Interest Rates and the Design of Financial Contracts

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Abstract

We show that loan interest rates are sticky, responding less than one-for-one with changes in interest rates, for several distinct reasons. The inverse relationship between interest rates and loan spreads is predicted by no-arbitrage models of credit spreads in perfect capital markets. However, the presence of interest rate floors and cross-sectional variation in loan term sensitivities to interest rates is due to a combination of banks' market power over funding sources and contracting parties' efforts to share risk and provide incentives.

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Despite a large body of evidence showing that nominal interest rates play a central role in the allocation of credit, there is much less evidence showing that interest rates affect the financial contracts defining that allocation. This dearth is troubling for several reasons. First, interest rate variation directly affects the risk of default. Second, interest rates affect the primitives governing the contracting problem between borrowers and lenders, namely, wealth and outside options. Finally, if financial contracts respond to interest rate variation, then this response has potentially important implications for borrowers, lenders, and policymakers.

The goal of this study is to identify how and why interest rates affect financial contracts using the syndicated loan market as a laboratory. Specifically, we focus on the implications of interest rate variation for loan pricing mechanisms, while exploring other features (e.g., maturity and covenants) as means to shed further light on any relations. We assemble a novel dataset of loan originations and prices for a market that channels over a trillion U.S. dollars to corporate borrowers annually. Lenders in this market cover a broad spectrum of investors including traditional commercial banks, insurance companies, asset managers (e.g., mutual funds, hedge funds), and collateralized loan obligations (CLOs).

We start by showing a robust negative relation between interest rates and loan pricing. A one percentage point decrease in LIBOR is associated with a 25 basis point increase in credit spreads. Because loan interest is computed as the sum of a benchmark rate (e.g., LIBOR) and the credit spread, loan interest rates are "sticky", responding less than one-for-one with changes in interest rates. Principal components analysis reveals that this effect embeds two aspects of interest rates more broadly. A one percentage point decrease in the level of interest rates (first principal component) is associated with a 52 basis point increase in loan spreads. This level effect is tempered by the slope effect (second principal component). A one percentage point decrease in the slope of the yield curve is associated with a 28 basis point decrease in spreads. Thus, the negative relation between interest rates and loan prices captures both the current rate environment, as well as expectations of future interest rates.

The sticky nature of loan interest rates is often attributed to market imperfections, such as information asymmetry (Berger and Udell (1992)) or market power (Drechsler et al. (2018)). We show that no-arbitrage models of credit risk (e.g., Merton (1976)) generate quantitatively similar interest rate sensitivities. Further, no-arbitrage models generate cross-sectional variation in interest rate sensitivities across loan credit ratings that also match that found in the data. Spreads in riskier loans are more sensitive to interest rate variation than safer loans. Put differently, loan interest rates are stickier for riskier loans.

Where no-arbitrage models fall short is in explaining other elements of the pricing mechanism and the role played by lenders. Over one third of the loans in our sample contain an interest rate floor that places a lower bound on the benchmark rate. While ostensibly a guard against negative rates, the median level of the floor is 1% suggesting that negative rates are not the only concern. With perfect capital markets, rate floors are irrelevant. Lenders can increase the spread to accommodate any additional expected cash flows that would be realized from the presence of a floor. That is, there always exists a value-equivalent adjustment to the spread that would make both contracting parties indifferent between the presence of a floor and a higher credit spread. Likewise, lenders are assumed to provide an infinitely elastic supply of capital.

We show that the probability of including a rate floor is decreasing in LIBOR and increasing in expectations of future interest rates. Further, the sensitivity of LIBOR floors to interest rates is increasing in borrower risk. When interest rates decline, loans to riskier borrowers are more likely to contain a rate floor than loans to safer borrowers. Economically, floors have a significant impact on borrowers and lenders. Between 2010 and 2015, rate floors were responsible for over 7% of the aggregate interest expense in the market.

Like borrower risk, lender risk also plays an important role in the structure of loan terms. The spreads in loans from lenders with larger interest rate risk exposure are more sensitive to interest rates than those from lenders with less exposure. Specifically, loan interest rates are stickier among lenders with greater interest rate exposure. These results are consistent with most banking theories predicated on market power over funding sources, notably deposits (e.g., Drechsler et al. (2018)). However, our results show that these same patterns exist among non-commercial bank lenders — investment banks, insurance companies, hedge funds, and collateralized loan obligations (CLOs) — that have no market power over funding sources. Thus, market power theories are at best a partial explanation for loan terms.

To complete the picture, we argue that risk-sharing and incentives — the central features of financial contracting (Freixas and Rochet (2008)) — play an important role in rationalizing our findings. Interest rate variation affects borrower and lender risk in an opposing manner. Declining interest rates lead to lower interest expense and stronger financial health for borrowers, but decreasing margins and weaker financial health for lenders. From a risk-sharing perspective, loan spreads should be inversely related to interest rates, and this relationship should be stronger (in magnitude) for riskier lenders, as we observe.

From an incentive perspective, rate floors are preferable to higher spreads because future increases in interest rates will exacerbate the incentive misalignment between borrowers and lenders (e.g., risk-shifting as in Jensen and Meckling (1976)). Indeed, the slope principal component of the yield curve is strongly positively correlated with the inclusion of a floor, suggesting that expectations of higher future interest rates are associated with a larger fraction of loans with rate floors. And, riskier loans are more likely to include an interest rate floor when rates decline than safer loans.

Because CLOs are the largest nonbank investor in this market, we show that the risk-appetite and incentives of CLO investors are not too different from those of bank investors. The fraction of CLO debt tranches including a rate floor exhibit a similar trend to the fraction of loans containing rate floors. In fact, the fraction of CLO debt tranches with rate floors exhibits a leading relationship to the fraction of loans with rate floors. Thus, CLO debt investors are no more, and arguably less, receptive to the idea of negative returns than depositors.

Rate floors also satisfy the incentives of CLO equity investors, which are often comprised of CLO managers. We show how rate floors in the loans held by CLOs provide equity investors with additional yield on their investment, on average. This additional yield also results in higher fees for CLO managers, which contain a performance components linked to equity returns. Thus, the incentives of investors, like those of borrowers, are reflected in loan terms.

This paper builds on a large and growing empirical literature studying the design of financial contracts, much of which focuses on debt.[1] Our study differs in several regards. We are able to match a number of empirical patterns using no-arbitrage models that are free of any market imperfections. Put differently, sticky loan interest rates provide a weak test against the null of perfect capital markets. Our study also emphasizes that the pricing mechanism is in part a reflection of market power over funding sources, and in part a reflection of risk-sharing and incentive provision.

This message, and supporting analysis, is also what distinguishes our study from recent work by Cohen, Lee, and Stebunovs (2016) and Arscott (2018), who argue that interest rate floors are a consequence of supply-side (i.e., lender) concerns. We argue that rate floors are a mechanism to reallocate risk and incentives in a state-contingent manner. Floors reallocate risk from lenders to borrowers in low-rate environments when lenders are financially weaker and borrowers financially stronger. Floors also allow lenders to keep spreads lower in case interest rates rise, borrower risk increases, and risk-shifting concerns become more important.[2]

The remainder of the paper is organized as follows. Section 1 describes the construction of the sample. Section 2 presents evidence on the relation between interest rates and loan terms.

[1] A number of studies investigate particular aspects of corporate debt contracts including: pricing (e.g., Asquith, Beatty, and Weber (2005), Drucker and Puri (2009), Berg, Saunders, and Steffen (2016)), maturity (e.g., Flannery (1986), James (1987), Stohs and Mauer (1996), Demirguc-Kunt and Maksimovic (1999), Fan, Titman, and Twite (2012), Li, Loutskina, and Strahan (2019)), collateral (e.g., Benmelech and Bergman (2008), Benmelech (2009)), and covenants (e.g., Smith and Warner (1979), Malitz (1986), Berlin and Mester (1992), Bradley and Roberts (2015), Becker and Ivashina (2017), Green (2018), Berlin, Nini, and Yu (2019), Prilmeier and Stulz (2019)). Recent work in the macrofinance literature examines the interaction between debt contracts and the transmission of economic shocks (e.g., Chodorow-Reich and Falato (2019), Greenwald (2019)) and the effects of low rates on bank lending (e.g., Balloch and Koby (2019), Wang et al. (2019)).

[2] Our analysis and economic message also distinguishes our work from Black and Rosen (2016) and Paligorova and Santos (2017), who explore the role of monetary policy on loan maturities and spreads, respectively.

Section 3 explores the economic channels underlying these results. Section 4 concludes.

1 Data

We rely on loan-level data from three sources: IHS Markit's Loan Pricing and Performance database, Standard and Poor's (S&P) Leveraged Commentary and Data, and Thomson-Reuters' Dealscan database. For brevity, we refer to these sources as Markit, S&P LCD, and Dealscan, respectively. Each database contains information on syndicated loan contracts; however, the loan coverage and the scope of information differ.[3] Our analysis focuses on the Markit database, which encompass most of the S&P LCD data based on conversations with data providers and our own analysis. The Internet Appendix contains analysis showing the consistency of our main results across datasets.

Loans in the Markit sample must satisfy the following criteria to be included in our analysis: U.S. dollar denominated, strictly positive loan principal, strictly positive maturity, nonnegative loan spread, and originated between January 1, 1997 and October 31, 2020. The sample is further limited to first-lien, secured loans to ensure comparability across contracts. Second-lien and unsecured loans dropped from the sample comprise less than ten percent of the sample. We exclude a small number of debtor-in-possession loans and loans rated CCC+ or lower from our sample because the issuers of these loans are in default or at imminent risk of default at the time of issuance. Finally, we exclude a small number of other loan types including: hybrid facilities, bridge loans, letters of credit, and notes.

Lender financial information is obtained from the Center for Research in Security Prices (CRSP), S&P Compustat, and Bank Holding Company FR Y-9C databases, accessed through Wharton Research Data Services. We obtain data on borrower financial statements from S&P Compustat by merging the loan-level data from Markit with Dealscan and applying

[3] Most syndicated loans involve privately held borrowers and are not subject to public disclosure, so contract information is sourced from the data providers' respective industry connections. Each of the databases contains between one-third and one-half of the approximately \$3.5 trillion of broadly syndicated loans outstanding (Bank of America Merrill Lynch (2019)) at the end of our sample period.

the Dealscan-Compustat link from Chava and Roberts (2008). Macroeconomic time series comes from the St. Louis Federal Reserve Economic Data (FRED) website. Information on the structure and pricing of CLOs comes from the Creditflux CLO-i database. Further details on the data sources and variable definitions may be found in the Internet Appendix.

