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Corporate Debt Maturity and Monetary Policy

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Do firms lengthen the maturity of their borrowing following a flattening of the Treasury yield curve that results from monetary policy operations? We explore this question separately for the years before and during the zero lower bound (ZLB) period, recognizing that the same change in the yield curve slope signifies different states of the economy and monetary policy over the two regimes. We find that the answer is robustly yes for the pre-ZLB period: Firms extended the maturity of their bond issuance by nearly three years in response to a policy-induced reduction of 1 percentage point in the maturity-matched Treasury term spread between the current and previous bond issuance. By comparison, the answer is more nuanced for the ZLB period: The magnitude and significance of the maturity response were even more pronounced during the peak quarter of the financial crisis (the fourth quarter of 2008), but they were much more muted afterward. In addition, we find that the corporate bond credit spread declined consistently following a policy-induced flattening of the yield curve, albeit not significantly after 2008:Q4. Most of these effects are due to the lower term premium, not due to the expected short-term rate. Taken together, these findings indicate that firms tend to adjust the maturity and composition of their debt issuance in order to benefit from changes in the term spread induced by monetary policy. Our analysis illustrates one channel through which unconventional policy operations can affect economic activity, especially when markets are under distress. This can help us understand the transmission of unconventional monetary policy, which has become a vital issue in the low-interest, low-inflation environment that has prevailed since the financial crisis.

Introduction

The general consensus is that the Federal Reserve's unconventional policies during the zero lower bound (ZLB) period reduced long-term Treasury yields. There is, however, less empirical evidence on how the lower long-term yields, and hence the term spread, were transmitted to stimulate the real economy. In this paper, we explore one specific channel of transmission: whether, as part of their optimal financing decision, firms lengthen (shorten) the maturity of their liability portfolio of bonds and loans, or switch from loans to longer-maturity bonds (or from bonds to loans) in response to policy-induced flattening (steepening) of the yield curve.

Understanding firms' responses is important for understanding the efficacy of unconventional policies (such as the maturity extension program [MEP]) and the associated optimal maturity composition of the Federal Reserve balance sheet. If corporate debt maturity is insensitive to changes in the term spread (for example, because of "maturity habitat"), then Fed balance-sheet policies during a ZLB period that are intended to reduce long-term yields will offer little relief in funding costs to firms borrowing in short maturities, even when these policies directly lower the cost of funds for firms borrowing long, all else being equal. On the other hand, if the corporate sector extends the debt maturity in response to a flatter yield curve, balance-sheet policies may provide additional stimulus even during a ZLB period by lowering the cost of funds, including for those firms that usually borrow short but would extend their debt maturities if the yield curve becomes flatter.

It should be noted, however, that the same change in the slope of the Treasury yield curve signifies different states of the economy and monetary policy actions over the pre-ZLB versus the ZLB periods. During the pre-ZLB period, a flattening of the yield curve tended to result from *tighter conventional* monetary policy (that is, an increase in the overnight policy rate). In contrast, under the ZLB regime, the yield curve tended to flatten as a result of *easier unconventional* monetary policy (that is, a decline in long-term Treasury yields brought about by asset purchases or forward guidance by the Fed). This implies that a

flattening of the yield curve generally corresponds to an economic boom during the pre-ZLB era, but to an economic downturn during the ZLB era, since the systematic component of monetary policy stipulates that the Fed tighten when the economy is booming, to prevent overheating, but ease when the economy is contracting, to stimulate activity. If firms react differently to a flatter Treasury yield curve depending on the state of the economy, then their response to the same reduction in the yield curve slope may well differ under the two regimes. We therefore explore this question separately for the pre-ZLB versus the ZLB periods.

We find that, on average, firms extend the maturity of their current bond issue by close to three years relative to their last bond issue in response to a policy-induced reduction of 1 percentage point in the term spread of Treasuries whose maturities are matched to those of the current and the last bond issue, respectively. This maturity extension effect is fairly robust for the pre-ZLB period. The effect is even stronger for the fourth quarter of 2008, the peak quarter of the financial crisis, when maturity extension increased to more than four years per 1 percentage point reduction in the term spread. By comparison, we find a weaker and mostly insignificant effect during the ZLB period that followed 2008:Q4. The maturity extension of newly issued corporate bonds over the ZLB period is attributed mostly to declines in the term premium component of the term spread, rather than to declines in the average expected future short rate.

