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Debt Maturity Structure and Credit Quality

Radhakrishnan Gopalan, Fenghua Song, and Vijay Yerramilli*

Abstract

We examine whether a firm's debt maturity structure affects its credit quality. Consistent with theory, we find that firms with greater exposure to rollover risk (measured by the amount of long-term debt payable within a year relative to assets) have lower credit quality; long-term bonds issued by those firms trade at higher yield spreads, indicating that bond market investors are cognizant of rollover risk arising from a firm's debt maturity structure. These effects are stronger among firms with a speculative-grade rating and declining profitability, and during recessions.

I. Introduction

The collapse of financial institutions such as Bear Stearns and Lehman Brothers during the recent financial crisis has once again focused attention on the risks arising from short-term debt. It is now universally acknowledged that the proximate cause for the failure of the two institutions was their overreliance on short-term debt that they were unable to roll over because of a fall in collateral values (e.g., Brunnermeier (2009)).[1] The theoretical literature has long

*Gopalan, gopalan@wustl.edu, Olin Business School, Washington University in St. Louis, Campus Box 1133, St. Louis, MO 63130; Song, song@psu.edu, Smeal College of Business, Pennsylvania State University, 312 Business Bldg, University Park, PA 16802; and Yerramilli, vyerramilli@bauer.uh.edu, Bauer College of Business, University of Houston, 240D Melcher Hall, Houston, TX 77204. An earlier version of the paper was circulated under the title "Do Credit Rating Agencies Underestimate Liquidity Risk?" We are particularly grateful to Daniel Carvalho (the referee) for very helpful comments. We also thank Bruce Arnold, Long Chen, Mark Flannery, Paolo Fulghieri, Amar Gande, Murali Jagannathan, Paul Malatesta (the editor), Vik Nanda, Lars Norden, David Skeie, Chester Spatt, Günter Strobl, Wei Xiong, and seminar participants at Australia National University, Binghamton University, Georgia Institute of Technology, Hong Kong University of Science and Technology, National University of Singapore, University of New South Wales, University of Sydney, University of Technology Sydney, Washington University in St. Louis, the 2010 European Finance Association annual conference, 2010 Financial Management Association annual conference, 2010 Federal Deposit Insurance Corporation's (FDIC) Center for Financial Research/Journal of Financial Services Research (JFSR) joint conference on finance and sustainable growth, 2010 Texas Lone Star finance conference, 2010 Centre for Applied Research in Finance (CAREFIN)/Bocconi University conference on matching stability and performance, 2010 New York Fed/Review of Corporate Finance Studies (RCFS) joint conference on financial stability and financial intermediary firms' behavior, and the 2011 Financial Intermediation Research Society annual conference for helpful comments.

[1] Such risks are certainly not confined to financial firms alone, as there is a long history of high-profile bankruptcies involving nonfinancial firms, where the inability to roll over maturing short-term debt compounded the effect of operating losses and led to sudden collapses (e.g., WorldCom, Enron, First Executive Corporation, and Penn Central).

recognized this "rollover risk" arising from short-term debt.[2] Diamond (1991) and Titman (1992) show that in the presence of credit market frictions, firms may face difficulty in rolling over maturing short-term debt, especially if refinancing coincides with a deterioration in either firm fundamentals or credit market conditions. Recent theoretical literature argues that rollover risk may itself be an additional source of credit risk, because it increases the possibility of a run on the firm (see He and Xiong (2012a), Morris and Shin (2009)), and exacerbates the conflict of interests between shareholders and debtholders (He and Xiong (2012b)).

Are the collapses of Bear Stearns and Lehman Brothers isolated incidents that occurred during periods of unprecedented stress in credit markets, or is there a systemic *causal* relation between a firm's debt maturity structure and its credit quality? Despite a large body of theoretical literature that argues the answer is yes, surprisingly, there is no empirical study that directly addresses this question. Identifying such a causal link is challenging because a firm's debt maturity structure is itself endogenous and may be determined by the same underlying risk characteristics that affect the firm's credit quality. Moreover, the firm's credit quality may directly affect its debt maturity structure (see Diamond (1991)), giving rise to potential reverse causality concerns.

In this paper, we measure firms' exposure to rollover risk using the amount of their long-term debt due for repayment during the year, and use this to identify the causal impact of rollover risk on credit quality. This approach, which is similar to the one employed in Almeida, Campello, Laranjeira, and Weisbenner (2012), is based on the idea that long-term debt payable during the year depends on the past long-term debt maturity decisions made by the firm and, hence, is less likely to be correlated with the firm's current risk characteristics or credit quality. In other words, our empirical analysis exploits variation in rollover risk arising from decisions made by firms in the distant past.[3] However, we do recognize that firms' ability to refinance or repay their long-term debt depends on their current risk characteristics, and these risk characteristics may partly explain the relation between long-term debt payable and credit quality that we document. We address this concern in a couple of different ways. First, we do a battery of additional tests and present evidence that in its entirety cannot just be explained by firms' current risk characteristics. Second, as we explain below, we exploit the detailed information on firms' long-term debt maturity structure available in Compustat to design robustness tests that further alleviate the endogeneity concerns.

Our sample spans the period 1986–2010 and includes all firms that have a long-term credit rating from Standard & Poor's (S&P) and for which financial information is available in Compustat. Our main measure of rollover risk is LT-1_{t-1}, which is defined as the amount of the firm's long-term debt outstanding at the end of year $t-1$ that is due for repayment in year t (i.e., Compustat item DD1 in year $t-1$) scaled by the book value of total assets at the end of year $t-1$. In constructing this measure, we focus only on maturing long-term debt and

[2] Other terms employed in the literature include liquidity risk, maturity risk, and refinancing risk.

[3] Almeida et al. (2012) use a similar idea and use the variation in firms' long-term debt due for repayment just after onset of the financial crisis in Aug. 2007 to identify the causal effects of financial contracting on firms' investments during the 2007 credit crisis.

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explicitly ignore any short-term debt that the firm may have issued in year $t-1$ that is due for repayment in year t. This is because of the concern that the amount of short-term debt will be affected by the firm's current credit quality. To the extent that short-term debt also contributes to rollover risk, LT-1_{t-1} is likely to understate the firm's exposure to rollover risk in year t. Thus, our estimates are likely to provide a lower bound.

Another advantage of focusing on long-term debt due is that long-term debt maturities are largely concentrated in certain periods of time and hence there are sharp variations in LT-1_{t-1} over time and across firms (see Almeida et al. (2012)). To take advantage of this feature of the maturity structure of long-term debt, we adopt a first-difference regression as our baseline specification, where the dependent variable is the year-on-year change in the firm's credit rating, and the key independent variable is the year-on-year change in LT-1_{t-1} (i.e., ΔLT-1_{t-1}). We include year fixed effects (YEAR_FE) in our specification and explicitly control for all observable firm characteristics that may affect a firm's credit quality.

Theories on rollover risk suggest that firms with a larger increase in the amount of long-term debt payable within a year (i.e., higher ΔLT-1_{t-1}) are, ceteris paribus, more likely to experience credit quality deterioration. To test this prediction, we first convert a firm's credit rating into an ordinal scale (ranging from 1 to 22), with a larger number indicating a worse rating. We then examine the relation between ΔLT-1_{t-1} and change in the firm's credit rating during year, ΔRATING$_t$, where a positive (negative) value of ΔRATING$_t$ indicates an adverse (favorable) change in the firm's credit quality. Consistent with the prediction, we find a positive and statistically significant correlation between ΔRATING$_t$ and ΔLT-1_{t-1}. This effect is also economically large: A 1-standard-deviation increase in ΔLT-1_{t-1} is associated with a 0.029-notch fall in the firm's credit rating. In comparison, the mean (median) annual change in our sample firm's credit rating is 0.109 notch (0 notch).

A positive correlation between ΔLT-1_{t-1} and ΔRATING$_t$ can arise either from a correlation between increases in LT-1_{t-1} and rating downgrades (ΔRATING$_t > 0$) or from a correlation between decreases in LT-1_{t-1} and rating upgrades (ΔRATING$_t < 0$). Although both are consistent with rollover risk contributing to credit risk, to understand which correlation is driving our results, we repeat our tests after splitting ΔRATING$_t$ into NOTCHES_DOWNGRADE and NOTCHES_UPGRADE, where NOTCHES_DOWNGRADE (NOTCHES_UPGRADE) is the number of notches by which a firm's rating is downgraded (upgraded) during the year, and takes a value 0 in the years in which the firm does not experience a rating downgrade (upgrade). We find that ΔLT-1_{t-1} is positively associated with NOTCHES_DOWNGRADE, but there is no significant correlation between ΔLT-1_{t-1} and NOTCHES_UPGRADE, suggesting that our results are mainly driven by firms experiencing a rating downgrade during years in which there is an increase in the amount of long-term debt due.

To better understand the relation between debt maturity structure and firm credit quality, we perform a number of cross-sectional tests. When we differentiate firms based on their prior credit quality, we find that the positive association between ΔLT-1_{t-1} and ΔRATING$_t$ is present only for firms with speculative-grade ratings (S&P rating below BBB−). This is consistent with such

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firms facing greater difficulty in refinancing or repaying their maturing long-term debt. We also find that the positive correlation between ΔLT-1$_{t-1}$ and ΔRATING$_t$ is stronger for firms that experience a year-on-year decline in operating profitability, during periods of economic recession, and during the 2007–2009 financial crisis. Interestingly, such a positive correlation is present during periods of economic expansion as well.

Next, we conduct two further tests to address additional concerns and strengthen our findings from the baseline analysis. First, rollover risk may become an issue only when there is a large increase in the amount of long-term debt due, and not otherwise. That is, we may expect a nonlinear relation between ΔLT-1$_{t-1}$ and ΔRATING$_t$. To address this issue, we define a dummy variable to identify firm-years in which LT-1$_{t-1}$ exceeds 5% (which is equal to its sample mean plus 1 standard deviation) and find that our results are stronger when we use this dummy instead of LT-1$_{t-1}$ as the measure of rollover risk. In terms of economic magnitude, we find that an increase in LT-1$_{t-1}$ from under 5% to over 5% is associated with a 0.126-notch increase in ΔRATING$_t$.