1.1 Sample Statistics

Using the Markit data, Panel A of Figure 1 reports the aggregate amount of new originations in the U.S. syndicated loan market broken out by tranche type. The tranches correspond to an important segmentation in this market.

Pro rata tranches, consisting of revolving lines of credit and term loan A facilities (Pro rata TL in the figure), are held primarily by commercial banks. Lines of credit may be drawn down and repaid over the life of the loan. Term loans are typically fully drawn at origination. Pro rata term loans are back according to an amortization schedule — hence the "A" designation in term loan A.

Institutional tranches are structured for nonbank investors, such as collateralized loan obligations (CLOs), loan funds, and hedge funds, though some commercial banks invest in these tranches as well.[4] Institutional term loans typically pay quarterly interest and a one-time principal (a.k.a., bullet) payment at maturity.

The growth of the market over the sample period is apparent, as is the effect of the financial crisis in 2008 and 2009. Less obvious but still significant is the changing composition of loans over time. Institutional lending has outpaced pro rata lending in most years since 2004.

Panel B of Figure 1 presents the temporal distribution of institutional tranche investors using data from S&P LCD. CLOs are the most prominent investor type, responsible for the majority of funding since 2002. Hedge funds, loan mutual funds, and high-yield bond funds

[4]We pool the pro rata and institutional loans throughout our main analysis to simplify the exposition. The Internet Appendix provides supplementary results showing that our main findings are qualitatively similar in both segments of the market.

provide most of the remaining funding, with insurance companies and finance companies accounting for a small share.

Table 1 reports summary statistics for the Markit sample. The typical loan principal is for 27 million dollars and has a stated maturity of 5.3 years. A small fraction, 9%, of loans in our sample, are classified as covenant-lite, though they are heavily concentrated in institutional tranches issued towards the end of our sample.[5] The average interest rate spread (a.k.a., credit spread, loan spread, or just "spread") to LIBOR is 3.78%. Over a third of loans contain a LIBOR Floor, identified by the indicator function $1(Floor)$. The typical floor is set at 1%, but the range spans from zero to over 5%.

Because of the prominence that LIBOR floors play in our analysis below, we briefly discuss their implications for calculating loan interest. Without a floor, the coupon rate is computed as the sum of a base interest rate that varies over time (e.g., LIBOR) and a loan spread that is fixed at issuance.[6] Floors place a lower bound on the base rate, effectively converting the loan to a fixed-rate instrument when the base rate is below the floor. For example, suppose the loan spread is 3% and the level of the floor is 2%. If LIBOR is 1%, then the floor binds and the annualized coupon rate is 5% (3% spread plus the level of the floor, 2%). If instead LIBOR is 4%, then the floor is not binding and the coupon rate is 7% (3% spread plus LIBOR, 4%).

[5] Covenant-lite indicates the presence of incurrence, as opposed to maintenance, financial covenants. An example is useful for understanding the difference. Consider a leverage covenant restricting the debt-to-EBITDA ratio to remain below four. Should the borrower's debt-to-EBITDA ratio rise above four for any reason, the borrower would be in violation of the loan agreement under a maintenance covenant. With an incurrence covenant, the borrower must take an action (e.g., issue debt) that generates a debt-to-EBITDA ratio greater than four to be in violation. So, if the borrower's debt-to-EBITDA ratio rises above four because of an earnings shock, the borrower would not be in violation of the incurrence covenant. See Becker and Ivashina (2017), Berlin, Nini, and Yu (2020), and Prilmeier and Stulz (2020) for more details on covenant-lite loans.

[6] Some loan spreads vary according to a predetermined schedule linking the spread to a borrower risk metric, such as credit ratings or leverage. These performance pricing measures are present in one-fifth of loans in the Dealscan sample.

2 Interest Rates and Contract Terms

Figure 2 presents a first look at the relation between interest rates and average contract terms. Our goal with these figures is to provide an unobstructed view of the data to understand potential associations. We focus on three-month LIBOR because, as the benchmark interest rate for virtually all of the loans in our sample, it is the most salient. Subsequent sections explore the robustness of any patterns, as well as the relation of contract terms to other features of the yield curve.

Several patterns in Figure 2 stand out. Loan spreads appear negatively correlated with LIBOR, though much of the variation in this series appears concentrated around the Great Recession. The presence and level of LIBOR floors appear weekly negatively correlated with LIBOR. More pronounced in these series are the trends. Though present as early as 2002, the presence of LIBOR floors increased dramatically from less than 5% in 2008 to over 80% by 2020. During that same period, average floor levels decreased from over 3% to less than 75 basis points. Finally, loan maturity is positively correlated with LIBOR; while, covenant-lite status behaves similarly to LIBOR floor inclusion but on a smaller scale.

Though informative, the plots raise more questions than they answer.

- Are other macroeconomic forces (e.g. aggregate productivity or demand) confounding the relations?
- Is variation in the composition or characteristics of borrowers and lenders responsible for the observed associations?
- Are other rates or features of the yield curve related to loan terms?

The remainder of this section answers these questions.

2.1 Panel Regressions

We answer the first two questions by estimating panel regressions of the following form:

$$y_{i,b,l,t} \quad = \quad \alpha + \beta r_t + \gamma W_t + \delta X_{i,b,l,t} + \mu_b + \kappa_l + \varepsilon_{i,b,l,t}. \tag{1}$$

The outcome variable y corresponds to a contract term (e.g., spread, presence of a LIBOR floor), r is three-month LIBOR, W is a vector macroeconomic controls, X is a vector of controls that vary cross-sectionally and temporally, μ is a borrower-fixed effect, κ is a lender-fixed effect, and ε is a loan-specific effect. The indices denote loan i to borrower b arranged by lender(s) l in quarter t.

The goal with these regressions is to mitigate endgoeneity concerns, primarily those arising from sample selection and omitted variables. Reverse causality is less of a concern as the loan market, while economically significant, is not large enough to cause variation in LIBOR or other interest rates (e.g. Treasury's). The fixed effects alleviate concerns that the composition of borrowers or lenders is changing over time in a manner that is correlated with credit supply or credit demand. Coupled with the control variables, W and X, the fixed effects also mitigate omitted variables concerns by holding fixed time-invariant observable determinants of credit supply and demand. Though not a solution to the omitted variables problem, the model in equation (1) is a useful starting point for isolating the relation between contract terms and the short rate.

Table 2 presents the estimation results using the Markit sample of loans. We estimate the model with (Panel B) and without (Panel A) fixed effects to isolate the impact of a changing composition of borrowers or lenders. The models used for both sets of results are otherwise identical. Indicators for loan credit ratings measure borrower credit risk. The log of loan principal measures borrower credit demand.[7] Indicators for loan type (line of credit

[7]For the term loans on which we focus, borrowers approach lenders with a predetermined funding need. Though there may be changes to the exact amount during the syndication process, most of the variation in loan principal is due to differences in funding requirements as opposed to equilibrium price changes. Indeed, Crawford et al. (2018) use loan principal as an exogenous variable in the context of small business lending.

vs. term loan) are included to hold constant fee structures, and distribution and payment terms.

The macroeconomic controls include real gross domestic product (GDP) growth, a recession indicator, and the cyclically adjusted equity market price-to-earnings (PE) ratio from Robert Shiller's website. The first two variables measure the state of the economy while allowing for a linear and nonlinear relation with contract terms. The recession indicator also alleviates the concern that any relations are isolated to the period surrounding the Great Recession. The PE ratio proxies for the cost of an alternative funding source, equity, while also capturing aspects of the broader economic environment.

We focus attention on the results from the fixed effect estimation in Panel B, which offer more conservative estimates of the interest rate relations. The attenuation in coefficient magnitudes observed when moving from Panel A (no fixed effects) to Panel B (fixed effects) suggests that a changing sample composition is partly responsible for the relations observed in Figure 2. However, all of the LIBOR coefficient estimates are economically and statistically significant. A one percentage point increase in LIBOR is associated with a 25 basis point decrease in average spread and an 8.2% decrease in the probability of a LIBOR floor being present in the contract. Conditional on a floor being present in the loan, a one percentage point increase in LIBOR is associated with a 9.6 basis point increase in the level of the floor.

The fourth column presents results for the spread equivalent of the LIBOR floor, if any, in the contract. This measure, referred to more succinctly as "floor value", is estimated using the Black (1976) model. In a world constrained only by no-arbitrage, the floor value is an estimate of how much higher spreads must be to compensate lenders for removing the LIBOR floor from the contract. Contracts that do not have a LIBOR floor have a floor value of zero. The LIBOR coefficient estimate implies that a one percentage point decrease in LIBOR is associated with a 3.3 basis point increase in floor values. Untabulated results show that, conditional on the contract having a floor provision, the average and standard deviation of the floor value measures are 36 and 29 basis points, respectively.

The fifth column aggregates the spread and floor value into one measure, adjusted spread. This measure is constructed by simply adding the spread and floor value. As such, the coefficient estimates are, but for rounding error, the sum of the coefficient estimates from the spread and floor value regressions. The key takeaway is that the floor value results in an increase in the magnitude of the interest rate relation from 25 to 29 basis points.

The last two columns present results for loan maturities and covenant-lite status to understand how these nonprice terms are moving with respect to interest rates. Loan maturities are positively associated with increasing interest rates — 3 months for each one percent. The propensity of a loan to be classified as covenant-lite declines by 3.4% for each one percent increase in interest rates. This is a large effect relative to the fraction of loans designated as such (9.2%).

Though not the focus of our study, we briefly note that the control variables play an important role in shaping loan terms. All three macroeconomic controls are economically important for shaping loan contract terms. And while not reported, loan rating indicators are highly statistically significant in most specifications. We look more closely at the role of borrower risk below.

In sum, there is a significant and robust negative association between LIBOR and loan terms. Unreported results using the yield on three-month Treasury bills are quantitatively similar. This similarity is unsurprising; the two rates have a correlation of 0.98.