In terms of heterogeneous reactions across firms of different sizes and riskiness, we find a robust effect of term-spread reduction on maturity extension for large, low-risk firms. At the same time, such firms pay a much lower credit spread on their bonds. Small, low-risk firms adjust their bond maturity by a similar degree, although the coefficient estimate is statistically insignificant. Large, high-risk firms do minimal maturity adjusting, probably because they are already borrowing long and therefore enjoy the largest reduction in credit spread. Small, high-risk firms do not appear to benefit from either maturity extension or credit spread reduction, likely because they are constrained in the options available to them.

All things considered, we find evidence that before the ZLB, changes in the term spread

had a nontrivial effect on the maturity structure of nonfinancial corporate firms: Firms extended their debt maturity to take advantage of the flattening of the yield curve. This effect became stronger during the Great Recession, partly due to the unconventional monetary policies that were implemented. However, this effect appears to have grown much weaker after the crisis, possibly because variations in the term spread became too small to induce firms to systematically adjust maturity of their debt issues. Nevertheless, larger and more creditworthy firms seemed to benefit the most even without changing their debt maturity.

1 Corporate Bond Maturity Choice and the Yield Curve

Our analysis is an effort to understand, along one specific dimension, the endogenous changes in the behavior of agents in response to monetary policy actions. This endogenous response constitutes part of the transmission mechanism and can affect the eventual impact of monetary policy on the real economy. For example, the Treasury may alter the maturity composition of its debt issuance to take advantage of lower yields in a segment of the yield curve, and this can dampen how much the Fed's balance-sheet operations influence the level and shape of the yield curve. The endogenous reaction of corporate debt issuance may affect the precise transmission of the policy into the amount and interest rate paid on debt and hence firms' cost of capital, which in turn can affect employment and output (and thus the degree of resource utilization).

We examine one specific potential reaction by private firms: whether, in response to changes in the yield-curve slope induced by the Fed's policy operations, they adjust the maturity of their borrowing (through bond issuance or loans) to achieve their objective of minimizing funding costs. Since corporate bonds tend to have maturities that are longer than those of bank loans, we also examine whether firms substitute bonds for loans when they want to borrow long, likely in response to a flatter yield curve (that is, a narrower term spread), and vice versa. This section discusses the mechanisms that likely can induce firms

to alter the maturity composition of their debt issuance.

A simple two-period model can help illustrate the economic mechanism. This model, which is presented in detail in A in the Appendix, supports the intuition that the term premium corresponds to the extra cost a firm has to pay to borrow long and so a firm will borrow long only if it does not have to pay any extra. Moreover, the risk-free and risky components of the term premium matter equally. This may be one reason why the same reduction in the Treasury yield curve slope can elicit different reactions from firms in their choice of corporate bond maturity during the pre-ZLB versus the ZLB era. If the risky component of the corporate term premium tends to rise (fall) when the economy is operating below (above) its potential, then a given reduction in the Treasury yield curve slope is likely to be (partially) offset by an increase in the risky term premium and thus results in a smaller reduction in the overall term premium for the corporate yield curve during the ZLB period compared with the pre-ZLB period. This can imply that firms are less likely to extend the maturity of their bond issues during the ZLB period than before it. In short, a firm will shift debt issuance to a longer maturity only if the overall term premium turns from positive to negative. The term premium turning more negative further lowers the financing cost for the firm but causes no apparent additional change in its debt maturity. In reality, because of cross-firm heterogeneity, we expect that an increase (a decrease) in the corporate term premium would make it less (more) likely for some firms to extend the maturity of their debt.