Second, although the exclusion of short-term debt from LT-1$_{t-1}$ mitigates endogeneity concerns, one can still argue that changes in LT-1$_{t-1}$ and changes in firm credit rating may be spuriously correlated because of reverse causality. For example, a large amount of long-term debt payable next year could be due to the firm not being able to roll over the debt because of an expected deterioration in its credit quality. To rule out such alternative explanations, we repeat our tests after replacing LT-1$_{t-1}$ with LT-2$_{t-2}$, which is defined as the amount of long-term debt due in year t as estimated 2 years ago (i.e., Compustat item DD2 at the end of year $t-2$) scaled by the book value of total assets at the end of year $t-1$. As LT-2$_{t-2}$ is estimated at the end of year $t-2$, it is unlikely to be correlated with changes in the firm's credit quality occurring around year t. But to the extent that the firm may renegotiate/settle its long-term debt between years $t-2$ and t, ΔLT-2$_{t-2}$ is likely to be a noisy proxy for the amount of long-term debt due in year t. To this extent, we expect our results to be attenuated with ΔLT-2$_{t-2}$. When we repeat our tests after replacing ΔLT-1$_{t-1}$ with ΔLT-2$_{t-2}$, we find that all our results are preserved. Consistent with ΔLT-2$_{t-2}$ being a noisier proxy for the amount of long-term debt due, we find that a 1- standard-deviation increase in ΔLT-2$_{t-2}$ (0.06) is associated with a 0.016-notch increase in ΔRATING$_t$, whereas the corresponding estimate using ΔLT-1$_{t-1}$ is 0.029 notch. When we differentiate between downgrades and upgrades, we again find our results to be mainly driven by a positive correlation between ΔLT-2$_{t-2}$ and NOTCHES_DOWNGRADE.

To shed further light on the impact of rollover risk arising from debt maturity structure, we next examine the relation between a firm's rollover risk exposure and its cost of long-term borrowing. To the extent that long-term creditors recognize the rollover risk arising from a firm's maturing debt, they should demand a premium to lend to firms with a greater exposure to rollover risk. We test this hypothesis by examining whether the yield spreads on a firm's long-term bonds are affected by the fraction of the firm's long-term debt payable within a year over its total assets (LT-1). To achieve this, we modify the bond yield spread model in Campbell and Taksler (2003) and estimate a first-difference regression, where the dependent variable is the year-on-year change in yield spread in the year

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before the long-term debt becomes due, and the main independent variable is the year-on-year change in LT-1 (ΔLT-1$_t$). The results confirm the hypothesis that long-term bonds of firms with a higher LT-1 in the next year trade at higher yield spreads. This result is also economically significant: A 1-standard-deviation increase in ΔLT-1$_t$ is associated with an 18% increase in yield spreads relative to the sample mean value of change in yield spreads. The results are even stronger when we proxy for rollover risk using the dummy variable to identify firm-years in which LT-1 exceeds the 5% threshold. We find that an increase in LT-1 from under 5% to over 5% is associated with a 34% increase in yield spreads relative to the sample mean value of change in yield spreads.

Our paper contributes to both the literature on debt maturity and the literature on credit risk by providing empirical validation to the theoretical predictions that rollover risk, arising from a firm's debt maturity structure, increases the firm's overall credit risk (e.g., He and Xiong (2012a), (2012b), Morris and Shin (2009)). This is an important finding because it has practical implications for a firm's choice of its debt maturity structure. Although the theoretical literature identifies rollover risk as an important determinant of debt maturity choice (e.g., Diamond (1991), Flannery (1986)), the empirical literature on debt maturity (e.g., Barclay and Smith (1995), Berger, Espinosa-Vega, Frame, and Miller (2005), Guedes and Opler (1996), and Stohs and Mauer (1996)) largely sidesteps this issue: The focus of that strand of literature is on documenting the observable firm characteristics that explain the firm's debt maturity choice.

Our paper also complements several recent studies that exploit the subprime crisis of 2007–2009 to highlight the adverse real impact to firms of not being able to roll over their maturing debt. Almeida et al. (2012) show that firms with a larger proportion of their long-term debt maturing right after Aug. 2007 (when the subprime crisis unfolded) experienced larger drops in their real investment rates. Duchin, Ozbas, and Sensoy (2010) find that the decline in corporate investment following the subprime crisis was more pronounced among firms that had more net short-term debt. Our paper differs from these papers in two important aspects. First, whereas these papers examine the effect of debt maturity structure on firm investments, we examine its effect on firm credit risk. Our main conclusion is that rollover risk is an additional source of credit risk that needs to be recognized by rating agencies and bond market investors ex ante. Second, our sample period is not confined to just the crisis period, and our results show that rollover risk contributes to credit risk even under benign credit market conditions. Our results do support the notion that rollover risk becomes more important during recessions when credit markets are likely to be stressed.

The rest of the paper proceeds as follows: We discuss the theoretical literature and outline our key hypotheses in Section II. We provide a description of our data and summary statistics of our sample in Section III, and present the empirical results in Sections IV and V. Section VI concludes.

II. Theory and Hypotheses

In this section, we outline the theoretical literature on rollover risk and highlight the key empirical predictions of this literature that we subsequently test.

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In an early study, Diamond (1991) highlights that short-term borrowing may subject a firm to excessive liquidation when the firm attempts to refinance by rolling over its maturing debt, especially if refinancing coincides with the release of bad news about the firm's prospects.[4] Morris and Shin (2009) argue that, similar to bank deposits, short-term debt is prone to runs due to lack of coordination among creditors, which can undermine a firm's credit quality and its ability to service its long-term creditors. They further argue that a proper measure of a firm's credit risk should incorporate "the probability of a default due to a run on its short-term debt when the firm would otherwise have been solvent" (Morris and Shin (p. 1), see also He and Xiong (2012a)). He and Xiong (2012b) show that short-term debt exacerbates the conflict of interests between shareholders and debtholders because shareholders bear rollover losses that arise when short-term debt is refinanced. Recognizing this, shareholders will choose to default at a higher fundamental firm value that the firm would otherwise have survived in the absence of rollover risk arising from short-term debt. Acharya, Gale, and Yorulmazer (2011) argue that when current owners of assets and future buyers are all short of capital, high refinance frequency associated with short-term debt can lead to a market freeze and precipitate defaults.

The main implication of these theoretical papers is that the amount of a firm's debt maturing in the short term can affect the firm's overall credit quality, aside from the firm's operating risk and leverage ratio. We refer to this as the *rollover risk hypothesis*, and test two of its key predictions.

Our first hypothesis follows directly from theoretical predictions that greater exposure to rollover risk increases the probability of the firm defaulting on its debt obligations, all else being equal.

Hypothesis 1. Firms with higher exposure to rollover risk should, ceteris paribus, have lower credit quality.

Second, rollover risk adversely affects a firm's long-term creditors, because any loss incurred while settling the maturing debt (e.g., due to higher interest payments/collateral requirements, fire sales of assets under the pressure of the creditors of maturing debt) will likely jeopardize the firm's ability to repay its long-term creditors in future (see Brunnermeier and Oehmke (2013), Morris and Shin (2009)). If long-term creditors are aware of these risks, they should price these risks ex ante. Thus, our second hypothesis is:

Hypothesis 2. Firms with higher exposure to rollover risk should, ceteris paribus, face a higher cost of long-term borrowing.

III. Data and Sample Characterization

In this section, we describe the data, define the variables of interest, and provide descriptive statistics of our sample.

[4]Froot, Scharfstein, and Stein (1993), Sharpe (1991), and Titman (1992) show that in the presence of credit market imperfections, short-term debt can lower firm value if it has to be refinanced at an overly high interest rate.

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A. Data

We obtain data on firms' long-term credit ratings from S&P; these ratings represent S&P's long-term assessment of a firm's overall credit quality but not specific to a particular security issued by the firm. These data are made available in Compustat on a monthly basis. We transform the credit ratings into an ordinal scale ranging from 1 to 22, where 1 represents a rating of AAA and 22 represents a rating of D (i.e., a smaller numerical value represents a higher rating; see the Appendix for details). We collect annual firm financial information from Compustat. Our sample spans 1986–2010 and consists of all firms that have an S&P long-term credit rating and are covered by Compustat. Information on individual stock returns and returns on the value-weighted index of all stocks comes from the Center for Research in Security Prices (CRSP).

We obtain data on long-term corporate bonds from the Mergent Fixed Income Securities Database (FISD). This database provides both issue characteristics and transaction information for all corporate bond trades among insurance companies from the National Association of Insurance Commissioners (NAIC) since 1995. Following Campbell and Taksler (2003), we take the following steps to filter the FISD sample to suit our purpose. First, given that insurance companies often limit their investments to investment-grade assets because of regulatory constraints, we exclude speculative-grade bonds from our sample because these trades in the FISD are unlikely to be representative of the general market. Next, to ease the computation of yield to maturity for the bond, we restrict our sample to fixed-rate bonds that are not callable, putable, convertible, substitutable, or exchangeable. To avoid dealing with currency exchange rates, we consider only U.S.-dollar-denominated bonds issued by domestic issuers. We also drop defaulted bond issues. Finally, we exclude bonds that are asset backed or include any credit enhancement features because we want the estimated yield to maturity for the bond to be driven solely by the underlying issuer's creditworthiness, and not by credit enhancements that we cannot fully control for in the cross section.

B. Key Variables

We measure a firm's exposure to rollover risk using the variable LT-1_{t-1}, which is defined as the amount of the firm's long-term debt outstanding at the end of year $t-1$ due for repayment in year t (i.e., Compustat item DD1 in year $t-1$) scaled by its book value of total assets (Compustat item AT) at the end of year $t-1$. Firms with a higher value of LT-1_{t-1} have a larger amount of long-term debt (relative to their total assets) maturing within year t and hence are likely to be exposed to greater rollover risk. Our empirical analysis is focused on ΔLT-$1_{t-1} \equiv$ LT-1_{t-1} − LT-1_{t-2}, which is the year-on-year change in the LT-1 variable. Hence, a larger value of ΔLT-1_{t-1} denotes a larger increase in the firm's exposure to rollover risk. As explained in the Introduction, we focus on ΔLT-1 to take advantage of the sharp variations in LT-1 over time and across firms.

Note that the numerator in LT-1_{t-1} excludes any short-maturity debt that the firm may have issued in year $t-1$ that is due in the current year t. The reason for this exclusion is that differences across firms in their reliance on short-term

debt are likely to be driven by differences in their risk characteristics and credit quality, which gives rise to potential endogeneity concerns.[5] Instead, the use of LT-1_{t-1} allows us to focus on variation in debt maturity arising from long-term debt due, which is plausibly more exogenous to the firm's current risk characteristics. In particular, the ΔLT-1_{t-1} variable is likely to be determined by the firm's long-term debt structure and repayment schedule, both of which are likely to have been determined in the distant past and hence are less likely to be correlated with current firm risk characteristics.