2.2 Term Structure Decomposition

Now we turn to the third question posed above that asks whether other interest rates might matter for loan terms. There is good reason to believe they should. Under the expectations hypothesis, long-term rates are relevant for the decision-making of rational borrowers (and lenders). The practical question is: Which rates and how can we disentangle their effects? Interest rates are highly correlated. The correlation matrix of daily zero-coupon Treasury yields over our sample horizon reveals that the smallest correlation is almost 0.70, while the average is 0.94. (See the Internet Appendix for a tabulation of these results.)

To address this challenge, we turn to the term structure literature. Litterman and Scheinkman (1991), as well as more recent studies (Cochrane and Piazzesi (2005) and Piazzesi (2010)), show that most of the information in interest rates can be distilled in the first three principal components (PCs), each of which captures a different feature of the yield curve. We replicate this analysis using daily zero-coupon Treasury yields from Gurkaynak, Sack, and Wright (2007) for the period 1997 to 2020. Untabulated results reveal that the first PC explains 94.2% of the variation in the yield curve. The first three PCs explain over 99.8% of the variation.

Figure 4 displays the first three yield factors. The results are consistent with previous studies. The first factor consists of strictly positive loadings, suggesting that shocks to this component affect all yields in a similar manner. Hence, this factor is referred to as the level factor. It coincides most closely with an interest rate level, such as the LIBOR regressor used in our previous analysis. The correlation between LIBOR and the first PC is 0.78.

The second factor consists of negative loadings on the short end and positive loadings on the long end of the yield curve. Shocks to this factor affect different ends of the yield curve in opposite directions. Thus, this factor is referred to as the slope factor. The correlation between the second PC and the long-short spread (10-year yield minus 3-month yield) is 0.90. Economically, the second PC measures expectations of future interest rates.

The third component has positive loadings on the very short-end and long-end of the curve, and negative loadings in the middle. This factor is referred to as curvature, and shocks to it correspond to a buckling of the yield curve. The economic interpretation of this component is less clear relative to the first two factors. Further, the marginal contribution of this component to the total explanatory power of the PCs is negligible, an incremental R^2 of 0.3%. Thus, we focus attention on the first two components in our analysis.

The last aspect of interest rates we explore is uncertainty as measured by the MOVE index. Developed by Merrill Lynch, the index is constructed from the implied volatilities for constant one-month at-the-money options on US Treasuries. The index measures market participants assessment of interest rate uncertainty, analogous to the VIX's measurement of equity value uncertainty.

Table 3 presents the estimation results for equation 1 where we have replaced LIBOR with the first two PCs of the yield curve and the MOVE index. We refer to these variables in the table as level PC, slope PC, and yield volatility, respectively. The specifications in Panels A and B are otherwise identical to those in the corresponding Panels of Table 2. As before, we discuss the more conservative results in Panel B obtained from the fixed effect specification.

The level PC coefficients are qualitatively similar the results found with LIBOR in Table 2. Quantitatively, there are some notable differences. The level PC is more strongly correlated with loan terms, highlighting the importance of the level of the yield curve as a whole. A one percentage point upward shift in the yield curve is associated with a 52 (25) basis point decrease in spreads, a 23% (8.2%) decrease in the probability of including a floor, and a 34 (9.6) basis point increase in the level of the floor. (The numbers in parentheses are the corresponding values from Table 2.) The floor values and adjusted spreads are similarly more strongly correlated with the level PC than with LIBOR. Finally, the nonprice terms, maturity and covenant-lite status, are also more strongly correlated with the level PC than LIBOR.

These findings suggest that LIBOR captures only some of the information in interest rates that is relevant for loan terms. The slope PC coefficients provides some insight into what exactly that information may be. The slope PC contains information about future interest rates under the expectations hypothesis. The coefficient estimates show that the slope PC is positively associated with both spread and the propensity to include a floor, which results in positive associations with the floor value and adjusted spread. As expectations of future interest rates increase, loans become more expensive for borrowers. However, the magnitudes of the slope coefficients are smaller than those of the level, suggesting that interest rate expectations moderate the effects of the current interest rate environment.

Uncertainty about future interest rates, as captured by yield volatility, has a significant effect on loan spreads and the level of the floor, though economically these effects are modest. Interest rate uncertainty is associated with higher loan spreads and floor levels, resulting in high adjusted spreads. Put differently, uncertainty about future interest rates leads to discounted loan prices, reminiscent of the information uncertainty premium in Stock returns (Zhang (2004)).

These findings demonstrate that different aspects of the yield curve are relevant for loan terms. Taking a bit of liberty with the regression coefficients reveals that the sum of the first and second PC coefficients are similar, though typically larger, in magnitude to the LIBOR coefficients in Table 2. Thus, LIBOR encapsulates different information from the yield curve but in a manner that is quantitatively similar to one that disaggregates the different components.

3 Why do Interest Rates Matter for Contract Terms

There are several reasons why interest rates might correlate with loan terms. This section explores those reasons. Specifically, we investigate the empirical implications of different theories of credit risk and bank lending. We pay close attention to non-overlapping implications in attempt to discriminate among different theories.

3.1 No Arbitrage Models of Credit Risk

Our null hypothesis is the perfect capital market setting of no-arbitrage models of credit risk. We focus attention on the Merton (1974) model because of its simplicity and transparency. We present corroborating results using the Black and Cox (1976) model in the Internet Appendix. The limitations of these models for pricing corporate bonds are well documented (Collin-Dufresne et al. (2001)), though still subject to debate (Feldhutter and Schaefer

(2018)). Because of the data required by these models, the analysis here uses the Markit-Dealscan sample.[8] The model-implied interest rate sensitivities of credit spreads for each loan are constructed as follows. Baseline estimates are constructed using the empirical counterpart for each model parameter at the prevailing interest rate. We then recompute the model-implied spread by increasing and decreasing the interest rate parameter by 0.5%. The difference in spreads is the model-implied, interest rate spread sensitivity. Further, details may be found in the Internet Appendix.

Table 4 presents the empirical distribution of loan spread interest rate sensitivities estimated from the Merton model. The statistics are computed for the whole sample, as well as each loan rating category. Unconditionally, the average sensitivity is -30 basis points. Intuitively, the Merton model generates spread responses to interest rate variation that dampen the effect of an interest rate change. In the language of Berger and Udell (1992), loan interest rates are sticky, responding less than one-for-one with changes in the interest rate.

Table 4 also shows that commercial loan rates become stickier as credit risk increases. Riskier borrowers, as measured by loan rating, face larger decreases in spreads when interest rates rise. Consequently, interest expense is less responsive to interest rate variation among riskier borrowers.

The question now is: How do the model-implied sensitivities compare to what we see in the data? The unconditional estimate of 30 basis points is, perhaps surprisingly, close to the empirical spread (25 basis points) and adjusted spread (29 basis points) sensitivities presented in Panel B of Table 2. Sensitivities by loan credit rating are estimated using the panel regression model in equation (1), augmented with interaction terms between LIBOR and loan credit rating indicators. The control variables include log issue size, GDP growth, a U.S. recession indicator, and fixed effects for loan type, credit rating, borrower industry,

[8]The Merton (1974) and Black and Cox (1976) models apply option-pricing techniques to the valuation of corporate liabilities. They require information on the borrower's debt structure, as well as the loan's maturity and the borrower's asset volatility. We calibrate asset volatility to the observed loan credit spread, instead of unlevering the borrower's equity volatility, to avoid the underestimation of credit spreads documented by Huang and Huang (2012). The Internet Appendix provides details on how we calibrate the model.

and lead arranger.

The estimation results are presented in Panel A of Table 5. The excluded rating category is investment grade-rated loans. Focusing on the first column, the sensitivity of spreads to LIBOR is increasing in borrower riskiness. The spread sensitivity to interest rates of investment grade-rated loans is -13.5 basis points, compared to that of a BB minus-rated loan, -24.1 basis points, or a B minus-rated loan, 37.2 basis points. The same sensitivities for adjusted spread are -15.3, 29.0, and 43.5 basis points, respectively.

To ease comparisons with the implications from the Merton model, Panel A of Figure 5 plots the interest rate sensitivities by rating category for the spread and adjusted spread, alongside the predictions from the Merton model. For rated loans, the Merton model overestimates the magnitude of the interest rate sensitivity. However, the pattern is strikingly similar and the difference in magnitude, for adjusted spreads, is typically less than 10 basis points. In a nutshell, the Merton model provides a qualitatively accurate representation of what we see in the data.

More difficult to see in Figure 5 is the role of LIBOR floors. The gap between the spread and adjusted spread widens as credit ratings decline. The second column in Panel A of Table 5 shows that the interest rate sensitivity of LIBOR floors is increasing with credit ratings. Riskier borrowers are more likely to include a LIBOR floor in their contracts as interest rates decline than less safe borrowers.

Floor levels exhibit the opposite pattern in Panel A of Table 5. Increases in LIBOR are associated with an increase in the floor level. However, for riskier borrowers, there is no relation between the floor level and LIBOR. For example, consider B+ rated firms. The interest rate sensitivity of floor levels for these firms is approximately zero, and similarly all firms rated BB- and lower.

In sum, no-arbitrage models of credit risk provide a qualitatively, and arguably quantitatively, consistent explanation for loan spread patterns observed in the data. The stickiness of loan interest rates often attributed to credit rationing (Stiglitz and Weiss (1981)) or market power (Drechsler et al. (2018)) exists in a world without market imperfections. However, credit risk models are of no help in explaining why borrowers and lenders choose interest rate floors, as opposed to higher spreads. Further, these models have nothing to say about any role that lenders play in the contracting process. The remaining sections explore these features of the data more closely.

3.2 Market Power

As mentioned, the stickiness of loan interest rates is not unique to no-arbitrage models of credit risk. Banking theories predicated on market power over funding sources argue that deposits act like long-term, fixed rate liabilities (Drechsler et al. (2020)). A natural hedge for this risk is long-term, fixed rate assets. While bank assets tend to be long-term, they are often floating rate, e.g., commercial loans. One way to mitigate interest rate risk is through spread adjustments that offset interest rate movements. In other words, the negative relation between spreads and interest rates are one way in which banks can hedge interest rate risk.