Of course, the model abstracts from several omitted factors as well as from several constraints that are likely also important. Those factors and constraints lead to some degree of inertia in firms' maturity choice, or a "habitat effect." Firms' maturity choice is likely tied to the expected economic lifespan of the project being financed. In extreme cases, some firms may prefer to match the maturity of their investment with the financing to avoid the need for refinancing entirely. This may be the fundamental reason for maturity habitat, and such firms may be reluctant to change the maturity structure of their borrowing solely in

response to changes in the term spread. On the other side, to the extent a firm has established a borrowing relationship with a specific lender (or group of investors), the lender's maturity preference may also influence the eventual equilibrium maturity choice. Likewise, certain markets may have long-standing conventions regarding the maturity of contracts, which makes it hard for borrowers to deviate if they want to stay in that market. For example, leveraged loans tend to have five-year maturities. So, to borrow long, a firm has to move from the loan market to the bond market.

Rollover risk is likely relevant for the choice of maturity on loans, which tend to have relatively short maturities compared with bonds, making some firms reluctant to shift from bonds to loans. These firms worry about the risk of not being able to refinance at maturity due to difficult market conditions, and thus they want to avoid the need to refinance frequently.[1] This factor should be much less relevant for corporate bonds, which tend to be of longer maturities. For instance, the increase in rollover risk is likely small for a switch in maturity from 10 years to 7 years, or from 15 years to 10 years. Nonetheless, firms may still want to "ladder" their debt maturity profile to avoid having to roll over a large fraction of debt all at once, as shown in Choi et al. (2018). Moreover, firms that are less creditworthy may not be able to shift their borrowing to the long end if an insufficient number of lenders are willing to lend to them at long maturities. Models with information asymmetry, such as that of Diamond 1991, can generate this outcome.

The simple model highlights that the risk-free and the risky components of the term premium matter equally. On the other hand, most studies of the effect of monetary policy focus on the risk-free yield curve. In particular, studies of unconventional policy operations, including large-scale asset purchases (LSAP) and the MEP, focus on their effects on long-term Treasury yields and, in turn, their effects on the Treasury term premium. Fed operations have disparate effects on different segments of the yield curve. More often than not, the

[1]There may be other considerations as well, since bonds and loans differ along multiple dimensions. For example, some firms may find the typical loan covenants too constraining and thus prefer bond, the contracts for which generally do not carry covenants.

term premium between long and short Treasuries (such as the one between 10- and 2-year bonds) responds by more than the term premium between 10-year and longer Treasuries. So firms that were already borrowing at 10-year or longer maturities likely have less incentive to further lengthen the maturity of their debt issuance in response to declines in the term premium. Note, however, that even without changing the maturity of debt issuance, these firms benefit from any decline in long yields resulting from policy actions.

At the same time, there is some evidence that monetary policy operations also matter for the level of the corporate risk spread. For example, Swanson (2017) finds that policy shocks (mostly forward guidance and LSAP surprises) that increase Treasury yields tend to reduce the credit spread, and the effect of forward guidance shocks is especially large during the ZLB period.[2] This is why we also examine the impact of policy actions on the credit spread, even though our focus is on the Treasury term spread. As will be shown, we find that a decline in the risk-free Treasury term spread induced by policy shocks causes the credit spread to decline too. To the extent that this reflects a lower price of credit risk, and assuming credit spreads at the long end tend to be more sensitive to the price of risk, the decline will correspond to a larger reduction in credit spread at the long end and hence a narrower term spread of the credit risk term structure as well.[3]

The model is applicable at the individual firm level. Since firms most likely have different loadings on the credit risk factor, with riskier firms featuring larger loadings (as demonstrated by, for example, Greenwood and Hanson 2013), a given change in the risk price should result in larger changes in the credit risk premium paid by riskier firms. This suggests that riskier firms are more likely to adjust the maturity of their debt issuance in response to policy-induced changes in the credit risk premium, to the extent they are not constrained from reaching their optimal choice.

Other studies (for example, Swanson 2017) cannot determine whether policy operations

[2]Swanson (2017) does not estimate the impact on the *term structure* of the corporate risk spread.