We use a firm's S&P long-term credit rating as a measure of its credit quality. We use the ordinal variable, RATING, to denote the firm's S&P rating. As we explain in detail in the Appendix, RATING takes the value 1 through 22, where a smaller numerical value denotes a higher credit rating.

To test Hypothesis 1, we use changes in firms' long-term S&P ratings to identify changes in their credit quality. Specifically, we define the variable, $\Delta\text{RATING}_t \equiv \text{RATING}_t - \text{RATING}_{t-1}$, to measure the change in a firm's RATING during year t. Because a larger value of RATING denotes a lower credit quality, a positive value of ΔRATING_t signifies that the firm experiences a deterioration in its credit quality in year t. The larger the ΔRATING_t, the more severe is the deterioration in the firm's credit quality. We test Hypothesis 1 by relating ΔRATING_t to ΔLT-1_{t-1}.

We also use the following alternative measures of credit quality change: i) NOTCHES_DOWNGRADE, which is defined as the number of notches by which a firm's credit rating is downgraded during the year (it takes the value 0 if the firm's rating is not downgraded during the year), and ii) NOTCHES_UPGRADE, which is defined as the number of notches by which a firm's credit rating is upgraded during the year (it takes the value 0 if the firm's rating is not upgraded during the year).

To test Hypothesis 2, we use the yield spread on a firm's long-term bonds (YIELD_SPREAD) as a measure of the cost of its long-term borrowing. We estimate the yield to maturity for each bond trade using its transaction price, time to maturity, coupon frequency (usually semiannual), and coupon rate. We then obtain the bond's yield spread during a month as the difference between its average yield to maturity imputed from all trades during the month and the yield on a U.S. Treasury security of comparable maturity. We obtain benchmark Treasury yields from the Web site of the Federal Reserve Board (http://www.federalreserve.gov/releases/h15/data.htm). We winsorize the data on yield spreads at the 1% level on both sides to reduce the effect of outliers.

C. Descriptive Statistics

We present the descriptive statistics for our full sample in Table 1. Definitions of all the variables are in the Appendix. Recall that our sample includes only Compustat firms that have long-term credit ratings from S&P. The mean value

[5] In fact, it has been theoretically predicted and empirically documented that low-risk and high-risk firms are more likely to issue short-term debt as compared to firms in the middle of the credit quality spectrum (e.g., Diamond (1991), Stohs and Mauer (1996)).

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of ln(TOTAL_ASSETS) of 7.724 corresponds to an average book value of total assets of approximately $2.26 billion for our sample firms. The corresponding value for the full Compustat sample during the same period is about $82 million. Thus, our sample of rated firms represents the subset of larger firms in Compustat.

TABLE 1

Summary Statistics

Table 1 provides the descriptive statistics of our sample, which includes all firms with an S&P long-term credit rating and financial information available from Compustat during 1986–2010. Definitions of the variables are provided in the Appendix.

Variable	*N*	Mean	Median	Std. Dev.
LT-1_{t-1}	22,131	0.019	0.007	0.031
RATING	22,131	10.400	10.636	3.906
INVESTMENT	22,131	0.465	0.000	0.499
DOWNGRADE	22,131	0.130	0.000	0.336
NOTCHES_UPGRADE	19,623	0.130	0.000	0.402
NOTCHES_DOWNGRADE	19,623	0.239	0.000	0.688
ln(TOTAL_ASSETS)	22,131	7.724	7.602	1.513
MARKET-TO-BOOK	21,640	1.682	1.415	0.878
R&D/TOTAL_ASSETS	22,131	0.017	0.000	0.034
OPERATING_INCOME/SALES	22,110	0.085	0.091	0.173
TOTAL_DEBT/MKT_CAP	21,648	0.817	0.299	1.769
LONG-TERM_DEBT/TOTAL_ASSETS	22,131	0.302	0.264	0.206
INTEREST_COVERAGE	22,131	9.262	4.542	17.158
INDUSTRY_VOLATILITY	21,962	0.124	0.080	0.103
TAXES/TOTAL_ASSETS	22,131	0.022	0.020	0.028
IDIOSYNCRATIC_VOLATILITY	20,320	0.029	0.026	0.013
TANGIBILITY	22,131	0.362	0.319	0.234
CASH/TOTAL_ASSETS	22,127	0.088	0.048	0.108

The mean value of LT-1_{t-1} is 0.019, which means that for the average firm in our sample the amount of long-term debt payable within a year is 1.9% of its total assets. The median value of LT-1_{t-1} is significantly lower at 0.007, suggesting an upward skewness in the distribution of LT-1_{t-1} in our sample. The median value of TOTAL_DEBT/MKT_CAP of the firms in our sample is 0.299, and the median value of LONG-TERM_DEBT/TOTAL_ASSETS is 0.264. Firms in our sample have an average interest coverage of 9.262. The median value of firm credit rating in our sample is 10.636, which corresponds to a rating slightly below BBB−. Consistent with this, we find that about 46.5% of the firms in our sample have investment-grade ratings (BBB− or above).

The average firm in our sample faces a 13% likelihood of experiencing a rating downgrade during a year. On average, firms in our sample experience a 0.13-notch upgrade in any year (as reflected in the mean value of NOTCHES_UPGRADE). Consistent with firms experiencing more severe downgrades as compared to upgrades, we find that the mean value of NOTCHES_DOWNGRADE in our sample is 0.239.

IV. Exposure to Rollover Risk and Credit Quality

We now proceed to formal multivariate analysis. In this section, we test Hypothesis 1, which predicts that firms with greater exposure to rollover risk should, all else being equal, have lower credit quality.

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A. Baseline Regressions

To test Hypothesis 1, we begin by estimating variants of the following first-difference regression:

$$\Delta\text{RATING}_{i,t} = \alpha + \beta\,\Delta\text{LT-1}_{i,t-1} + \gamma\,\Delta X_{i,t} + \text{YEAR_FE}. \quad (1)$$

The dependent variable, $\Delta\text{RATING}_{i,t}$, represents the change in firm i's credit rating during year t, with a positive (negative) value of $\Delta\text{RATING}_{i,t}$ denoting that firm i experienced a deterioration (improvement) in its credit quality during the year. The key independent variable, $\Delta\text{LT-1}_{i,t-1} \equiv \text{LT-1}_{i,t-1} - \text{LT-1}_{i,t-2}$, denotes the change in the amount of long-term debt payable in year t (scaled by book value of total assets) relative to year $t-1$. Thus, a positive value of $\Delta\text{LT-1}_{i,t-1}$ implies that firm i's exposure to rollover risk has increased in year t. We estimate regression (1) on a panel that has one observation for each firm-year combination, spans 1986–2010, and includes all Compustat firms with an S&P long-term credit rating.

We control the regression for changes (during year t) in important firm characteristics ($\Delta X_{i,t} \equiv X_{i,t} - X_{i,t-1}$) that may affect the likelihood of a change in the firm's credit quality. The firm characteristics that we control for are: size using ln(TOTAL_ASSETS), leverage using TOTAL_DEBT/MKT_CAP and INTEREST_COVERAGE, profitability using OPERATING_INCOME/SALES and TAXES/TOTAL_ASSETS, growth opportunities using MARKET-TO-BOOK and R&D/TOTAL_ASSETS, operating risk using INDUSTRY_VOLATILITY and IDIOSYNCRATIC_VOLATILITY, and asset composition using TANGIBILITY and CASH/TOTAL_ASSETS. Detailed definitions of all these variables are provided in the Appendix. In all specifications, we also include YEAR_FE to control for any macroeconomic variables that may affect changes in firm credit quality. The standard errors are robust to heteroskedasticity and are clustered at the industry level, where we define industry at the level of Fama-French (1997) 48-industry category.

We present the results in Panel A of Table 2. In Table 2 and the rest of Section IV where we describe our results, to ease exposition we drop the subscripts of the variables where there is no cause of confusion. For example, we refer to $\Delta\text{LT-1}_{i,t-1}$ as simply ΔLT-1. The positive and significant coefficient on ΔLT-1 in column 1 indicates that firms with a larger increase in the amount of maturing long-term debt during the year (larger ΔLT-1) are more likely to experience a deterioration in their credit quality (larger ΔRATING) during the same year. The result is also economically significant: A 1-standard-deviation increase in ΔLT-1 (0.09) is associated with an increase of 0.029 in ΔRATING, which represents a 27% increase relative to the sample mean of ΔRATING (0.109). Because this is a first-difference specification, the result implies that, all else being equal, firms with greater rollover risk exposure, as measured by the amount of long-term debt due within a year, have lower credit quality.

In terms of the coefficient estimates on the control variables, we find that credit quality is lower for firms that are smaller (negative coefficient on Δln(TOTAL_ASSETS)), highly levered (positive coefficient on ΔTOTAL_DEBT/MKT_CAP), less profitable (negative coefficients on ΔOPERATING_INCOME/

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TABLE 2

Rollover Risk and Firm Credit Quality

Table 2 reports the results of regressions aimed at understanding the effect of firms' long-term debt (scaled by total assets) payable during the year on their credit quality. We estimate variants of the following first-difference regression specification:

$$\Delta Y_{i,t} = \alpha + \beta\, \Delta\text{LT-1}_{i,t-1} + \gamma\, \Delta X_{i,t} + \text{YEAR_FE}.$$