Another way to mitigate this risk is through the inclusion of interest rate floors that explicitly convert floating rate debt to fixed rate debt below a certain threshold. Further, floors address concerns with fixed operating costs. Even if interest rate risk is perfectly hedged, the risk associated with fixed operating costs increases as interest rates, and therefore interest income, decline with interest rates. Floors ensure a minimal return regardless of how low interest rates go. The unconditional results in Tables 2 and 3 are consistent with this rationale. As interest rates decline, spreads increase and loans are more likely to incorporate rate floors.

Market power theories also predict that lenders with larger interest rate exposure should exhibit larger loan spread sensitivities. Panel B of Table 5 explores this implication. The regression is similar to that found in Panel A and discussed above. The one difference is that loan-rating indicators are replaced with lender income gap indicators representing tertiales of the income gap distribution. We use tertiales instead of quartiles beacuse of the lender data requirement and corresponding smaller sample size.

The income gap (Gomez et al. (2020)) measures the difference between the values of assets and liabilities that mature or reprice within one year. In doing so, this measure captures the interest rate exposure of bank profits to interest rate fluctuations. When interest rates increase, interest income/expense increases. If a bank's income gap is large, the increase in interest income is greater than interest expense and the bank is better off. When interest rates decrease, banks with a large income gap will be worse off as the decline in interest income is relatively larger than the decline in interest expense. Banks with small income gaps are less sensitive to interest rate variation because of similar effects on interest income and interest expense.

The results in Panel B of Table 5 show that loan spread sensitivities are increasing with the income gap. When interest rates decline, spreads increase by more for lenders with larger income gaps. Though, we don't see similar results for the presence of a floor or the floor level. Thus, the predictions of market power theories are consistent with the data as it pertains to the spread, but these theories are less clear on the presence of rate floors.

Panel B of Figure 5 visualizes the spread and adjusted spread results, along with the predictions from the Merton model. We see no meaningful variation in interest rate sensitivities from the Merton model across lender income gaps. This result makes sense. There is no lender in the Merton model. The empirical results are different. Both spread and adjusted spread lines are declining in the income gap, consistent with the implications of market power theories.

Reconciling the results from Panels A in Figure 5 and Table 5 with market power theories is more difficult. Putting aside LIBOR floors, changes in interest rates affect low- and high-risk borrowers similarly because the computation of interest is the same. To tease out an implication, one must look at secondary effects and even then the implication is ambiguous. Loans to low-risk borrowers tend to be larger, implying that variation in interest rates has a larger effect on interest income generated by highly rated firms. On the other hand, the probability of default for high-risk borrowers is more sensitive to interest rate variation, implying that variation in interest rates has a larger effect on interest income generated by low-rated borrowers.

Less ambiguous is the group of lenders for which market power over funding sources is most relevant, commercial banks. Commercial banks hold the deposit franchise, in the language of Dreschler et al. (2020). Therefore, the stickiness of loan interest rates should be most pronounced among commercial banks. To distinguish commercial banks from other lenders, we use loan type. As discussed, pro rata tranches are held primarily by commercial banks, institutional tranches primarily by nonbank intermediaries. While there are exceptions, they are just that, exceptions.

Panel C of Table 5 explores this hypothesis by interacting LIBOR with an indicator for institutional term loans. The LIBOR coefficients capture the interest rate sensitivity of loan terms for pro rata tranches, our proxy for commercial bank creditors. The coefficient estimate in each models is economically large in magnitude and statistically significant. Loan interest rates are sticky for commercial banks, who are also more likely to incorporate a floor and at a higher level in response to declining interest rates.

Interestingly, institutional tranches, our proxy for nonbank intermediaries, exhibit similar, if not stronger, behavior than pro rata tranches. With the exception of the floor level specification, the interaction coefficient estimates are all negative and statistically significant. For example, a one percentage point decline in interest rates is associated with a 23 basis point increase in spreads for pro rata tranches, and a 27 basis point increase for institutional tranches. Nonbank lenders are also twice as likely as commercial banks to include an interest rate floor when interest rates decline.

For these nonbank intermediaries, there is no deposit franchise, no market power over funding sources. On the contrary, the funding sources for these intermediaries are highly competitive. Thus, while market power theories are consistent with our findings for pro rata tranches, these theories cannot explain the similar empirical patterns found in institutional tranches.

3.3 Risk-Sharing and Incentives

Abstracting from institution-specific mechanisms, we can view lending as an application of financial contracting (e.g., Hart (1995)). A central tension in contract theory is between risk-sharing and incentives (Freixas and Rochet (2008)). Variation in interest rates affects both of these forces. For borrowers, lower interest rates improve financial health by lowering interest expense and increasing asset values. The corresponding reduction in risk mitigates incentive misalignment with lenders (Jensen and Meckling (1976)). Increases in interest rates have the opposite implications — worse financial health and exacerbated incentive misalignment with lenders.

For lenders, decreasing interest rates have a more nuanced effect that is a function of the relative interest rate exposure of their assets and liabilities. This linkage was discussed in the previous section and motivated our use of the income gap to capture variation in this exposure. For lenders with a large income gap, declining interest rates reduces financial health because interest income from assets falls by more than interest expense to liabilities. Increases in interest rates have the opposite effect. Lenders with a small income gap have a balance sheet in which interest rate risk is naturally hedged. Thus, variation in interest rates has a smaller if not negligible impact on small income gap lenders.

Importantly, these considerations are not unique to commercial banks. Investment banks, insurance companies, financial firms, etc. face similar risk and incentive considerations. Further, all of these intermediaries face fixed costs of operation that are difficult to hedge.[9] Thus, our results above are consistent with an optimal contracting story in which borrowers and lenders structure the contract to engage in risk-sharing and incentive provision.

One loose end is CLOs. Panel B of Figure 1 shows that the majority of institutional tranches are held by CLOs. These securitizations are pass-through vehicles, channeling

[9]Reducing fixed costs amounts to eliminating potentially important infrastructure and labor reductions.

interest and principal from institutional tranches in their collateral pool to investors in their funding pool (Benmelech and Dlugosz (2012)). Nonetheless, CLOs are in many ways similar to a bank, though without the market power over funding sources. CLOs face fixed operating costs, captured by significant fees (Liebscher and Mahlmann (2017), Cordell et al. (2020)). CLO investors have incentives not unlike those of banks. CLO investors don't want to pay storage costs in negative rate environments. Further, equity investors, often CLO managers, expect a certain yield on their investment. We explore these incentives in Figures 6 and 7.

Figure 6 presents two quarterly time series. The first is the fraction of newly issued CLOs with a LIBOR floor in their senior tranche. Every CLO rate floor is set at zero. The second, for comparison, is the fraction of institutional term loans with a LIBOR floor. Both lines are trending up over time, though the term loan line more consistently so. There is also an apparent lead-lag relationship between the two lines. Increases in LIBOR floors among CLOs forecasts increases in LIBOR floors among institutional tranches. We don't want to draw a strong causal inference from the relation of these two time series. Rather, we want to point out that the presence of a LIBOR floor in commercial loans is consistent with demands from investors in these loans.

Figure 7 illustrates the effect of LIBOR floors on CLO equity yields. We construct a simulation based on our sample of loans and data on CLO tranche structures and coupon rates from CLO-i. First, we compute the principal value-weighted loan spread, level of LIBOR floor, CLO leverage, and CLO tranche coupon rates in each year from 2003 to 2018, the period over which we have data on CLOs. Then we compute the initial equity yield, equal to the difference between the coupons on the loan pool and the coupons on the CLO tranches divided by the principal amount of the equity tranche, under three scenarios. The first uses the observed level of loan spreads and LIBOR floor terms (inclusion, floor). The second uses the same loan spreads and assumes no loans have floors. The third also assumes no loans have floors, but adjusts the loan spread upwards by an amount that sets the market value of the loan without a floor equal to the market value of a loan with a floor. We compute the fair value of the floor using Black's (1976) model for pricing interest rate derivatives and data on the implied volatility of over-the-counter floor contracts from Bloomberg. The Internet Appendix provides additional detail on these calculations.

The pricing of loans and CLOs in our sample period is such that the equity investor in a typical CLO, usually the manager of the collateral pool, earns a current yield between 15% and 30%.[10] LIBOR floors serve to increase this equity yield because they increase the level of coupons received by the collateral pool relative to the coupons paid on purely floating-rate CLO tranche securities. The effect of LIBOR floors is to increase the CLO equity yield by between two and four percentage points from 2012 to 2015. The inclusion of LIBOR floors in the post-crisis period is central to the ability of CLO managers to offer similar equity payoffs to the pre-crisis period, allowing investors to meet their sticky rate-of-return targets. The direct impact of floor inclusion disappears in 2016, when the typical floor is set below the prevailing LIBOR rate, but the spread adjustment still has an effect due to the floor's option value.

4 Conclusion

Interest rates play an important role in shaping loan terms. Somewhat surprisingly, no-arbitrage models of credit risk do a good job of matching observed loan spreads' responses to interest rate variation. Sticky loan interest rates are a natural consequence of no-arbitrage models in perfect capital markets. Further, risk-sharing is a first-order consideration for loan pricing. However, perfect capital markets only get one so far in explaining loan terms. Banks' market power and the incentives of contracting parties are additional forces necessary to understand the nature of loan contracts.

While we have made progress in understanding the relation between the macroeconomic environment and financial contract design, many questions remain. For example, does the

[10] The high return to CLO equity is attributable to 10-to-1 leverage and the gap between the coupon rates of syndicated loans in the collateral pool and the tranche securities issued by the securitization vehicle. See Benmelech and Dlugosz (2009) for a primer on the economics of CLOs.

endogenous response of contracts to interest rate variation help explain the lack of compelling evidence relating corporate investment to the cost of capital? How should one measure the cost of capital when its determination is state-contingent and a complex function of the pricing mechanism? In other words, are credit spreads really sufficient statistics for the cost of credit? What are the implications of monetary policy on credit provision and real outcomes when loan contracts endogenously respond to changes in interest rates? We look forward to future research that addresses these questions.