[3]Note that the observed change in the risky term spread may not follow this pattern if sample selection is present: Among the risky firms, only those considered relatively safe can borrow at the long end.

affect the credit spread indirectly, directly, or both indirectly and directly. The indirect effect on credit spread would work through policy operations' effect on the risk-free term premium and yields, which leads to changes in aggregate demand. For example, a decline in the term premium and, in turn, in long yields stimulates spending, which improves firms' cash flow and thus lowers their default probability and, in turn, reduces the credit spread. An improved economy can even lower the price of credit risk as well. It is less clear how policy actions can directly influence the credit risk premium without also changing aggregate demand. One possible mechanism is the so-called risk-taking channel, whereby some institutions reach for risk just because the prevailing level of the risk-free rates is low, even if there is little change to the Treasury term premium. Our estimates regarding the effect of policy-induced changes in the credit spread should be regarded as the composite of the direct and indirect effects.

2 Data and Methodology

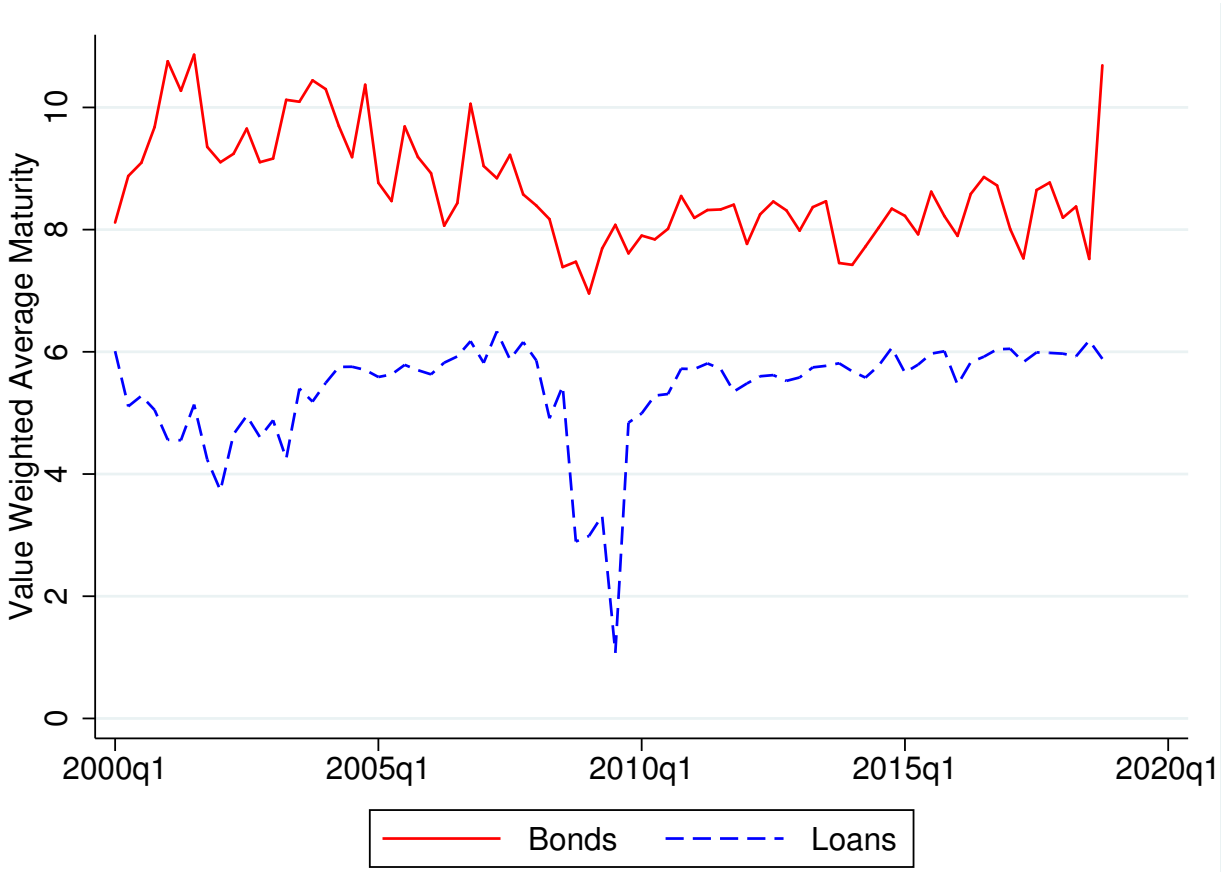
We use microdata at the level of corporate debt issues to exploit within-firm variation so that we can isolate the effect of policy on debt issuance characteristics. First, we use individual bond and loan issuance data from Capital IQ from 2000:Q1 through 2015:Q4 (latest available monetary policy shocks). Figure 1 depicts the average maturity of newly issued corporate bonds and loans reported in the Capital IQ data set. While Capital IQ data on bond issuance are comprehensive, Capital IQ loan issuance data are restricted to syndicated leveraged loans. Bonds clearly have a longer average maturity than loans do (eight to nine years versus five to six years), and the average maturity of loans has been remarkably stable, except for a steep dip during the financial crisis.