The dependent variable is $\Delta\text{RATING}_{i,t}$ in Panel A, $\text{NOTCHES_UPGRADE}_{i,t}$ in Panel B, and $\text{NOTCHES_DOWNGRADE}_{i,t}$ in Panel C. The main independent variable is $\Delta\text{LT-1}_{i,t-1}$ in all panels. Results of the tests of the differences between the interaction terms in columns 2–5 are presented in the row titled ΔCOEF in each panel. Definitions of the variables are provided in the Appendix. In all panels, the standard errors are robust to heteroskedasticity and are clustered at the industry level, where we define industry at the level of Fama-French (1997) 48-industry categories. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	ΔRATING				
Variable	1	2	3	4	5
Panel A. Effect of ΔLT-1 on ΔRATING					
ΔLT-1	0.326 (0.090)***				
ΔLT-1 × SMALL		0.272 (0.112)**			
ΔLT-1 × (1 − SMALL)		0.385 (0.102)***			
ΔLT-1 × INVESTMENT			−0.040 (0.059)		
ΔLT-1 × (1 − INVESTMENT)			0.601 (0.151)***		
ΔLT-1 × RECESSION				0.479 (0.129)***	
ΔLT-1 × (1 − RECESSION)				0.264 (0.099)***	
ΔLT-1 × DECLINE					0.488 (0.106)***
ΔLT-1 × (1 − DECLINE)					0.221 (0.090)**
ΔCASH/TOTAL_ASSETS	0.155 (0.117)	0.154 (0.116)	0.161 (0.118)	0.156 (0.116)	0.156 (0.116)
ΔMARKET-TO-BOOK	−0.143 (0.020)***	−0.143 (0.020)***	−0.144 (0.020)***	−0.142 (0.020)***	−0.140 (0.020)***
ΔINDUSTRY_VOLATILITY	−0.344 (0.246)	−0.344 (0.246)	−0.335 (0.244)	−0.346 (0.247)	−0.327 (0.250)
ΔIDIOSYNCRATIC_VOLATILITY	26.200 (6.362)***	26.140 (6.336)***	26.632 (6.324)***	26.308 (6.434)***	26.302 (6.375)***
ΔTANGIBILITY	−0.172 (0.204)	−0.174 (0.203)	−0.160 (0.205)	−0.172 (0.204)	−0.180 (0.205)
Δln(TOTAL_ASSETS)	−0.498 (0.037)***	−0.502 (0.037)***	−0.484 (0.037)***	−0.499 (0.037)***	−0.499 (0.037)***
ΔR&D/TOTAL_ASSETS	−0.758 (0.427)*	−0.744 (0.429)*	−0.806 (0.417)*	−0.770 (0.434)*	−0.758 (0.422)*
ΔTAXES/TOTAL_ASSETS	−1.159 (0.468)**	−1.157 (0.468)**	−1.168 (0.459)**	−1.149 (0.465)**	−1.104 (0.454)**
ΔOPERATING_INCOME/SALES	−0.462 (0.240)*	−0.464 (0.240)*	−0.454 (0.237)*	−0.462 (0.239)*	−0.434 (0.232)*
ΔTOTAL_DEBT/MKT_CAP	0.175 (0.010)***	0.175 (0.010)***	0.173 (0.010)***	0.175 (0.010)***	0.174 (0.010)***
ΔINTEREST_COVERAGE	−0.003 (0.0008)***	−0.003 (0.0008)***	−0.003 (0.0008)***	−0.003 (0.0008)***	−0.002 (0.0008)***
Constant	0.092 (0.061)	0.093 (0.061)	0.089 (0.061)	0.092 (0.061)	0.093 (0.061)
ΔCOEF		−0.113 (0.122)	−0.641 (0.148)***	0.215 (0.132)*	0.267 (0.08)***
No. of obs.	17,457	17,457	17,457	17,457	17,457
R^2	0.152	0.152	0.155	0.152	0.153
YEAR_FE	Yes	Yes	Yes	Yes	Yes

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SALES and ΔTAXES/TOTAL_ASSETS), have lower interest coverage (negative coefficient on ΔINTEREST_COVERAGE), and have higher volatility (positive coefficient on ΔIDIOSYNCRATIC_VOLATILITY). Also, to ensure that our results are not biased because too many control variables are included, in unreported

TABLE 2 (continued)

Rollover Risk and Firm Credit Quality

	NOTCHES_UPGRADE				
Variable	1	2	3	4	5
Panel B. Effect of ΔLT-1 on NOTCHES_UPGRADE					
ΔLT-1	0.018				
	(0.026)				
ΔLT-1 × SMALL		0.042			
		(0.044)			
ΔLT-1 × (1 − SMALL)		−0.007			
		(0.040)			
ΔLT-1 × INVESTMENT			−0.014		
			(0.020)		
ΔLT-1 × (1 − INVESTMENT)			0.042		
			(0.038)		
ΔLT-1 × RECESSION				0.004	
				(0.045)	
ΔLT-1 × (1 − RECESSION)				0.024	
				(0.029)	
ΔLT-1 × DECLINE					0.041
					(0.033)
ΔLT-1 × (1 − DECLINE)					0.004
					(0.029)
ΔCASH/TOTAL_ASSETS	−0.086	−0.085	−0.085	−0.086	−0.085
	(0.058)	(0.058)	(0.058)	(0.058)	(0.058)
ΔMARKET-TO-BOOK	−0.068	−0.068	−0.068	−0.068	−0.068
	(0.014)***	(0.014)***	(0.014)***	(0.014)***	(0.014)***
ΔINDUSTRY_VOLATILITY	−0.095	−0.095	−0.094	−0.095	−0.093
	(0.062)	(0.062)	(0.062)	(0.062)	(0.062)
ΔIDIOSYNCRATIC_VOLATILITY	6.404	6.430	6.442	6.394	6.419
	(4.308)	(4.319)	(4.320)	(4.290)	(4.328)
ΔTANGIBILITY	−0.072	−0.071	−0.071	−0.072	−0.073
	(0.070)	(0.070)	(0.070)	(0.070)	(0.070)
ΔSIZE	−0.151	−0.149	−0.150	−0.151	−0.151
	(0.019)***	(0.019)***	(0.019)***	(0.019)***	(0.019)***
ΔR&D/TOTAL_ASSETS	−0.249	−0.255	−0.253	−0.248	−0.249
	(0.341)	(0.336)	(0.338)	(0.341)	(0.340)
ΔTAXES/TOTAL_ASSETS	−0.389	−0.390	−0.390	−0.390	−0.381
	(0.192)**	(0.191)**	(0.191)**	(0.192)**	(0.189)**
ΔOPERATING_INCOME/SALES	−0.104	−0.103	−0.103	−0.104	−0.100
	(0.054)*	(0.054)*	(0.054)*	(0.054)*	(0.055)*
ΔDEBT/MKT_CAP	0.036	0.036	0.036	0.036	0.036
	(0.006)***	(0.006)***	(0.006)***	(0.006)***	(0.006)***
ΔINTEREST_COVERAGE	−0.0008	−0.0008	−0.0008	−0.0008	−0.0007
	(0.0003)***	(0.0003)***	(0.0003)***	(0.0003)***	(0.0003)***
Constant	−0.144	−0.144	−0.144	−0.144	−0.144
	(0.028)***	(0.028)***	(0.028)***	(0.028)***	(0.028)***
ΔCOEF		0.049	−0.056	−0.020	0.037
		(0.066)	(0.039)	(0.051)	(0.034)
No. of obs.	17,457	17,457	17,457	17,457	17,457
R^2	0.044	0.044	0.044	0.044	0.044
YEAR_FE	Yes	Yes	Yes	Yes	Yes

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TABLE 2 (continued)
Rollover Risk and Firm Credit Quality

	NOTCHES_DOWNGRADE				
Variable	1	2	3	4	5
Panel C. Effect of ΔLT-1 on NOTCHES_DOWNGRADE					
ΔLT-1	0.308 (0.083)***				
ΔLT-1 × SMALL		0.230 (0.107)**			
ΔLT-1 × (1 − SMALL)		0.393 (0.088)***			
ΔLT-1 × INVESTMENT			−0.027 (0.051)		
ΔLT-1 × (1 − INVESTMENT)			0.558 (0.142)***		
ΔLT-1 × RECESSION				0.476 (0.123)***	
ΔLT-1 × (1 − RECESSION)				0.240 (0.084)***	
ΔLT-1 × DECLINE					0.446 (0.107)***
ΔLT-1 × (1 − DECLINE)					0.218 (0.073)***
ΔCASH/TOTAL_ASSETS	0.240 (0.077)***	0.239 (0.078)***	0.246 (0.079)***	0.242 (0.077)***	0.242 (0.077)***
ΔMARKET-TO-BOOK	−0.075 (0.011)***	−0.075 (0.011)***	−0.076 (0.010)***	−0.074 (0.011)***	−0.073 (0.010)***
ΔINDUSTRY_VOLATILITY	−0.249 (0.219)	−0.249 (0.219)	−0.241 (0.217)	−0.251 (0.221)	−0.234 (0.221)
ΔIDIOSYNCRATIC_VOLATILITY	19.795 (6.253)***	19.709 (6.267)***	20.190 (6.129)***	19.914 (6.264)***	19.884 (6.182)***
ΔTANGIBILITY	−0.100 (0.164)	−0.103 (0.164)	−0.088 (0.165)	−0.099 (0.164)	−0.107 (0.165)
ΔSIZE	−0.347 (0.030)***	−0.352 (0.031)***	−0.335 (0.030)***	−0.348 (0.030)***	−0.348 (0.030)***
ΔR&D/TOTAL_ASSETS	−0.509 (0.527)	−0.488 (0.517)	−0.553 (0.536)	−0.522 (0.542)	−0.510 (0.528)
ΔTAXES/TOTAL_ASSETS	−0.770 (0.375)**	−0.767 (0.376)**	−0.778 (0.368)**	−0.759 (0.372)**	−0.723 (0.364)**
ΔOPERATING_INCOME/SALES	−0.359 (0.194)*	−0.360 (0.194)*	−0.351 (0.192)*	−0.359 (0.194)*	−0.334 (0.187)*
ΔDEBT/MKT_CAP	0.139 (0.007)***	0.139 (0.007)***	0.137 (0.007)***	0.139 (0.007)***	0.139 (0.007)***
ΔINTEREST_COVERAGE	−0.002 (0.0007)***	−0.002 (0.0007)***	−0.002 (0.0007)***	−0.002 (0.0007)***	−0.002 (0.0007)**
Constant	0.236 (0.049)***	0.237 (0.049)***	0.234 (0.049)***	0.236 (0.049)***	0.237 (0.049)***
ΔCOEF		0.163 (0.115)	−0.585 (0.137)***	0.236 (0.108)**	0.228 (0.071)***
No. of obs.	17,457	17,457	17,457	17,457	17,457
R^2	0.129	0.130	0.133	0.130	0.130
YEAR_FE	Yes	Yes	Yes	Yes	Yes

tests, we repeat the estimation in column 1 after dropping one control variable at a time and find our results to be robust.

In column 2 of Table 2, we repeat the regression in column 1 after replacing ΔLT-1 with two interaction terms, ΔLT-1 × SMALL and ΔLT-1 × (1 − SMALL), where SMALL is a dummy variable that identifies firms with below-sample-median values of TOTAL_ASSETS. We do this to examine whether the effect

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of rollover risk on credit quality varies between small and large firms. We find that the coefficients on both interaction terms are positive and significant, which indicates that an increase in the amount of long-term debt due during the year is associated with a deterioration in credit quality for both small and large firms. When we compare the coefficients on the two interaction terms (see the row titled ΔCOEF), we find that the two coefficients are not significantly different from each other.