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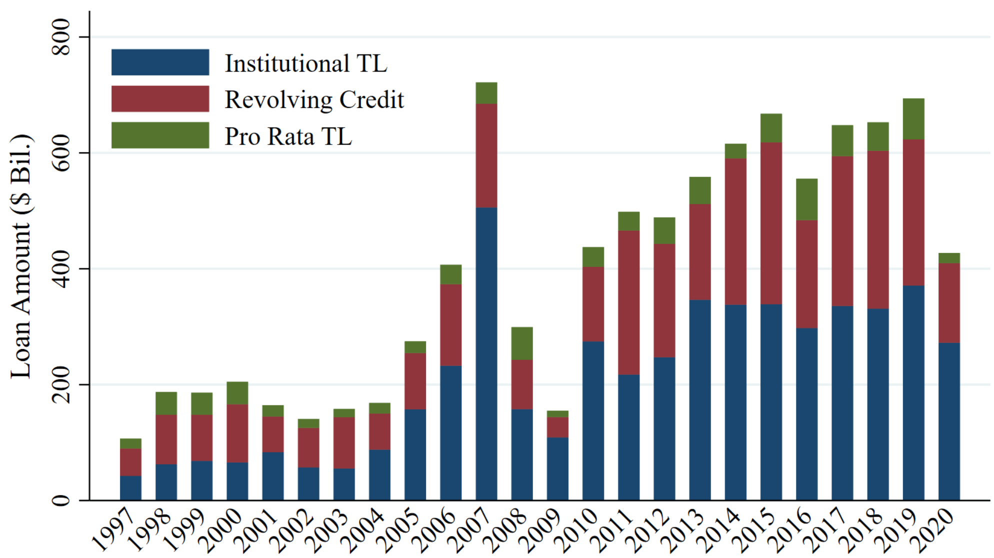
Figure 1: Syndicated Loan Market Originations

This figure reports aggregate volumes in the syndicated loan market by segment and the breakdown of investor types in the institutional segment. Panel A reports the total amount of U.S. dollar issuance for the main loan types in the Markit data. The sample is restricted to originations between January 1997 and October 2020, inclusive, with nonmissing data for the loan spread, maturity, and size of the loan. Panel B reports the market shares in the institutional segment of various types of nonbank investor. Data on investor shares are from S&P Leveraged Commentary & Data from 2002 to 2020. Panel C is based on the same sample as Panel A and reports annual issuance by loan-level rating category.

Panel A: Annual Amount of Loan Originations



Panel B: Annual Investor Shares in the Institutional Segment

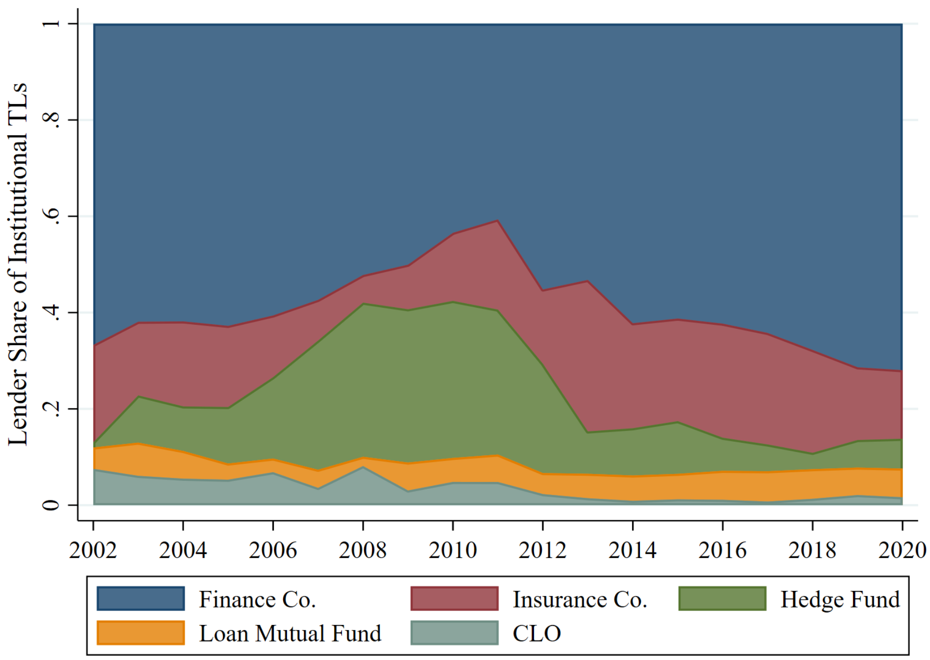


Figure 2: Interest Rates and Contract Terms

This figure presents time-series plots of contract terms against short-term interest rates. Each panel presents two quarterly time series. The dashed red line presents the average three-month LIBOR rate for the quarter. The solid blue line corresponds to a component of the contract pricing mechanism, expressed as an average weighted by loan size. For ease of presentation, each quarterly series is presented as a moving average with one-half weight on the current quarter and one-quarter weight on each of the neighboring quarters.

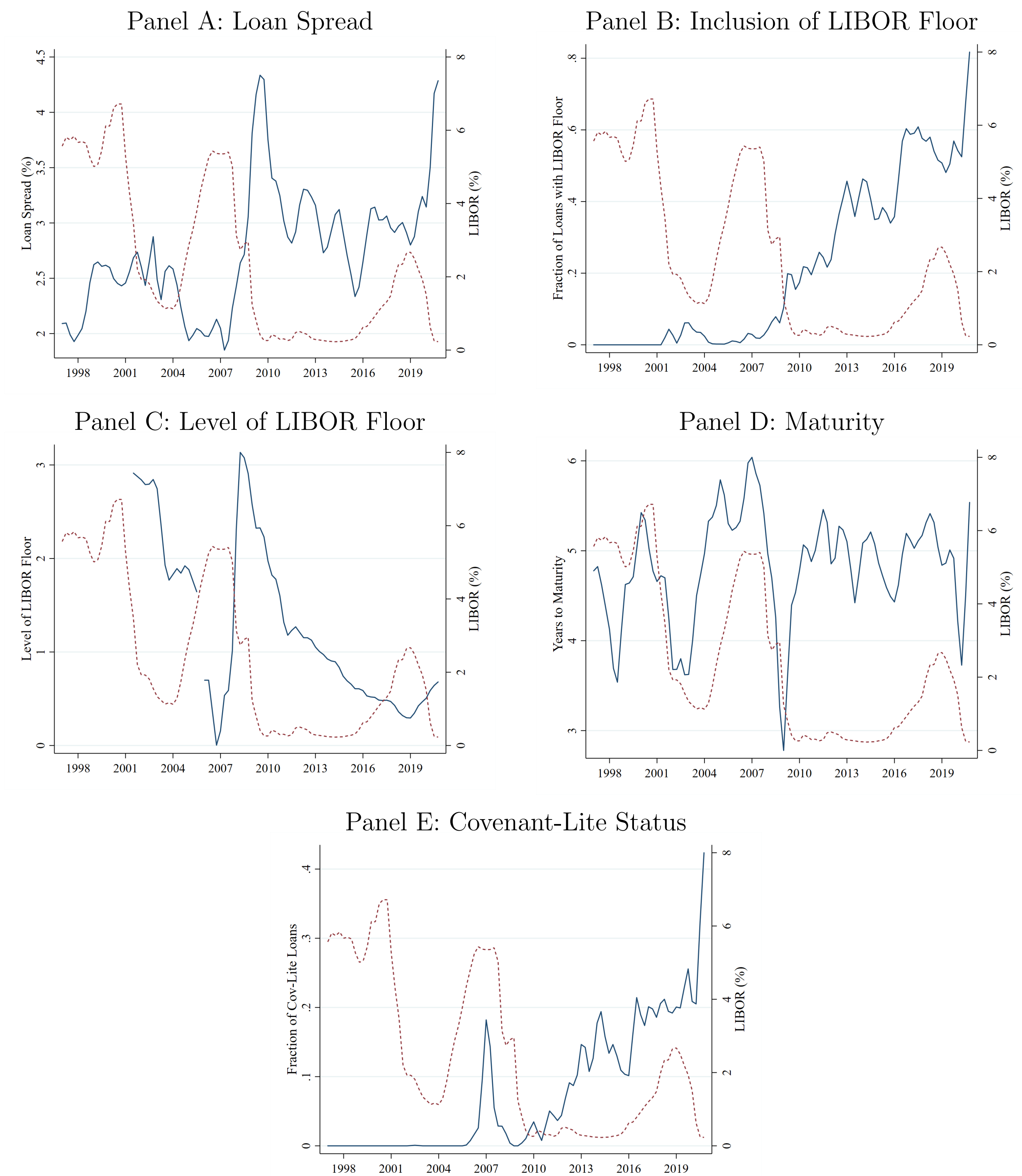


Figure 3: Distribution of LIBOR Floor Levels

This figure presents box-and-whisker plots of the cross-sectional distribution of LIBOR floor levels over time. The horizontal lines of the box denote the quartiles of the distribution. Boxes with fewer than three lines correspond to a concentration of observations. The whiskers extend 1.5 quartiles away from the median of the distribution. Observations beyond 1.5 quartiles from the median are displayed individually as dots.

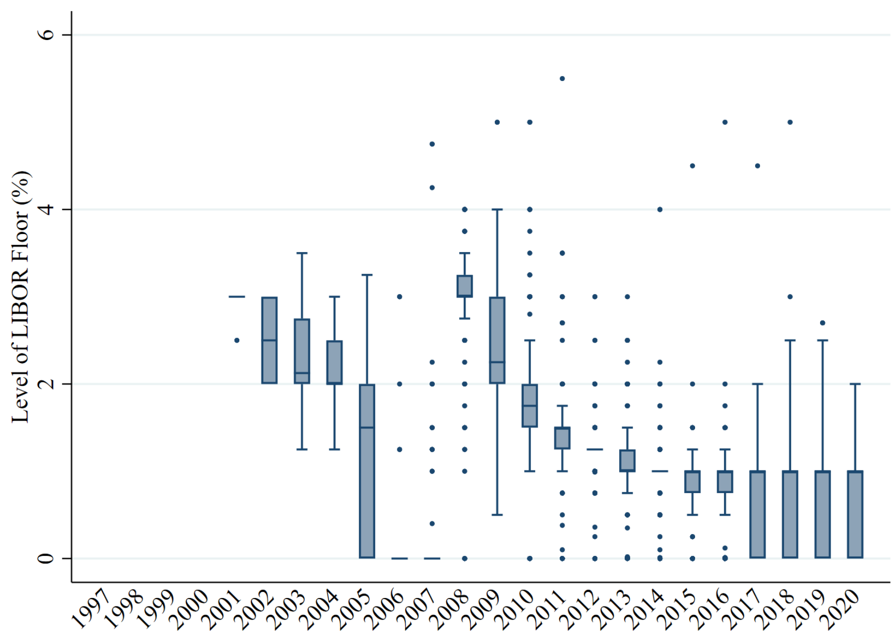


Figure 4: Principal Components of the Treasury Yield Curve

This figure presents the principal component (PC) loadings of the Treasury yield curve by time to maturity. Data on zero-coupon Treasury yields are from Gurkaynak, Sack, and Wright (2007). Following the literature, we refer to the PCs as Level, Slope, and Curvature.

