm level. We present *t* statistics in parentheses. The symbols ***, **, and * denote statistical significance level at the 1%, 5%, and 10% levels, respectively. We provide detailed description of the variables in the Appendix.

	Security	Covenant intensity	Maturity	PVIOL	PVIOLPERF	PVIOLCAP
	1	2	3	4	5	6
DEFICIT	0.2178	0.0934	-0.1536	0.1739	0.1543	0.0725
	(2.18)**	(2.10)**	(-3.59)***	(3.50)***	(3.17)***	(1.97)**
LOGASSETS	-0.2371	-0.1523	-0.0178	-0.0033	-0.0112	0.003
	(-12.29)***	(-15.73)***	(-1.57)	(-0.26)	(-0.93)	(0.37)
LEVERAGE	0.7106	0.1771	0.0754	0.6091	0.561	0.134
	(6.73)***	(3.58)***	(1.98)**	(11.12)***	(9.96)***	(3.89)***
PPE	0.0046	0.0806	0.0095	-0.0802	-0.1157	0.0223
	(0.04)	(1.47)	(0.24)	(-1.36)	(-2.08)**	(0.65)
CASH	0.0962	-0.2139	-0.0614	0.0597	0.0207	0.0759
	(0.43)	(-1.96)**	(-0.79)	(0.63)	(0.22)	(1.44)
ROA	-1.3835	-0.5644	0.5022	-1.7673	-1.6906	-0.2961
	(-4.40)***	(-3.75)***	(3.65)***	(-10.96)***	(-9.98)***	(-3.58)***
MTB	-0.1521	-0.0910	-0.0027	-0.0100	-0.0081	-0.0069
	(-4.95)***	(-5.89)***	(-0.29)	(-0.80)	(-0.64)	(-0.98)
Z_SCORE	-0.0420	-0.0092	0.0213	0.0017	0.0053	-0.0025
	(-1.92)*	(-0.86)	(2.55)**	(0.14)	(0.43)	(-0.45)
EARNVOL	0.0275	-0.0078	0.0010	0.0017	0.0029	-0.004
	(2.14)**	(-1.30)	(0.20)	(0.24)	(0.40)	(-1.04)
TERMSTR	-0.0036	-0.0323	-0.0344	-0.049	-0.0502	0.0174
	(-0.05)	(-1.03)	(-1.65)*	(-1.85)*	(-1.93)*	(1.38)
CRSPREAD	-0.0015	0.0065	-0.003	0.0034	0.0043	-0.0011
	(-0.10)	(0.83)	(-0.69)	(0.54)	(0.68)	(-0.25)
LNSIZE	0.0306	0.1040	0.0521	-0.0432	-0.0303	-0.0179
	(1.64)	(11.44)***	(6.77)***	(-3.58)***	(-2.51)**	(-2.43)**
LNMATURITY	0.0408	0.0265		0.0062	0.0137	-0.0149
	(1.10)	(1.42)		(0.29)	(0.65)	(-1.08)
Constant	0.9736	-0.4406	1.2179	1.4692	1.3538	0.1882
	(1.09)	(-0.95)	(5.08)***	(4.38)***	(4.56)***	(1.00)
Loan type, purpose and syndication fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Ratings fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year and industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2/Pseudo R^2	0.3277	0.2536	0.6795	0.3447	0.3350	0.1338
N	10,280	10,298	10,298	3,489	3,489	3,489

TABLE 9
Further Analyses

Panel A of this table reports the results of the tests reported in Section VII. In Model 1, we show the effect of the ratio of pension liabilities to market capitalization on loan spreads. Model 2 shows the effect of the number of DB participants scaled by market capitalization on loan spreads. In Model 3, we include mandatory pension contributions as an additional control variable in Equation (2). Model 4 reports the results of estimating Equation (2) on the subsample of loans initiated from 1998 to 2002, whereas Model 5 reports the results of estimating Equation (2) on the subsample of loans initiated from 2004 to 2008. We cluster the standard errors at the firm level. We present *t* statistics in parentheses. The symbols ***, **, and * denote statistical significance level at the 1%, 5%, and 10% levels, respectively. We provide detailed description of the variables in the Appendix.