In column 3 of Table 2, we repeat the regression after replacing ΔLT-1 with ΔLT-1 $\times$ INVESTMENT and ΔLT-1 $\times$ (1 $-$ INVESTMENT), where INVESTMENT is a dummy variable that identifies firms with an investment-grade rating (S&P rating BBB$-$ or above). Not surprisingly, we find that an increase in the amount of long-term debt due within the year is associated with a deterioration in credit quality only for firms with speculative-grade ratings. We find that the coefficients on the two interaction terms are significantly different from each other (see the row titled ΔCOEF).

In column 4 of Table 2, we examine whether economic conditions affect the relation between ΔLT-1 and ΔRATING. We achieve this by estimating the regression after replacing ΔLT-1 with two interaction terms, ΔLT-1 $\times$ RECESSION and ΔLT-1 $\times$ (1 $-$ RECESSION), where RECESSION identifies the years classified by the National Bureau of Economic Research (NBER) as recessionary. We find that although ΔLT-1 is positively associated with rating downgrades during both recessions and expansions, the magnitude of the effect is greater during recessions; note the coefficient on ΔLT-1 $\times$ RECESSION is significantly greater than that on ΔLT-1 $\times$ (1 $-$ RECESSION) (see the row titled ΔCOEF). Because credit market conditions are likely to be related to economic conditions, this result highlights that rollover risk is important during periods of both benign and stressed credit market conditions (albeit the effect is stronger during stressed conditions). In unreported tests, we obtain similar findings when we differentiate between the recent financial crisis period (2007–2009) and other years.

Theories on rollover risk also suggest that rollover risk should be more pronounced for firms with declining profitability. We test this prediction in column 5 of Table 2 by estimating regression (1) after replacing ΔLT-1 with ΔLT-1 $\times$ DECLINE and ΔLT-1 $\times$ (1 $-$ DECLINE), where DECLINE is a dummy variable that identifies firms that experience a year-on-year decline in profitability (measured using OPERATING_INCOME/SALES). Consistent with theory, we find that the coefficient on ΔLT-1 $\times$ DECLINE is significantly larger than that on ΔLT-1 $\times$ (1 $-$ DECLINE), suggesting that ΔLT-1 is associated with *more* severe rating downgrades for firms that experience a decline in profitability.

B. Credit Quality Improvement versus Deterioration

The positive correlation between ΔRATING and ΔLT-1 can arise either from increases in LT-1 being associated with rating downgrades (ΔRATING $>$ 0) or from decreases in LT-1 being associated with rating upgrades (ΔRATING $<$ 0). Although both are consistent with Hypothesis 1, we perform further tests to examine which correlation drives our results. In Panel B of Table 2, we repeat all our tests in Panel A with NOTCHES_UPGRADE as the dependent variable.

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Recall NOTCHES_UPGRADE is the number of notches by which a firm's credit rating is upgraded during the year; it takes a value 0 if the firm's rating is not upgraded during the year. The empirical specification and control variables are exactly the same as those in Panel A.

As can be seen from column 1 of Panel B in Table 2, we do not find any significant correlation between ΔLT-1 and NOTCHES_UPGRADE. This indicates that firms with less long-term debt payable during the year (relative to total assets) as compared to the previous year do not experience a rating upgrade. In columns 2–5 where we differentiate across firms and economic conditions, we continue to find an insignificant relation.

In Panel C of Table 2, we repeat all our tests in Panel A with NOTCHES_DOWNGRADE as the dependent variable with the same empirical specification and control variables. Recall NOTCHES_DOWNGRADE is the number of notches by which a firm's rating is downgraded during the year; it takes a value 0 if the firm's rating is not downgraded during the year.

From column 1 of Panel C in Table 2, we find that firms with an increase in the amount of long-term debt payable during the year experience a more severe rating downgrade. Our results are also economically significant: A 1-standard-deviation increase in ΔLT-1 (0.09) is associated with an increase of 0.028 in NOTCHES_DOWNGRADE, which represents a 12% increase relative to the sample mean value of NOTCHES_DOWNGRADE (0.239). Column 2 shows that the correlation between ΔLT-1 and NOTCHES_DOWNGRADE is present among both small and large firms, although there is some weak evidence that the effect is stronger for large firms. From column 3, we find that not surprisingly, only speculative-grade firms experience more severe rating downgrades when they have a large amount of long-term debt due. The coefficients on the two interaction terms are significantly different from each other (see the row titled ΔCOEF). In column 4, we differentiate between recessions and expansions and find that the effect of ΔLT-1 on NOTCHES_DOWNGRADE is significantly greater during recessions. Finally, from column 5 we find that the positive correlation between ΔLT-1 and NOTCHES_DOWNGRADE is significantly greater for firms that experience a decline in operating profitability.

To summarize, the results in Table 2 indicate that firms with a larger increase in long-term debt due within a year are more likely to experience rating downgrades during the year. This effect is present for both small and large firms, firms with and without declining profitability, is confined to firms with speculative-grade ratings, and is present both during recessions and expansions. These findings are consistent with Hypothesis 1 that predicts that greater exposure to rollover risk will lower a firm's credit quality.

C. Additional Tests

We now perform two sets of further tests to strengthen our findings from the baseline analysis.

1. Nonlinear Effect of Long-Term Debt Payable on Credit Quality

In practice, firms' long-term debt maturities tend to be concentrated in a few periods (see Almeida et al. (2012)), which would cause their ΔLT-1 to increase

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sharply during such periods as compared to other periods. This raises the possibility that the effect of ΔLT-1 on deterioration in firm credit quality may be nonlinear in nature. That is, small increases in LT-1 may have no impact on firm credit quality, while only large increases in LT-1 do.

To identify such potential nonlinear effects, we define the dummy variable, LT-1_DUMMY, to identify firm-year observations in which LT-1 $\geq$ 5%. Thus, LT-1_DUMMY identifies firms with a large amount of long-term debt due within a year. We choose a cutoff of 5% in defining LT-1_DUMMY because the mean value of LT-1 (0.019) plus its standard deviation (0.031) equals 5%. In unreported tests, we show that our results are robust to using other cutoff values. We then reestimate regression (1) after replacing LT-1 with the dummy variable LT-1_DUMMY. Thus, our main independent variable in this specification is ΔLT-1_DUMMY$_{t-1} \equiv$ LT-1_DUMMY$_{t-1}-$LT-1_DUMMY$_{t-2}$. Note that ΔLT-1_DUMMY$_{t-1}$ takes the value 1 (-1) if the firm's LT-1 increases (decreases) from less (more) than 5% in the previous year to more (less) than 5% in the current year; ΔLT-1_DUMMY$_{t-1} = 0$ if the firm's LT-1 was either greater or less than 5% in both years. In other words, ΔLT-1_DUMMY$_{t-1} = 1$ (ΔLT-1_DUMMY$_{t-1} = -1$) identifies firms that experience a sharp increase (decrease) in their rollover risk exposure in the current year compared to the previous year, whereas ΔLT-1_DUMMY$_{t-1} = 0$ identifies firms without a sharp change in their rollover risk exposure.

The results are presented in Panel A of Table 3. In these regressions, we include all the control variables in Table 2. However, to conserve space we do not report the coefficients on those controls in Table 3. The positive and significant coefficient on ΔLT-1_DUMMY in column 1 indicates that our results are robust to this alternative construction of the independent variable. Moreover, the economic magnitude is larger than the corresponding result in column 1 of Panel A in Table 2: The coefficient of 0.126 on ΔLT-1_DUMMY indicates that a firm whose amount of long-term debt due within a year (scaled by assets) increases beyond the 5% threshold during the year is likely to experience a rating downgrade of 0.126 notch, which represents a 116% increase relative to the sample mean value of 0.109 for ΔRATING. Such impact of long-term debt due on firm credit quality continues to hold when we differentiate across firm and economic conditions in columns 2–5. In unreported tests, we differentiate between downgrades and upgrades, and find that the results in Panel A are mainly driven by a positive correlation between ΔLT-1_DUMMY and NOTCHES_DOWNGRADE.

In unreported tests, we use an alternative method to identify the nonlinearity in the relation between LT-1 and firm credit quality. Specifically, we construct a dummy variable ΔLT-1_$\widehat{\text{DUMMY}}$ to identify the years in which ΔLT-1 is greater than the 95th percentile. We then repeat our tests after replacing ΔLT-1_DUMMY with ΔLT-1_$\widehat{\text{DUMMY}}$. Note the main difference between ΔLT-1_DUMMY and ΔLT-1_$\widehat{\text{DUMMY}}$ is that while the latter cleanly identifies the years in which there is a significant increase in ΔLT-1, it does not identify the years in which there is a significant decrease in ΔLT-1 (whereas the former does). When we repeat our tests with this alternative measure, we obtain results similar to those reported in Panel A of Table 3.