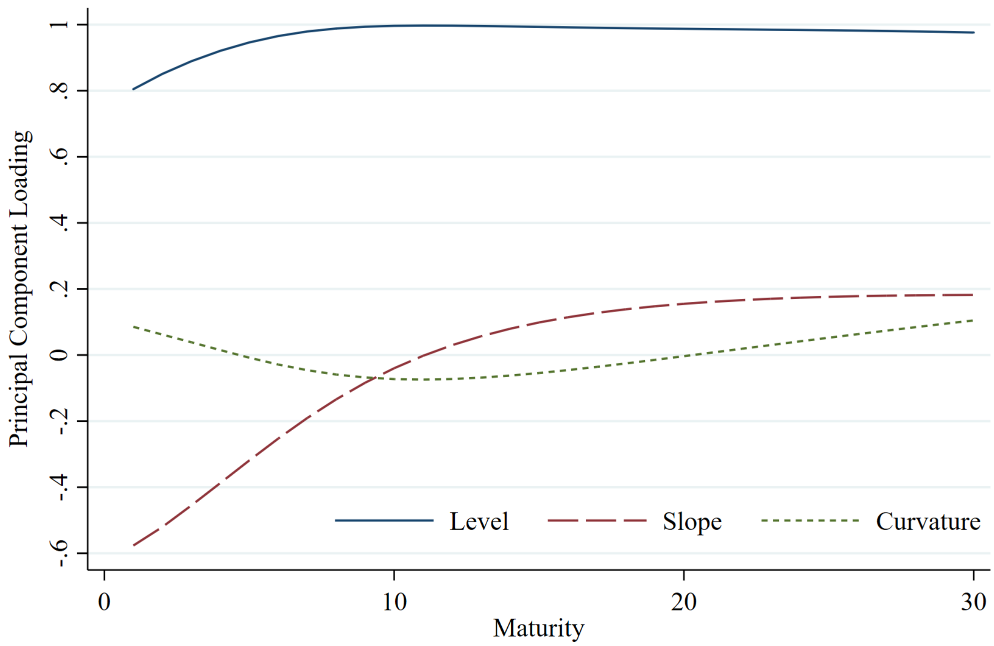
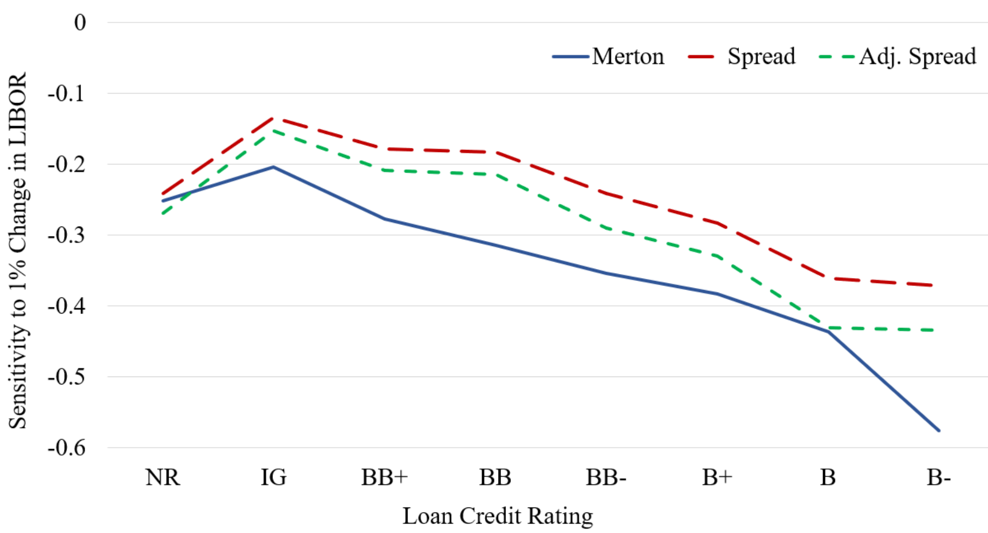


Figure 5: Merton (1974) Model and Empirical Sensitivity of Loan Spreads to Risk-Free Rates

This figure presents the sensitivity of loan credit spreads to risk-free rates as a function of the loan's credit rating (Panel A) and the lead arranger's income gap (Panel B). Empirical sensitivities for the loan spread and floor-adjusted spread are from Table 5. We obtain sensitivities for the Merton model predictions by estimating loan-level regressions of the model-implied sensitivity (from Table 4) on indicators for loan credit rating or tercile of the lead arranger income gap.

Panel A: Loan Credit Rating



Panel B: Lead Arranger Income Gap

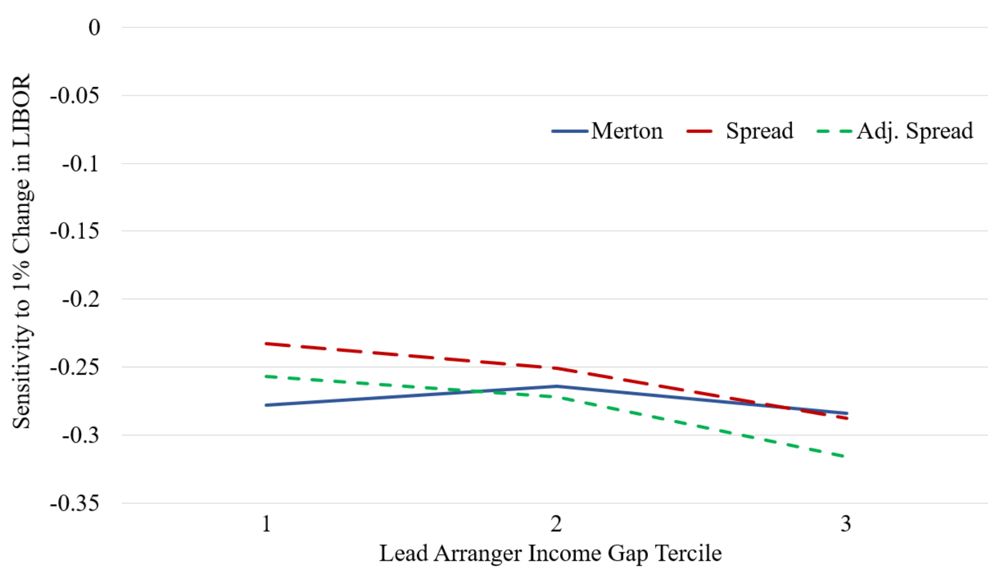


Figure 6: LIBOR Floors on CLO Tranches

This figure presents the fraction of newly issued CLOs with a LIBOR floor (blue line), along with the fraction of institutional term loans with a floor for comparison (red dashed line). For ease of presentation, each quarterly series is presented as a moving average with one-half weight on the current quarter and one-quarter weight on each of the neighboring quarters. Data are from Bloomberg.

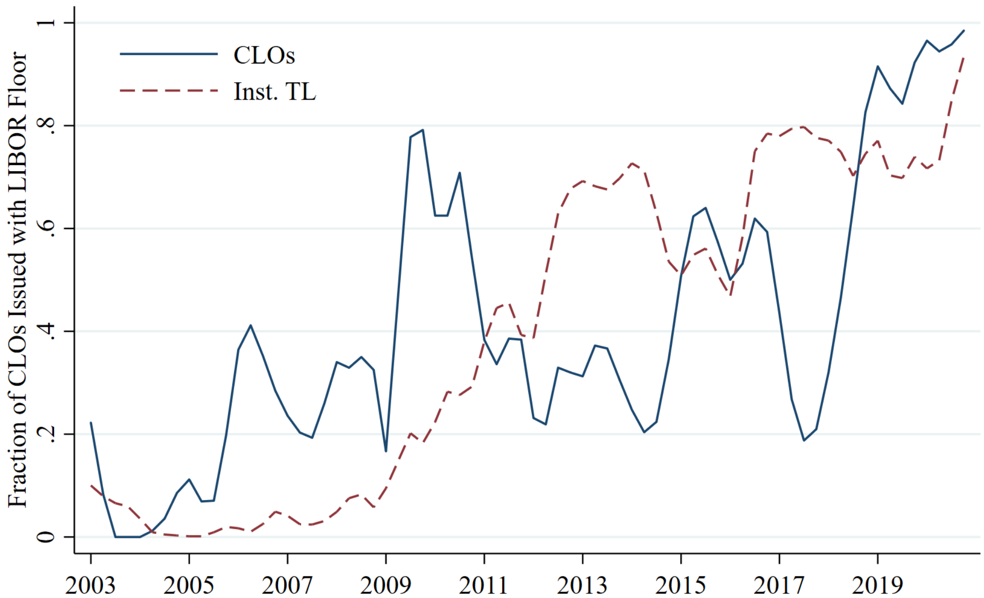


Figure 7: Effect of LIBOR Floors on CLO Equity Distributions

This figure illustrates the effect of LIBOR floors on the equity yields of collateralized loan obligations (CLOs). The calculation uses the principal value-weighted terms of loans and CLOs in each year from 2003 to 2018, including loan spreads, the inclusion of floors and their levels, the capital structure of CLOs, and the coupon rates paid on CLO tranche securities. The equity yield paid on the typical CLO in each year is calculated as the difference between coupons paid to the collateral pool and coupons paid on CLO tranche securities divided by the principal amount of the CLO equity tranche. The solid blue line reports the equity yield using the average loan spread, the fraction of loans with a LIBOR floor, and the average level of the LIBOR floor. The dashed red line is based on the alternative assumption that no loans have a floor. The dashed green line also assumes no loans have a floor but adjusts the loan spread upwards in an amount that offsets the theoretical value of the average LIBOR floor and fraction of loans with a floor each year. The period 2008 to 2011 is excluded due to a dearth of new CLO issuance during and after the financial crisis.