	Models				
	1	2	3	4	5
DEFICIT			0.281	0.1685	0.4091
			(5.08)***	(2.16)**	(4.36)***
LIABILITIES	0.0853				
	(7.29)***				
EMP		0.0034			
		(4.25)***			
MC			-1.8239		
			(-1.42)		
Constant	7.3842	8.117	7.5125	7.2609	7.0957
	(15.98)***	(13.78)***	(15.01)***	(18.81)***	(21.57)***
Difference					0.2406
$\chi 2$ for difference test					(3.83)*
Loan syndication dummy	Yes	Yes	Yes	Yes	Yes
All other controls	Yes	Yes	Yes	Yes	Yes
Loan type and loan purpose fixed effects	Yes	Yes	Yes	Yes	Yes
Credit ratings fixed effects	Yes	Yes	Yes	Yes	Yes
Year and industry fixed effects	Yes	Yes	Yes	Yes	Yes
R2/Pseudo R2	0.707	0.748	0.706	0.769	0.758
N	10,298	5,868	10,298	2,809	2,836

Internet Appendix

Pension Deficits and the Design of Private Debt Contracts

We structure the internet appendix as follows. Section A provides an overview of the regulations of DB pension plans. We discuss how we address the joint determination of loan terms method in the Section B. We discuss the results on additional robustness tests on the impact of DB pension deficits on the cost of borrowing in Section C.

A. Regulations of DB Pension Plans

The Employment Retirement Income Security Act (ERISA) of 1974 governs the regulation of DB pension plans. According the ERISA, plan sponsors are required to meet 90% of the underfunded pension liabilities within 30 years. In addition, DB plans are subject to a number of accounting regulations, including the SFAS 87, introduced in 1985, the SFAS 132, introduced in 1997, and the SFAS 158, introduced in 2006. Under the SFAS 132 rule, companies are no longer required to report separate items for overfunded and underfunded plans. The new accounting standard (SFAS 158) requires plan sponsors to account for estimated salary increases, in addition to the current salary levels as adopted in the SFAS 87. The US Congress also passed the Pension Protection Act (PPA) in 1987 that aimed to improve the overall funding of pension plans by requiring severely underfunded firms to make "catch-up" contributions. The "catch-up" contribution ranges from 13.75% – 30% of the underfunding amount (Campbell, Dhaliwal and Schwartz, 2012). The PPA 2006 made substantial changes in contribution requirements. For example, plan sponsors are now required to fund fully their DB plans within seven years instead of 30 years.

In addition to the above regulatory frameworks, the Pension Benefit Guaranty Corporation (PBGC), a government-owned entity managed by the US Department of Labor, protects the retirement income of employees covered by DB pensions plan. When an employer terminates a DB pension plan, the PBGC is responsible for meeting the pension obligations to its employees. However, the PBGC's liability is limited to a certain amount. In 2013, the maximum annual retirement benefit per retiree for single-employer plans was capped at US$ 57,477. For multi-employer plans, the guaranteed benefits are substantially smaller (Brown et al., 2013). Because of their insurance service, the PBGC charges a premium per plan participant that increases with the amount of underfunding. The PBGC also has the authority to force a plan to terminate if it does not meet statutory tests. In addition, plan sponsors may choose to freeze their plans to prevent the accrual of new benefits.[16]

A pension plan is in deficit (underfunded) if its pension liabilities exceed its pension assets. Under the ERISA, when the underfunding amount exceeds 10% of the plan's asset value, the sponsor is required to make a mandatory contribution to reduce the deficit within three to five years. However, the actual amount of contributions can vary. For example, if the pension fund falls short by 20% but stays below 10% in the previous two years, the sponsor can avoid the required contribution. In addition, DB sponsors are allowed to request a hardship waiver or an extension of their contribution period (Franzoni and Marin, 2006).

Overall, the regulations of DB pension plans and the explicit insurance of DB pension benefits by the government (through the PBGC) highlight the importance of DB pension plans. In addition, the complexity of pension accounting and the fact that pension contributions are amortized over time indicate that it is rather difficult to correctly measure the exact amount of

[16] For further details, see Brown et al. (2013).

pension liabilities. This implies that the decision to fund DB pension plans could exacerbate information problems faced by the sponsoring firm. In addition, underfunded pension plans face the risk of making mandatory contributions and paying a higher insurance premium to the PBGC, which creates cash flow constraints.