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TABLE 3

Further Tests of the Relation between Long-Term Debt Payable and Firm Credit Quality

Table 3 reports the results of additional regressions aimed at understanding the effect of firms' long-term debt (scaled by total assets) payable during the year on their credit quality. In Panel A, we estimate the following first-difference regression:

$$\Delta\text{RATING}_{i,t} = \alpha + \beta\,\Delta\text{LT-1_DUMMY}_{i,t-1} + \gamma\,\Delta X_{i,t} + \text{YEAR_FE},$$

where LT-1_DUMMY is a dummy variable that identifies firm-year observations for which LT-1 exceeds 5%. In Panel B, we estimate the following first-difference regression:

$$\Delta\text{RATING}_{i,t} = \alpha + \beta\,\Delta\text{LT-2}_{i,t-2} + \gamma\,\Delta X_{i,t} + \text{YEAR_FE}.$$

In both panels, the dependent variable is $\Delta\text{RATING}_{i,t}$. Results of the tests of the differences between the coefficients on the interaction terms in columns 2–5 are presented in the row titled ΔCOEF in each panel. Definitions of the variables are provided in the Appendix. In all panels, the standard errors are robust to heteroskedasticity and are clustered at the industry level, where we define industry at the level of Fama-French (1997) 48-industry categories. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	ΔRATING				
	1	2	3	4	5
Panel A. Nonlinear Effect of ΔLT-1 on ΔRATING					
ΔLT-1_DUMMY	0.126 (0.020)***				
ΔLT-1_DUMMY × (1 − SMALL)		0.133 (0.026)***			
ΔLT-1_DUMMY × SMALL		0.119 (0.032)***			
ΔLT-1_DUMMY × INVESTMENT			0.054 (0.024)**		
ΔLT-1_DUMMY × (1 − INVESTMENT)			0.189 (0.033)***		
ΔLT-1_DUMMY × RECESSION				0.163 (0.032)***	
ΔLT-1_DUMMY × (1 − RECESSION)				0.114 (0.023)***	
ΔLT-1_DUMMY × DECLINE					0.184 (0.025)***
ΔLT-1_DUMMY × (1 − DECLINE)					0.076 (0.028)***
Constant	0.093 (0.062)	0.093 (0.062)	0.092 (0.062)	0.093 (0.062)	0.091 (0.062)
ΔCOEF		0.014 (0.042)	−0.135 (0.04)***	0.049 (0.036)	0.108 (0.035)***
No. of obs.	17,457	17,457	17,457	17,457	17,457
R^2	0.152	0.152	0.153	0.152	0.153
YEAR_FE	Yes	Yes	Yes	Yes	Yes
Panel B. Further Lags: Effect of ΔLT-2 on ΔRATING					
ΔLT-2	0.268 (0.122)**				
ΔLT-2 × SMALL		0.535 (0.155)***			
ΔLT-2 × (1 − SMALL)		0.186 (0.160)			
ΔLT-2 × INVESTMENT			−0.099 (0.218)		
ΔLT-2 × (1 − INVESTMENT)			0.357 (0.147)**		
ΔLT-2 × RECESSION				0.254 (0.164)	
ΔLT-2 × (1 − RECESSION)				0.273 (0.139)**	
ΔLT-2 × DECLINE					0.496 (0.191)***
ΔLT-2 × (1 − DECLINE)					0.152 (0.125)

(continued on next page)

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TABLE 3 (continued)
Further Tests of the Relation between Long-Term Debt Payable and Firm Credit Quality

	ΔRATING				
	1	2	3	4	5
Panel B. Further Lags: Effect of ΔLT-2 on ΔRATING (continued)					
Constant	0.109	0.109	0.109	0.109	0.110
	(0.066)*	(0.066)*	(0.066)*	(0.066)*	(0.066)*
ΔCOEF		0.349	−0.456	−0.019	0.344
		(0.243)	(0.276)	(0.185)	(0.189)*
No. of obs.	16,402	16,402	16,402	16,402	16,402
R^2	0.156	0.156	0.156	0.156	0.156
YEAR_FE	Yes	Yes	Yes	Yes	Yes

2. Exposure to Rollover Risk Measured with Longer Lags

Our baseline regression in (1) uses long-term debt payable in the next year (LT-1) as a measure of a firm's exposure to rollover risk. Although LT-1 is less subject to endogeneity concerns, one can still argue that firms may try to settle their long-term debt before their maturities and that firms with a large amount of long-term debt due within a year (large LT-1) may face difficulty in settling their debt. This may be due to concerns about a deterioration in their credit quality. To assuage such endogeneity concerns with LT-1, in the next set of tests we use an alternative measure of a firm's exposure to rollover risk. The long-term debt information in Compustat allows us to identify the amount of long-term debt due not only in the next year but also up to 5 years out. We exploit this feature of Compustat data and construct LT-2_{t-2} as the ratio of total long-term debt payable in year t based on information in the firm's year $t-2$ balance sheet (Compustat item DD2) over the book value of total assets at the beginning of year t. We then repeat our tests using ΔLT-$2_{t-2} \equiv$ LT-2_{t-2} − LT-2_{t-3} as our main independent variable.[6] Note that similar to ΔLT-1_{t-1}, ΔLT-2_{t-2} measures the change in the amount of long-term debt due in year t as compared to year $t-1$. The main difference between the two measures is that whereas the former uses information available as of the end of year $t-1$, the latter uses information available as of the end of year $t-2$, which is less likely to be correlated with changes in the firm's credit quality around year t. This enables us to make a stronger argument of exogeneity with ΔLT-2_{t-2}. On the other hand, to the extent that the firm may settle part of its long-term debt during year $t-1$, ΔLT-2_{t-2} is likely to be a less precise proxy for the extent of rollover risk faced by the firm as compared to ΔLT-1_{t-1}.

In Panel B of Table 3, we reestimate all the regressions in Panel A of Table 2 using ΔLT-2_{t-2} as the main independent variable.[7] The result from column 1 indicates a strong positive association between ΔLT-$2_{i,t-2}$ and ΔRATING$_{i,t}$. Consistent with ΔLT-$2_{i,t-2}$ being a noisier measure of rollover risk, we find the magnitude of the effect to be smaller. A 1-standard-deviation increase in ΔLT-$2_{i,t-2}$

[6] We thank the referee for suggesting this test.

[7] Specifically, the regression in Panel B of Table 3 is $\Delta\text{RATING}_{i,t} = \alpha + \beta\,\Delta\text{LT-2}_{i,t-2} + \gamma\,\Delta X_{i,t} +$ YEAR_FE.

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(0.06) is associated with a 0.016-notch increase in $\Delta\text{RATING}_{i,t}$; in comparison, the corresponding estimate using $\Delta\text{LT-1}_{i,t-1}$ is 0.029.[8] From column 2, we find that the positive correlation between $\Delta\text{LT-2}_{i,t-2}$ and $\Delta\text{RATING}_{i,t}$ is present only for small firms, although the coefficients on the two interaction terms are not significantly different from each other. The results in other columns indicate that the positive association between $\Delta\text{LT-2}_{i,t-2}$ and $\Delta\text{RATING}_{i,t}$ is present among firms with speculative-grade rating and for firms that experience a decline in their operating profitability. Somewhat surprisingly, in column 4 we find that the positive association between $\Delta\text{LT-2}_{i,t-2}$ and $\Delta\text{RATING}_{i,t}$ is not statistically significant during recessions but is significant outside recessions; however, the coefficients on the two interaction terms are not significantly different from each other. Overall, our results here are consistent with our results in Table 2.

In unreported tests, we take further lags and construct LT-3_{t-3} as the ratio of total long-term debt payable in year t based on information in the firms' year $t-3$ balance sheet (Compustat item DD3) over total assets at the beginning of year t. The idea is that LT-3_{t-3} uses information in year $t-3$ and hence is even less likely to be correlated with changes in firm credit quality around year t. We then repeat our tests using $\Delta\text{LT-3}_{t-3} \equiv \text{LT-3}_{t-3} - \text{LT-3}_{t-4}$ as our main independent variable and find our results to be robust to this alternative measure of rollover risk.

V. Exposure to Rollover Risk and Cost of Long-Term Debt

In this section we turn to Hypothesis 2, which states that firms with greater exposure to rollover risk should, ceteris paribus, have higher cost of long-term borrowing. This is because any rollover losses resulting from the firm's maturing debt will likely jeopardize the firm's ability to repay its long-term creditors in future, who will have to be compensated through higher yields ex ante.

To test this prediction, we use the yield spreads on firms' long-term bonds as a measure of their cost of long-term borrowing. We then estimate the following first-difference model that is adapted from bond yield spread model in Campbell and Taksler (2003):

$$\Delta\text{YIELD_SPREAD}_{b,t} = \alpha + \beta\,\Delta\text{LT-1}_{i,t} + \gamma_1\,\Delta X_{i,t} + \gamma_2\,\Delta X_{m,t} + \text{YEAR_FE}. \quad (2)$$

In equation (2), subscript b denotes the bond, subscript i denotes the firm that issued the bond, subscript m denotes the market, and subscript t denotes the year. $\text{YIELD_SPREAD}_{b,t}$ denotes the average yield spread on bond b in December of year t. Therefore, the dependent variable in regression (2), $\Delta\text{YIELD_SPREAD}_{b,t} \equiv \text{YIELD_SPREAD}_{b,t} - \text{YIELD_SPREAD}_{b,t-1}$, is the year-on-year change in yield spreads on bond b over year t (specifically, from December of year $t-1$ to December of year t). The key independent variable,

[8] When we regress $\Delta\text{LT-1}_{i,t-1}$ on $\Delta\text{LT-2}_{i,t-2}$, we obtain a coefficient estimate of 0.48. This indicates that a \$1 change in $\Delta\text{LT-2}_{i,t-2}$ is associated with only a \$0.48 change in $\Delta\text{LT-1}_{i,t-1}$. This confirms that $\Delta\text{LT-2}_{i,t-2}$ is a noisier proxy for rollover risk as compared to $\Delta\text{LT-1}_{i,t-1}$ and helps reconcile the difference in economic magnitudes across the two variables.

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ΔLT-$1_{i,t} \equiv$ LT-$1_{i,t}$ − LT-$1_{i,t-1}$, is the change in the amount of long-term debt payable (scaled by assets) in year $t + 1$ relative to that in year t. In other words, regression (2) examines whether the yield spreads on a firm's bonds change by the end of year t *in anticipation of* the firm's changing exposure to rollover risk in year $t + 1$. By contrast, regression (1) examines whether the firm's credit rating changes *during* the year in which it experiences a change in its exposure to rollover risk. The reason we use a different specification for yield spreads is as follows. If bond market investors expect the firm's rollover risk exposure to increase in the coming year, they should price the risk right away, causing yield spreads to increase during the current year.

We control regression (2) for the first differences in all firm characteristics ($\Delta X_{i,t} \equiv X_{i,t} - X_{i,t-1}$) and market characteristics ($\Delta X_{m,t} \equiv X_{m,t} - X_{m,t-1}$) employed in the Campbell and Taksler (2003) model. The firm characteristics we control for are: AVERAGE_EXCESS_RETURN and EQUITY_VOLATILITY, defined as the mean and standard deviation, respectively, of the firm's daily "excess return" (i.e., return on the firm's stock minus the return on the CRSP value-weighted index) over the 180 days preceding the bond trade; MKT_CAP/INDEX, defined as the ratio of the firm's market capitalization to the market capitalization of the CRSP value-weighted index; the ratio of total long-term debt to the book value of total assets (LONG-TERM_DEBT/TOTAL_ASSETS); the ratio of total debt to the sum of the market value of equity and book value of total liabilities (TOTAL_DEBT/MKT_CAP); the ratio of operating income before depreciation to net sales (OPERATING_INCOME/SALES); and three dummy variables that identify firms with INTEREST_COVERAGE below 5, between 5 and 10, and above 10, respectively. We also control for the bond's credit rating, BOND_RATING. The market characteristics we control for are: AVERAGE_INDEX and SYSTEMATIC_VOLATILITY, defined as the mean and standard deviation, respectively, of the daily return on the CRSP value-weighted index over the 180 days preceding the bond transaction date, and SLOPE, defined as the difference in yield between a 10-year Treasury and a 2-year Treasury. We include year fixed effects in all regressions. The standard errors are robust to heteroskedasticity and are clustered at the individual bond issue level.