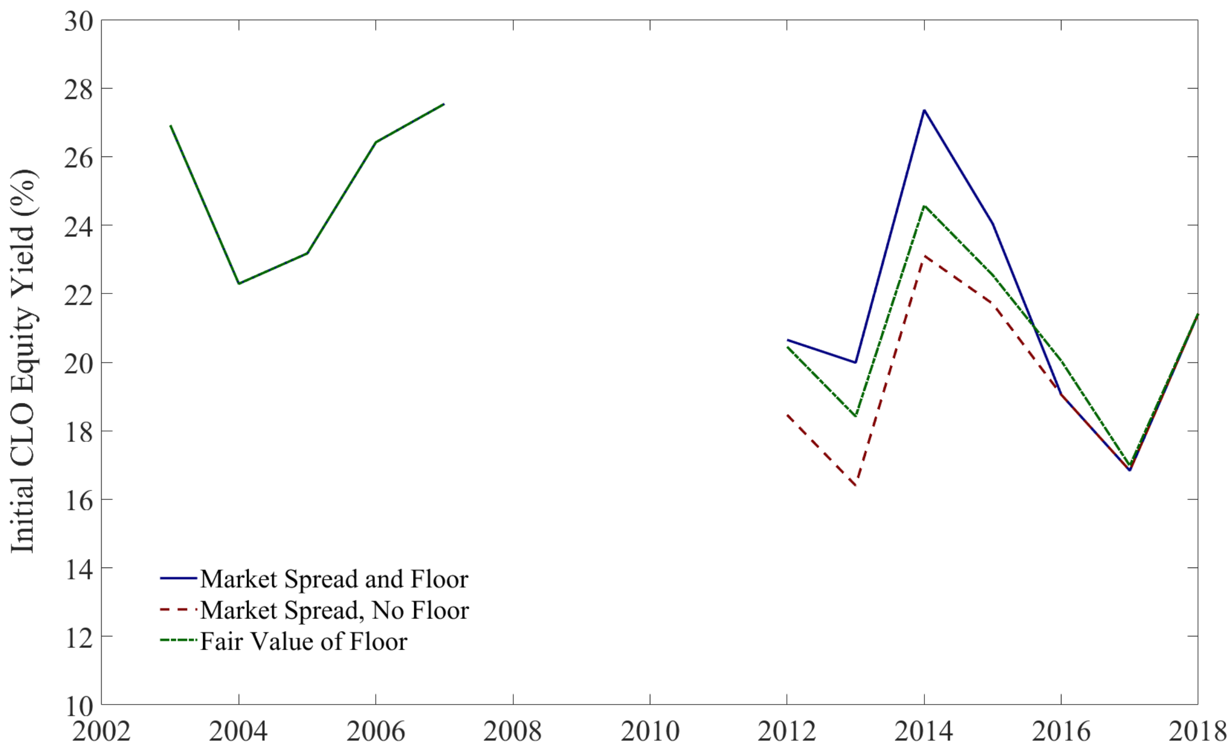


Table 1: Summary Statistics

This table presents loan counts and contract term summary statistics for the Markit sample of syndicated loans. The sample is restricted to U.S. dollar-denominated first-lien lines of credit and term loans with nonmissing information on loan spread, maturity, and issue size. Variables denoted $1(\cdot)$ correspond to indicator variables. Maturity is measured in years.

	Mean	Std.Dev.	Min.	p10	p50	p90	Max.	Obs.
Spread (%)	3.78	2.12	0.02	1.75	3.25	6.25	63.8	50,470
1(Floor)	0.37	0.48	0	0	0	1	1	50,470
LIBOR Floor (%)	0.90	0.64	0	0	1	1.50	5.50	18,442
Loan Amount ($ MM)	327.0	724.0	0.10	15.0	115.0	800.0	49,000	50,470
Maturity	5.29	1.72	0.03	3.00	5.00	7.00	39.8	48,067
1(Cov-Lite)	0.09	0.29	0	0	0	0	1	50,470
1(Inst. TL)	0.52	0.50	0	0	1	1	1	50,470

Table 2: Aggregate Determinants of Contract Terms – LIBOR

This table reports panel regressions of loan contract terms on macroeconomic variables. Each column has a different contract term as the dependent variable. Loan spreads and floors are in percentage terms and maturity is in years. Floor Val. is the spread adjustment implied by the Black (1976) value of the floor. Adj. Spread is the spread of a floating-rate loan with the same value as the loan with a floor. LIBOR is the three-month LIBOR rate on the loan's start date, in percentage terms. Equity CAPE is the cyclically adjusted price-earnings ratio from Robert Shiller's website. Real GDP Growth is lagged by one quarter. 1(Recession) is an indicator for NBER U.S. recession dates, lagged by one month. Panel A controls for loan credit rating and borrower industry indicators, log issue size, and indicators for revolving lines of credit and Term Loan A facilities. Panel B includes the same controls and adds borrower and lead arranger fixed effects. *t*-statistics based on standard errors clustered by firm and year-quarter are reported in parentheses. *, **, and *** denote *p*-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: No Fixed Effects

Dependent Variable	Spread	1(Floor)	Floor Level	Floor Val.	Adj. Spread	Maturity	1(Cov-Lite)
LIBOR (%)	-0.369***	-0.132***	0.144***	-0.043***	-0.412***	0.120***	-0.031***
	(-19.00)	(-16.70)	(3.14)	(-12.48)	(-19.00)	(8.60)	(-6.79)
Equity CAPE	0.022***	0.025***	-0.116***	0.000	0.023***	0.003	0.012***
	(2.81)	(5.96)	(-10.27)	(0.09)	(2.69)	(0.45)	(5.19)
Real GDP Growth	-0.008	-0.004*	0.005	0.000	-0.009	0.014**	-0.002
	(-0.80)	(-1.67)	(0.89)	(0.08)	(-0.60)	(2.06)	(-1.59)
1(Recession)	0.563***	-0.037	0.512***	0.124**	0.663***	-0.646***	-0.005
	(2.88)	(-0.81)	(3.10)	(2.07)	(2.68)	(-5.05)	(-0.28)
Controls	X	X	X	X	X	X	X
Outcome Mean	3.775	0.365	0.904	0.125	3.880	5.293	0.095
Outcome SD	2.116	0.482	0.638	0.242	2.220	1.718	0.293
Adj. R^2	0.358	0.313	0.427	0.213	0.371	0.140	0.167
Observations	50,448	50,448	18,431	49,001	49,001	48,046	50,448

Panel B: Borrower and Lead Arranger Fixed Effects

Dependent Variable	Spread	1(Floor)	Floor Level	Floor Val.	Adj. Spread	Maturity	1(Cov-Lite)
LIBOR (%)	-0.251***	-0.082***	0.096***	-0.035***	-0.286***	0.123***	-0.015***
	(-14.28)	(-13.62)	(2.79)	(-10.35)	(-14.31)	(9.18)	(-3.93)
Equity CAPE	0.005	0.014***	-0.102***	-0.002	0.004	0.010*	0.008***
	(0.58)	(7.06)	(-12.05)	(-1.32)	(0.41)	(1.77)	(4.67)
Real GDP Growth	-0.006*	-0.004***	0.004	-0.000	-0.007	0.015**	-0.002***
	(-1.75)	(-3.76)	(0.94)	(-0.07)	(-1.49)	(2.18)	(-3.02)
1(Recession)	0.576***	-0.018	0.495***	0.100***	0.662***	-0.731***	-0.013
	(6.01)	(-0.86)	(3.82)	(2.82)	(6.14)	(-6.46)	(-1.49)
Borrower FE	X	X	X	X	X	X	X
Lead Arranger FE	X	X	X	X	X	X	X
Controls	X	X	X	X	X	X	X
Outcome Mean	3.514	0.360	0.885	0.122	3.618	5.367	0.103
Outcome SD	1.691	0.480	0.658	0.234	1.802	1.549	0.304
Adj. R^2	0.677	0.624	0.727	0.429	0.683	0.464	0.507
Observations	40,442	40,442	13,740	39,347	39,347	38,364	40,442

Table 3: Aggregate Determinants of Contract Terms – Yield Curve Principal Components

This table reports panel regressions of loan contract terms on macroeconomic variables. Each column has a different contract term as the dependent variable. Loan spreads and floors are in percentage terms and maturity is in years. Floor Val. is the spread adjustment implied by the Black (1976) value of the floor. Adj. Spread is the spread of a floating-rate loan with the same value as the loan with a floor. Level and Slope PC are the first two principal components of the zero-coupon Treasury yield curve. Yield Volatility is the MOVE Index, a weighted average of implied volatilities from one-month options on the 2-year, 5-year, 10-year, and 30-year Treasury yields. Equity CAPE is the cyclically adjusted price-earnings ratio from Robert Shiller's website. Real GDP Growth is lagged by one quarter. 1(Recession) is an indicator for NBER U.S. recession dates, lagged by one month. Panel A controls for loan credit rating and borrower industry indicators, log issue size, and indicators for revolving lines of credit and Term Loan A facilities. Panel B includes the same controls and adds borrower and lead arranger fixed effects. t-statistics based on standard errors clustered by firm and year-quarter are reported in parentheses. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: No Fixed Effects

Dependent Variable	Spread	1(Floor)	Floor Level	Floor Val.	Adj. Spread	Maturity	1(Cov-Lite)
Level PC	-0.858***	-0.311***	0.390***	-0.103***	-0.967***	0.230***	-0.083***
	(-22.05)	(-20.68)	(6.20)	(-14.59)	(-23.91)	(6.89)	(-11.66)
Slope PC	0.240***	0.046***	-0.025	0.042***	0.280***	-0.131***	-0.011**
	(5.79)	(2.94)	(-0.52)	(5.62)	(6.13)	(-4.21)	(-2.04)
Yield Volatility	0.002	-0.001*	0.004***	-0.000	0.002	-0.003*	-0.001***
	(1.20)	(-1.82)	(4.73)	(-0.78)	(0.91)	(-1.96)	(-2.71)
Equity CAPE	0.021**	0.020***	-0.073***	0.002	0.024**	-0.001	0.009***
	(2.28)	(6.79)	(-6.51)	(1.13)	(2.38)	(-0.10)	(6.05)
Real GDP Growth	0.001	-0.001	0.004	0.001	0.001	0.013	-0.000
	(0.13)	(-0.14)	(1.58)	(0.34)	(0.13)	(1.41)	(-0.29)
1(Recession)	0.339**	-0.068	0.649***	0.113**	0.433***	-0.521***	-0.007
	(2.61)	(-1.10)	(5.86)	(2.29)	(2.72)	(-3.31)	(-0.38)
Controls	X	X	X	X	X	X	X
Outcome Mean	3.775	0.365	0.904	0.125	3.880	5.293	0.095
Outcome SD	2.116	0.482	0.638	0.242	2.220	1.718	0.293
Adj. R^2	0.373	0.399	0.492	0.247	0.392	0.139	0.205
Observations	50,448	50,448	18,431	49,001	49,001	48,046	50,448