B. 2SLS Model to Test the Joint Determination of Loan Terms

This section of the internet appendix explains the 2SLS regressions employed to test the joint determination of loan terms, following Bharath et al. (2011), Dennis, Nandy and Sharpe (2000) and Hollander and Verriest (2016). Bharath et al. (2011) argue that loan price is determined after all other non-price terms are settled. Initially, the lead bank conducts due diligence and determines the non-price features. Then, the interest charged on the loan is determined following a book-building process to gauge the interest of potential lenders. Accordingly, loan spread has a unidirectional relation with other non-price loan terms whereas the relations between loan maturity, covenant intensity and collateral are bidirectional. We thus can express the relation between loan spread, loan maturity, covenant intensity and security as follows:

(A1) $SPREAD_{i,j,t} = f(LNMATURITY_{i,j,t}, SECURITY_{i,j,t}, COVENANTS_{i,j,t}, DEFICIT_{i,t-1}, CONTROLS).$

As loan maturity, security and covenant intensity are endogenous variables, in the first stage of the 2SLS procedure, we estimate Equations (7), (8) and (9) using the OLS, logit, and Poisson regression methods, respectively:

(A2) $LNMATURITY_{i,j,t} = f(IVs, CONTROLS),$

(A3) $SECURITY_{i,j,t} = f(IVs, CONTROLS),$

(A4) $COVENANTS_{i,j,t} = f(IVs, CONTROLS),$

where *IVs* denotes the set of instruments for loan maturity, security and covenant intensity. We follow Hollander and Verriest (2016) and Bharath et al. (2011) to choose instruments for loan maturity and security (collateral requirement). The instrument for loan maturity is the average loan maturity in the previous three months (*LNMATURITY_3M*). The instruments for collateral requirement are loan concentration (*LOANCON*)[17] and the four-digit SIC industry median tangibility ratio (*PPE_SIC4*). With regards to covenant intensity, we use the 360-day historical default (*HIS_DEF)* as an instrument. We measure *HIS_DEF as* the total size of the lead bank's defaulted loans in the previous 360 days prior to the facility start date scaled by the total amount of defaulted loans experienced by the lead bank in the three years from year *t-4* to year *t-2* to adjust for the lead bank's history of delinquent loans, with *t* denoting the year of the facility start date. (*HIS_DEF*).[18] Our instrument for covenant intensity is motivated by Murfin (2012), who finds that the lead bank's recent default experience influences the strictness of covenants in subsequent loans.

From the first-stage equations, we obtain the fitted values for loan maturity, security and covenant intensity and substitute these fitted values for the actual values for these variables in Equations (A1) in the second stage. In other words, we estimate the following equation using OLS:

(A5) $SPREAD_{i,j,t} = f(ELNMATURITY_{i,j,t}, ESECURITY_{i,j,t}, ECOVENANTS_{i,j,t}, DEFICIT_{i,t-1}, CONTROLS)$,

where *ELNMATURITY* is the predicted value of loan maturity obtained from Equation (A2), *ESECURITY* is the predicted probability of loan security obtained from Equation (A3), and *ECOVENANTS* is the predicted value of covenant intensity obtained from Equation (A4).

[17] Measured as the current loan amount divided by the sum of the loan amount plus existing debt.

[18] To identify defaulted loans, we first identify defaulting borrowers using S&P monthly ratings. A company is in default if it has a "D" or "SD" rating by S&P. Using the GVKEY symbol and the date of the "D" or "SD" rating, we are able to trace all outstanding loans of the defaulting borrower and the lead bank(s) of these loans.

CONTROLS denotes all control variables outlined in Equation (2). We report the second-staged regression results in Table 4 of the main text.

C. Other Robustness Checks

In this section, we perform a battery of additional analysis and robustness tests on the impact of DB pension deficits on the cost of borrowing. We report the results in Table IA. First, to mitigate the influence of extreme observations, we use a median regression with robust standard errors to estimate Equation (2) and report the results in Model 1. The size and significance of the explanatory variables are consistent with our baseline results, indicating that outliers do not influence our baseline results.