The results are presented in Panel A of Table 4. As in Section IV, to ease exposition, in our following discussions we drop the subscripts of the variables where there is no cause of confusion. In column 1, the positive and significant coefficient on ΔLT-1 indicates that bonds issued by firms with a larger fraction of long-term debt maturing within the next year over total assets trade at higher yield spreads in the current year, even after we control for all other factors that are known to affect bond yields, including the bond's credit rating. This result highlights that rollover risk arising from maturing long-term debt increases a firm's overall credit risk over and above what is captured by the credit rating. The economic magnitude is also sizable: A 1-standard-deviation increase in ΔLT-1 (0.09) is associated with an 18% increase in ΔYIELD_SPREAD (38.6 basis points).

In column 2 of Table 4, we repeat the regression in column 1 after replacing ΔLT-1 with ΔLT-1 × SMALL and ΔLT-1 × (1 − SMALL). Only the coefficient on ΔLT-1 × SMALL is positive and significant, indicating that the positive association between the amount of maturing long-term debt within the next year and

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TABLE 4

Rollover Risk and Cost of Long-Term Debt

Table 4 reports the results of regressions aimed at understanding the effect of firms' long-term debt (scaled by total assets) payable during the year on the cost of its long-term borrowing. In Panel A, we estimate the following first-difference regression:

$$\Delta\text{YIELD_SPREAD}_{b,t} = \alpha + \beta\ \Delta\text{LT-1}_{i,t} + \gamma_1\ \Delta X_{i,t} + \gamma_2\ \Delta X_{m,t} + \text{YEAR_FE}.$$

In Panel B, we estimate the following first-difference regression:

$$\Delta\text{YIELD_SPREAD}_{b,t} = \alpha + \beta\ \Delta\text{LT-1_DUMMY}_{i,t} + \gamma_1\ \Delta X_{i,t} + \gamma_2\ \Delta X_{m,t} + \text{YEAR_FE},$$

where LT-1_DUMMY is a dummy variable that identifies firm-year observations for which LT-1 exceeds 5%. Results of the tests of the differences between the interaction terms in columns 2–5 are presented in the row titled ΔCOEF in each panel. Definitions of the variables are provided in the Appendix. In all panels, the standard errors are robust to heteroskedasticity and are clustered at the individual bond level. ***, **, and *indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

	ΔYIELD_SPREAD				
Variable	1	2	3	4	5
Panel A. Effect of ΔLT-1 on ΔYIELD_SPREAD					
ΔLT-1	0.768 (0.210)***				
ΔLT-1 × SMALL		0.868 (0.218)***			
ΔLT-1 × (1 − SMALL)		0.384 (0.569)			
ΔLT-1 × INVESTMENT			0.634 (0.192)***		
ΔLT-1 × (1 − INVESTMENT)			1.239 (0.620)**		
ΔLT-1 × RECESSION				1.487 (0.372)***	
ΔLT-1 × (1 − RECESSION)				0.585 (0.228)**	
ΔLT-1 × DECLINE					1.095 (0.254)***
ΔLT-1 × (1 − DECLINE)					0.534 (0.233)**
ΔAVERAGE_INDEX	509.519 (1,025.380)	510.897 (1,025.632)	516.306 (1,022.583)	527.300 (1,023.810)	485.794 (1,029.231)
ΔAVERAGE_EXCESS_RETURN	−57.181 (92.221)	−57.186 (92.391)	−52.167 (91.599)	−53.385 (92.158)	−59.518 (92.301)
ΔEQUITY_VOLATILITY	38.547 (28.762)	38.734 (28.763)	36.963 (28.493)	38.517 (28.785)	39.631 (28.739)
ΔSYSTEMATIC_VOLATILITY	−167.731 (153.374)	−168.779 (153.369)	−175.025 (151.875)	−169.986 (153.356)	−169.972 (153.282)
ΔMKT_CAP/INDEX	−23.975 (22.446)	−23.937 (22.465)	−24.119 (22.385)	−24.601 (22.479)	−21.103 (22.288)
ΔBOND_RATING	0.209 (0.024)***	0.210 (0.024)***	0.207 (0.024)***	0.209 (0.024)***	0.211 (0.024)***
ΔLONG-TERM_DEBT/ TOTAL_ASSETS	0.342 (0.346)	0.302 (0.344)	0.379 (0.344)	0.353 (0.346)	0.338 (0.346)
ΔINTEREST_COVERAGE-1	−0.103 (0.097)	−0.100 (0.096)	−0.106 (0.097)	−0.106 (0.096)	−0.115 (0.097)
ΔINTEREST_COVERAGE-2	−0.124 (0.087)	−0.121 (0.087)	−0.127 (0.087)	−0.125 (0.087)	−0.132 (0.087)
ΔINTEREST_COVERAGE-3	−0.121 (0.066)*	−0.119 (0.066)*	−0.122 (0.066)*	−0.121 (0.065)*	−0.124 (0.066)*
ΔOPERATING_INCOME/SALES	−2.373 (0.349)***	−2.373 (0.349)***	−2.371 (0.349)***	−2.382 (0.349)***	−2.321 (0.350)***
ΔTOTAL_DEBT/MKT_CAP	0.258 (0.032)***	0.258 (0.032)***	0.258 (0.032)***	0.258 (0.031)***	0.258 (0.032)***

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TABLE 4 (continued)
Rollover Risk and Cost of Long-Term Debt

	ΔYIELD_SPREAD				
Variable	1	2	3	4	5
Panel A. Effect of ΔLT-1 on ΔYIELD_SPREAD (continued)					
ΔSLOPE	0.177	0.179	0.184	0.165	0.170
	(0.389)	(0.389)	(0.388)	(0.388)	(0.391)
Constant	0.289	0.290	0.293	0.274	0.270
	(0.684)	(0.684)	(0.682)	(0.683)	(0.687)
ΔCOEF		0.484	−0.605	0.902	0.561
		(0.61)	(0.637)	(0.395)**	(0.245)**
No. of obs.	13,905	13,905	13,905	13,905	13,905
R^2	0.385	0.385	0.386	0.386	0.386
YEAR_FE	Yes	Yes	Yes	Yes	Yes
Panel B. Nonlinear Effect of ΔLT-1 on ΔYIELD_SPREAD					
ΔLT-1_DUMMY	0.133				
	(0.052)**				
ΔLT-1_DUMMY × SMALL		0.143			
		(0.052)***			
ΔLT-1_DUMMY × (1 − SMALL)		0.081			
		(0.156)			
ΔLT-1_DUMMY × INVESTMENT			0.158		
			(0.051***		
ΔLT-1_DUMMY × (1 − INVESTMENT)			0.028		
			(0.171)		
ΔLT-1_DUMMY × RECESSION				0.287	
				(0.101)***	
ΔLT-1_DUMMY × (1 − RECESSION)				0.075	
				(0.051)	
ΔLT-1_DUMMY × DECLINE					0.205
					(0.063)***
ΔLT-1_DUMMY × (1 − DECLINE)					0.049
					(0.064)
Constant	0.281	0.281	0.263	0.272	0.260
	(0.682)	(0.683)	(0.692)	(0.683)	(0.690)
ΔCOEF		0.062	0.130	0.212	0.156
		(0.161)	(0.18)	(0.101)**	(0.07)**
No. of obs.	13,905	13,905	13,905	13,905	13,905
R^2	0.385	0.385	0.385	0.385	0.385
YEAR_FE	Yes	Yes	Yes	Yes	Yes

yield spreads on long-term bonds is confined to small firms. Although the coefficient on ΔLT-1 $\times$ (1 $-$ SMALL) is insignificant, due to noise in our estimation, from the row titled ΔCOEF we find that the coefficients on the two interaction terms are not significantly different from each other. In column 3, we repeat the regression in column 1 after replacing ΔLT-1 with ΔLT-1 $\times$ INVESTMENT and ΔLT-1 $\times$ (1 $-$ INVESTMENT). The coefficients on both terms are positive and significant, indicating that a greater exposure to rollover risk is associated with higher yields for firms with both investment-grade and speculative-grade ratings.

In column 4 of Table 4, we replace ΔLT-1 with ΔLT-1 $\times$ RECESSION and ΔLT-1 $\times$ (1 $-$ RECESSION). We find that although ΔLT-1 is positively associated with yield spreads both during recessions and expansions, the magnitude of the effect is much greater during recessions: As can be seen from the row titled ΔCOEF, the coefficients on the two interaction terms are significantly different

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from each other. In column 5, we replace ΔLT-1 with ΔLT-1 $\times$ DECLINE and ΔLT-1 $\times$ (1 $-$ DECLINE), and find that the positive association between ΔLT-1 and ΔYIELD_SPREAD is stronger for firms with declining profitability.

To identify potential nonlinear effects of LT-1 on yield spreads, we replicate the analysis in Panel A after using LT-1_DUMMY instead of LT-1 as a measure of the firm's exposure to rollover risk. Recall that LT-1_DUMMY is a dummy variable that identifies firm-year observations with LT-1 $\geq$ 5% (i.e., with large levels of exposure to rollover risk). The results are presented in Panel B of Table 4. As is evident from Panel B, not only are our results largely robust to this alternative construction of the independent variable, but also the economic magnitude of the effect is much larger: The coefficient on ΔLT-1_DUMMY of 0.133 in column 1 indicates that a firm whose amount of long-term debt due within a year (scaled by assets) increases to more than the 5% threshold during the year experiences a 34% increase in yield spread (relative to the sample mean of ΔYIELD_SPREAD of 38.6 basis points) 1 year before the debt becomes due. The results of the cross-sectional tests in columns 2, 4, and 5 are also consistent with the corresponding tests in Panel A. The only inconsistent result is in column 3, where we find that the positive association between ΔLT-1_DUMMY and ΔYIELD_SPREAD is statistically significant only for investment-grade firms. One possible explanation for the lack of statistical significance on the interaction between ΔLT-1_DUMMY and (1 $-$ INVESTMENT) is that speculative-grade ratings largely capture the potential nonlinear effect of LT-1 on yield spreads.