Panel B: Borrower and Lead Arranger Fixed Effects

Dependent Variable	Spread	1(Floor)	Floor Level	Floor Val.	Adj. Spread	Maturity	1(Cov-Lite)
Level PC	-0.522***	-0.234***	0.338***	-0.109***	-0.628***	0.342***	-0.079***
	(-12.75)	(-17.85)	(6.56)	(-14.66)	(-13.88)	(8.43)	(-9.87)
Slope PC	0.284***	0.065***	-0.038	0.038***	0.323***	-0.057**	-0.012**
	(7.98)	(6.29)	(-0.90)	(6.63)	(8.21)	(-2.23)	(-2.33)
Yield Volatility	0.007***	-0.000	0.004***	-0.000	0.007***	-0.003**	-0.000**
	(4.78)	(-1.21)	(5.80)	(-0.10)	(4.30)	(-2.06)	(-2.19)
Equity CAPE	0.015*	0.016***	-0.082***	0.001	0.017*	0.011*	0.008***
	(1.80)	(8.29)	(-8.01)	(0.65)	(1.74)	(1.88)	(5.40)
Real GDP Growth	-0.002	-0.002	0.004*	0.000	-0.002	0.011*	-0.001
	(-0.39)	(-0.98)	(1.93)	(0.20)	(-0.31)	(1.91)	(-1.04)
1(Recession)	0.267**	-0.047	0.620***	0.082***	0.340***	-0.589***	-0.015
	(2.48)	(-1.33)	(6.93)	(2.72)	(2.74)	(-5.68)	(-1.21)
Borrower FE	X	X	X	X	X	X	X
Lead Arranger FE	X	X	X	X	X	X	X
Controls	X	X	X	X	X	X	X
Outcome Mean	3.514	0.360	0.885	0.122	3.618	5.367	0.103
Outcome SD	1.691	0.480	0.658	0.234	1.802	1.549	0.304
Adj. R^2	0.682	0.635	0.759	0.448	0.689	0.465	0.520
Observations	40,442	40,442	13,740	39,347	39,347	38,364	40,442

Table 4: Merton (1974) Model Sensitivity of Loan Spreads to Risk-Free Rates

This table reports the sensitivity of loan spreads to risk-free rates in the Merton (1974) model calibrated to the borrowers and loan terms in our sample. For each loan, we compute the model-implied change in the credit spread over the risk-free rate with respect to a one percent change in the risk-free rate. We summarize the distribution of these elasticities for the full sample and by loan credit rating, grouping the investment-grade (IG) loans together. We calibrate asset volatility in the model to match the observed loan spread, setting the risk-free rate to the five-year swap rate, the expected life of the debt to one-half of the loan's maturity (to account for prepayment), and the face value of debt equal to the borrower's loan debt outstanding at the prior quarter-end plus the face value of the present loan. We obtain data on the borrower's capital structure from Capital IQ after merging the Markit sample to Dealscan by loan name and applying the Dealscan-Compustat link from Chava and Roberts (2008). Details on the Markit-Dealscan merge are provided in the Internet Appendix.

Loan Rating	Any	IG	BB+	BB	BB-	B+	B	B-	NR
Mean	-0.296	-0.204	-0.278	-0.318	-0.361	-0.389	-0.462	-0.577	-0.255
St. Dev.	0.269	0.115	0.171	0.245	0.281	0.318	0.405	0.300	0.253
p25	-0.352	-0.248	-0.336	-0.364	-0.425	-0.446	-0.533	-0.800	-0.301
p50	-0.225	-0.179	-0.239	-0.248	-0.289	-0.294	-0.356	-0.452	-0.189
p75	-0.145	-0.130	-0.157	-0.170	-0.196	-0.197	-0.236	-0.351	-0.121
Observations	3,920	215	238	414	500	345	153	31	2,024

Table 5: Cross-Sectional Determinants of Contract Terms

This table reports panel regressions of loan contract terms on LIBOR interacted with cross-sectional proxies for lender hedging demand and borrower moral hazard. Panel A uses indicators for the loan credit rating, with investment-grade loans as the baseline group. Each column has a different contract term as the dependent variable. Panel B uses indicators for terciles of the lead arranger's income gap, with the bottom tercile (lowest income gap) as the baseline group for both. Panel C uses an indicator for institutional term loans, with pro rata loans as the baseline group. Loan spreads and floors are in percentage terms and maturity is in years. Floor Val. is the spread adjustment implied by the Black (1976) value of the floor. Adj. Spread is the spread of a floating-rate loan with the same value as the loan with a floor. Panel A includes lead arranger fixed effects but not borrower fixed effects, due to insufficient within-borrower variation in credit rating. Panel B includes borrower fixed effects but no lead arranger fixed effects, due to insufficient within-bank variation in income gap. Panel C includes borrower and lead arranger fixed effects. All of the specifications control for loan type, credit rating, and borrower industry indicators, log issue size, and the macroeconomic variables from Tables 2 and 3: GDP Growth, Unemployment, and a U.S. recession indicator. t-statistics based on standard errors clustered by firm and year-quarter are reported in parentheses. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: Loan Credit Ratings

Dependent Variable	Spread	1(Floor)	Floor Level	Floor Val.	Adj. Spread
LIBOR (%)	-0.135***	-0.102***	0.211**	-0.020***	-0.153***
	(-4.99)	(-9.67)	(2.51)	(-4.32)	(-5.25)
LIBOR × 1(BB+ Rated)	-0.044*	-0.017	-0.096	-0.009*	-0.056*
	(-1.66)	(-1.65)	(-1.26)	(-1.88)	(-1.89)
LIBOR × 1(BB Rated)	-0.048**	-0.030***	-0.119	-0.015**	-0.062**
	(-2.05)	(-2.68)	(-1.63)	(-2.59)	(-2.30)
LIBOR × 1(BB- Rated)	-0.106***	-0.044***	-0.181**	-0.030***	-0.137***
	(-3.91)	(-4.05)	(-2.62)	(-4.91)	(-4.44)
LIBOR × 1(B+ Rated)	-0.148***	-0.041***	-0.211***	-0.032***	-0.177***
	(-5.67)	(-3.72)	(-2.86)	(-4.77)	(-5.88)
LIBOR × 1(B Rated)	-0.226***	-0.046***	-0.217***	-0.049***	-0.278***
	(-6.98)	(-4.33)	(-2.92)	(-6.07)	(-7.62)
LIBOR × 1(B- Rated)	-0.237***	-0.043***	-0.204**	-0.046***	-0.282***
	(-5.32)	(-3.55)	(-2.61)	(-6.01)	(-5.83)
LIBOR × 1(Non-Rated)	-0.106***	0.003	-0.044	-0.009**	-0.116***
	(-4.33)	(0.40)	(-0.68)	(-2.25)	(-4.33)
Lead Arranger FE	X	X	X	X	X
Controls	X	X	X	X	X
Outcome Mean	3.513	0.358	0.885	0.120	3.614
Outcome SD	1.737	0.479	0.656	0.233	1.847
Adj. R^2	0.446	0.431	0.517	0.279	0.462
Observations	43,091	43,091	15,426	41,902	41,902

Panel B: Lead Arranger Income Gap

Dependent Variable	Spread	1(Floor)	Floor Level	Floor Val.	Adj. Spread
LIBOR (%)	-0.233***	-0.075***	-0.001	-0.026***	-0.257***
	(-12.13)	(-10.62)	(-0.03)	(-7.85)	(-12.25)
LIBOR × 1(Inc. Gap. Q2)	-0.018	0.002	0.050	0.005*	-0.015
	(-0.95)	(0.40)	(0.66)	(1.70)	(-0.71)
LIBOR × 1(Inc. Gap. Q3)	-0.055**	0.009	0.005	-0.003	-0.059**
	(-2.28)	(1.49)	(0.08)	(-0.77)	(-2.23)
1(Inc. Gap. Q2)	0.074	0.015	-0.049	-0.002	0.080
	(1.03)	(0.64)	(-0.68)	(-0.19)	(1.01)
1(Inc. Gap. Q3)	0.231***	-0.015	-0.015	0.017	0.252***
	(2.89)	(-0.64)	(-0.28)	(1.12)	(2.87)
Borrower FE	X	X	X	X	X
Controls	X	X	X	X	X
Outcome Mean	3.018	0.258	0.955	0.093	3.094
Outcome SD	1.505	0.438	0.720	0.213	1.603
Adj. R^2	0.611	0.570	0.763	0.409	0.616
Observations	15,969	15,969	3,726	15,641	15,641

Panel C: Institutional vs. Pro Rata Loans

Dependent Variable	Spread	1(Floor)	Floor Level	Floor Val.	Adj. Spread
LIBOR (%)	-0.230***	-0.055***	0.124***	-0.018***	-0.247***
	(-13.82)	(-9.74)	(3.55)	(-6.28)	(-13.19)
LIBOR × 1(Inst. TL)	-0.040***	-0.050***	-0.034*	-0.032***	-0.072***
	(-5.93)	(-9.27)	(-1.86)	(-8.65)	(-8.46)
1(Inst. TL)	0.609***	0.224***	0.217***	0.135***	0.748***
	(20.00)	(9.75)	(6.46)	(9.09)	(19.73)
Borrower FE	X	X	X	X	X
Lead Arranger FE	X	X	X	X	X
Controls	X	X	X	X	X
Outcome Mean	3.514	0.360	0.885	0.122	3.618
Outcome SD	1.691	0.480	0.658	0.234	1.802
Adj. R^2	0.677	0.636	0.728	0.450	0.685
Observations	40,442	40,442	13,740	39,347	39,347