Second, our loan observations are at the facility level. Given that multiple loan facilities might belong to the same loan package, cross-sectional regression standard errors may be biased, resulting in overstating the statistical significance of our results. To overcome this problem, we re-estimate the baseline model at the loan package level. However, important loan information, including maturity, security, type, and purpose, is lost when we examine loan packages. Therefore, rather than using loan packages, we restrict our sample to include only the largest loan facility per loan package per year, following Hasan et al. (2014). We then re-estimate Equation (2) for this sample of 7,683 loan facilities. As shown in Model 2, the results for this sample are consistent with our main results reported in Table 2 of the main text.

Similarly, loans initiated by the same lender have high correlation with one another, leading to biased standard errors. We address this concern by using a two-way firm-lead bank clustering method to adjust the standard errors. We identify the lead lender for each loan facility using Ivashina (2009) definition of the lead arranger role. In particular, we search for lenders identified as the administrative agent by Dealscan. If the loan does not have an administrative agent, we then search for the terms *agent, arranger, book runner, lead arranger, lead bank,* and *lead manager* in the lender role field. We remove loan observations for which information about the lead bankers are not available. The final sample includes 3,928 observations. We report the results of this analysis in Model 3.

In addition, our results are robust to an alternative measure of total borrowing costs that includes various fees charged by lenders. We use the sum of loan spread, upfront fee, commitment fee, utilization fee, facility fee and cancellation fee provided by Berg, Saunders and Steffen (2016) as a proxy for total borrowing costs. Model 4 reports the relation between the pension deficit ratio and the total borrowing cost. The positive and significant coefficient for the pension deficit ratio indicates that pension underfunding has a material impact on the overall cost of borrowing. Finally, we also restrict our sample to firms that are older than five years to ensure our results are not driven by firm age. The results are reported in Model 5. Overall, the coefficients of *DEFICIT* in all models in Table IA are positive and significant, consistent with the baseline results documented in Table 2 of the paper.

[Insert Table IA here]

We also perform a number of other robustness checks. First, we exclude financial years before 1987 due to the change in the requirement of mandatory contributions under PPA 1987. Second, to address the potential effect of the firm cycle on pension funding status (for instance, older firms might have larger pension deficits as their pension contributions are accumulated over a longer period of time), we also include the natural log of firm age as a control variable in Equation (2). Overall, our additional robustness checks presented in this section provide strong support that the extent of pension deficits increases the cost of bank loans.

TABLE IA
Further Robustness Checks

This table presents various robustness test results on the impact of pension deficits on the cost of bank loans. The dependent variable in all analyses is the log of the all in drawn spread variable obtained from Dealscan. In Model 1, we use the median regression with robust standard errors. In Model 2, we include only the largest loan facility within a loan package per year in our sample. In Model 3, we rerun Equation (2) with a two way clustering of standard errors at the firm level and at the lender level. In Model 4, we use the overall cost of borrowing, including interest costs and other fees, in Berg, Saunders and Steffen (2016) as the dependent variable. In Model 5, we require the sample firms to have at least five years of age. We cluster the standard errors at the firm level in Models 1, 2 and 5.We present *t* statistics in parentheses. The symbols ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. We provide detailed description of the variables in Appendix 1 of the paper.

	Models				
	1	2	3	4	5
DEFICIT	0.2606	0.2415	0.2024	0.2484	0.2507
	(10.82)***	(4.80)***	(2.47)***	(5.32)***	(4.53)***
Constant	7.8938	5.1224	7.282	7.5576	5.4759
	(11.43)***	(12.51)***	(17.26)***	(28.52)***	(14.32)***
Loan syndication dummy	Yes	Yes	Yes	Yes	Yes
All other controls	Yes	Yes	Yes	Yes	Yes
Loan type and loan purpose fixed effects	Yes	Yes	Yes	Yes	Yes
Credit ratings fixed effects	Yes	Yes	Yes	Yes	Yes
Year and industry fixed effects	Yes	Yes	Yes	Yes	Yes
R2/Pseudo R2	0.5089	0.7206	0.6913	0.8196	0.7101
N	10,298	7,683	3,928	8,026	9,912

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