Overall, the evidence in Table 4 indicates that bond investors seek a premium for investing in bonds issued by firms with a high proportion of long-term debt maturing in a year, even after controlling for the bond's credit rating. This suggests that debt maturity structure matters independent of the credit rating. All else being equal, shorter debt maturity increases a firm's overall credit risk, but this seems to be not fully captured by the bond's credit rating.

In unreported tests, following the spirit of the tests in Section IV.C.2, we take further lags and use long-term debt payable within the second year and the third year as a measure of a firm's exposure to rollover risk. We find our results to be robust to these alternative measures.

VI. Conclusion

In this paper, we examine whether a firm's debt maturity structure affects its overall credit risk. Our analysis is motivated by the collapse of financial institutions such as Bear Stearns and Lehman Brothers during the recent financial crisis as well as a large body of theoretical research that argues that, in the presence of credit market imperfections, short-term debt exposes a firm to rollover risk of not being able to settle its maturing debt, especially if the settlement coincides with a deterioration in either firm fundamentals or credit market conditions. Recent theoretical advances argue that rollover risk is an additional source of credit risk. We refer to this as the rollover risk hypothesis and test its key predictions.

Our empirical findings offer strong support to the rollover risk hypothesis. We find that firms that experience a large increase in the amount of their long-term debt (scaled by assets) payable within the year are, ceteris paribus, likely to

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experience a more severe deterioration in their credit quality during the year, as measured by downgrades to their credit ratings. Bond market investors seem to recognize the effect of rollover risk because bonds issued by firms with a larger amount of long-term debt (scaled by assets) payable within a year trade at higher yield spreads. These effects are stronger for firms with declining profitability and during recession years.

An interesting avenue for future research is to explore whether credit rating agencies adequately account for the effect of rollover risk on credit risk. Our results seem to suggest that they do not, because we obtain our results even after we control for firms' and bonds' credit ratings. The following quote from S&P's RatingsDirect issued May 13, 2008, also seems to acknowledge some shortcomings of ratings in accounting for rollover risk and promises to correct for it:

> Although we believe that our enhanced analytics will not have a material effect on the majority of our current ratings, individual ratings may be revised. For example, a company with heavy debt maturities over the near term (especially considering the current market conditions) would face more credit risk, notwithstanding benign long-term prospects.

However, further research is needed before we can draw stronger conclusions.

Appendix. Variable Definitions

The variables used in the empirical analysis are defined as follows:

AVERAGE_EXCESS_RETURN is the mean of daily excess returns relative to the CRSP value-weighted index for each firm's equity over the 180 days preceding (not including) the bond transaction date.

AVERAGE_INDEX is the mean of the CRSP value-weighted index returns over the 180 days preceding (not including) the bond transaction date.

BOND_RATING is the issue rating of the bond from the FISD.

CASH/TOTAL_ASSETS is the ratio of book value of cash and marketable securities (Compustat item CHE) to the book value of total assets (Compustat item AT).

DECLINE is a dummy variable that takes the value 1 if a firm experiences a decline in profitability (OPERATING_INCOME/SALES) during the year as compared to the previous year, and 0 otherwise.

DOWNGRADE is a dummy variable that takes the value 1 if the firm experiences a rating downgrade during the year, and 0 otherwise.

EQUITY_VOLATILITY is the standard deviation of daily excess returns relative to the CRSP value-weighted index for each firm's equity over the 180 days preceding (not including) the bond transaction date.

IDIOSYNCRATIC_VOLATILITY is the standard deviation of daily excess returns relative to the CRSP value-weighted index for each firm's equity during a year.

INDUSTRY_VOLATILITY is the standard deviation of the operating income of all firms in the same industry during the year. We define industry at the level of 2-digit Standard Industrial Classification (SIC) code.

INTEREST_COVERAGE is the ratio of operating income after depreciation (Compustat items OIADP + XINT) to the total interest expenditure (Compustat item XINT). INTEREST_COVERAGE-1, INTEREST_COVERAGE-2, and INTEREST_COVERAGE-3 are dummy variables that identify firms with INTEREST_COVERAGE below 5, between 5 and 10, and above 10, respectively.

INVESTMENT is a dummy variable that takes the value 1 if a firm's S&P's long-term credit rating is BBB− or above, and 0 otherwise.

ln(TOTAL_ASSETS) is the natural logarithm of the book value of total assets (Compustat item AT).

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LONG-TERM_DEBT/TOTAL_ASSETS is the ratio of total long-term debt (Compustat item DLTT) to the book value of total assets (Compustat item AT).

LT-1_{t-i}, $i \in \{1, 2, 3\}$, is the ratio of long-term debt due in year t as estimated from the firm's year $t - i$ balance sheet (Compustat item DDI) to total assets at the beginning of year t (Compustat items AT).

ΔLT-i_DUMMY, $i \in \{1, 2, 3\}$, is defined as the year-on-year change in LT-i_DUMMY, where LT-i_DUMMY $= 1$ if LT-$i \geq 5\%$, and LT-i_DUMMY $= 0$ if LT-$i < 5\%$.

MKT_CAP/INDEX is the ratio of the market value of equity to the value of CRSP value-weighted index of all stocks listed in New York Stock Exchange (NYSE), American Stock Exchange (AMEX), and NASDAQ.

MARKET-TO-BOOK is the ratio of market value of total assets to the book value of total assets. We calculate the market value of total assets as the sum of book value of total assets and the market value of equity less the book value of equity.

NOTCHES_DOWNGRADE (NOTCHES_UPGRADE) is the number of notches by which a firm's credit rating is downgraded (upgraded) during the year; it takes the value 0 if the rating is not downgraded (upgraded).

OPERATING_INCOME/SALES is the ratio of operating income after depreciation (Compustat item OIADP) to total sales (Compustat item SALE).

R&D/TOTAL_ASSETS is the ratio of research and development expenditure (Compustat item XRD) to book value of total assets (Compustat item AT). We replace missing values of XRD as 0.

RATING is an ordinal variable that indicates the S&P long-term credit rating of the firm. The variable is coded as follows: AAA = 1, AA+ = 2, AA = 3, AA− = 4, A+ = 5, A = 6, A− = 7, BBB+ = 8, BBB = 9, BBB− = 10, BB+ = 11, BB = 12, BB− = 13, B+ = 14, B = 15, B− = 16, CCC+ = 17, CCC = 18, CCC− = 19, CC = 20, C = 21, D = 22.

ΔRATING$_t$ is the change of RATING during year t.

RECESSION is a dummy variable that takes the value 1 for years 1981, 1982, 1990, 1991, 2001, 2007–2008, and 0 otherwise.

SMALL is a dummy variable that takes the value 1 for firms with book value of total assets (Compustat item AT) below the sample median, and 0 otherwise.

SYSTEMATIC_VOLATILITY is the standard deviation of the CRSP value-weighted index returns over the 180 days preceding (not including) the bond transaction date.

TANGIBILITY is the ratio of book value of property plant and equipment (Compustat item PPENT) to the book value of total assets (Compustat item AT).

TAXES/TOTAL_ASSETS is the ratio of tax expenditure (Compustat item TXT) to book value of total assets (Compustat item AT).

TOTAL_DEBT/MKT_CAP is the ratio of total debt (Compustat items DLC + DLTT) to the market value of equity.

SLOPE is the difference between the 10- and 2-year Treasury yields.

YIELD_SPREAD is the difference between the average yield to maturity for all bond trades during the month and the yield to maturity on a Treasury with comparable maturity.

References

Acharya, V. V.; D. Gale; and T. Yorulmazer. "Rollover Risk and Market Freezes." *Journal of Finance*, 66 (2011), 1177–1209.

Almeida, H.; M. Campello; B. Laranjeira; and S. Weisbenner. "Corporate Debt Maturity and the Real Effects of the 2007 Credit Crisis." *Critical Finance Review*, 1 (2012), 3–58.

Barclay, M. J., and C. W. Smith. "The Maturity Structure of Corporate Debt." *Journal of Finance*, 50 (1995), 609–631.

Berger, A. N.; M. A. Espinosa-Vega; W. S. Frame; and N. H. Miller. "Debt Maturity, Risk, and Asymmetric Information." *Journal of Finance*, 60 (2005), 2895–2923.

Brunnermeier, M. K. "Deciphering the Liquidity and Credit Crunch of 2007–2008." *Journal of Economic Perspectives*, 23 (2009), 77–100.

Brunnermeier, M. K., and M. Oehmke. "The Maturity Rat Race." *Journal of Finance*, 68 (2013), 483–521.

https://doi.org/10.1017/S0022109014000520 Published online by Cambridge University Press

Campbell, J. Y., and G. B. Taksler. "Equity Volatility and Corporate Bond Yields." *Journal of Finance*, 58 (2003), 2321–2349.

Diamond, D. W. "Debt Maturity Structure and Liquidity Risk." *Quarterly Journal of Economics*, 106 (1991), 709–737.

Duchin, R.; O. Ozbas; and B. A. Sensoy. "Costly External Finance, Corporate Investment, and the Subprime Mortgage Credit Crisis." *Journal of Financial Economics*, 97 (2010), 418–435.

Fama, E., and K. R. French. "Industry Costs of Equity." *Journal of Financial Economics*, 43 (1997), 153–193.

Flannery, M. J. "Asymmetric Information and Risky Debt Maturity Choice." *Journal of Finance*, 41 (1986), 19–37.

Froot, K. A.; D. S. Scharfstein; and J. C. Stein. "Risk Management: Coordinating Corporate Investment and Financing Policies." *Journal of Finance*, 48 (1993), 1629–1658.

Guedes, J., and T. Opler. "The Determinants of the Maturity of Corporate Debt Issues." *Journal of Finance*, 51 (1996), 1809–1833.

He, Z., and W. Xiong. "Dynamic Debt Runs." *Review of Financial Studies*, 25 (2012a), 1799–1843.

He, Z., and W. Xiong. "Rollover Risk and Credit Risk." *Journal of Finance*, 67 (2012b), 391–429.

Morris, S., and H. S. Shin. "Illiquidity Component of Credit Risk." Working Paper, Princeton University (2009).

Sharpe, S. A. "Credit Rationing, Concessionary Lending, and Debt Maturity." *Journal of Banking and Finance*, 15 (1991), 581–604.

Stohs, M. H., and D. C. Mauer. "The Determinants of Corporate Debt Maturity Structure." *Journal of Business*, 69 (1996), 279–312.

Titman, S. "Interest Rate Swaps and Corporate Financing Choices." *Journal of Finance*, 47 (1992), 1503–1516.

https://doi.org/10.1017/S0022109014000520 Published online by Cambridge University Press