Using these data, we estimate the following baseline regression at the firm-quarter level:

$$\Delta \mathrm{Y}_{i,t} = \beta \Delta \text{Term Spread}_t + \gamma X_{i,t} + \epsilon_{i,t}, \tag{1}$$

where $\Delta \mathrm{Y}_{i,t}$ measures changes in key terms of individual bond issuance of firm i in quarter

Figure 1: Average Maturity of Bonds and Loans.
Source: S&P Capital IQ.



t relative to the previous issuance: (1) maturity (in years), (2) volume (in logs), and (3) credit spread (in percentage points).[4] Note that the regression uses firm-specific changes; that is, we link changes in debt issuance characteristics (for example, maturity, volume, and credit spread) within a given firm to changes in the term spread. As a result, the difference operator (Δ) in the above equation always represents the difference in bond attributes and term spread relative to the period of the *last issuance by the same firm*. We measure the term spread as the difference between Treasury yields (in percentage points) with tenor corresponding, respectively, to the maturities of the current and the previous bond issuance

[4]When a firm issues multiple bonds within a given quarter, the volume is the sum across these issues, and the maturity and credit spread are the volume-weighted averages.

by the same firm. For example, if a firm issued a 10-year bond in 2005:Q3 and its previous issuance was a 5-year bond in 2003:Q1, the dependent variable ΔTerm Spread$_t$ in the above regression is the difference in spread between the 5-year and the 2-year Treasury notes in 2005:Q3 relative to 2003:Q1. The control vector $X_{i,t}$ includes credit spread, maturity, and log volume of the previous bond issue, as well as firm characteristics (including log assets, cash, intangibles, and long- and short-term debt as shares of assets) at the last quarter-end before the current debt issuance, and firm fixed effects.

To isolate exogenous monetary-policy-induced variation in the yield curve, we combine the within-firm variation with an instrumental variable (IV) setup. Specifically, we instrument the firm-bond-maturity-matched Treasury term spread with the monetary policy shocks identified in Gurkaynak et al. (2005) and Swanson (2017).[5] Instrumenting the term spread helps minimize coefficient bias due to simultaneity in the above equation. For example, aggregate demand effects or other confounding factors may drive changes in both the attributes of new debt issuance and the term spread, biasing our coefficient estimates. Given our interest in the effect of monetary policy transmission, we instrument the term spread to isolate the variation that is driven by monetary policy surprises and is thus exogenous to economic conditions. Moreover, instrumenting changes in the Treasury term spread with policy shocks should, in principle, make the coefficients of the pre-ZLB and ZLB periods more comparable, because a flattening of the Treasury yield curve due to a policy *shock* can occur during either the boom or the downturn phase of a cycle. This contrasts with an observed curve flattening, which is mostly driven by the systematic component of policy and thus associated with an economic boom before the ZLB and a downturn during the ZLB.

[5]We thank Eric Swanson for sharing the updated data.

3 Effect of Term Spread on Corporate Debt Attributes

3.1 Effect of Term Spread Changes on Corporate Bond Issuance

This section presents results on bond issuance separately for the pre-crisis sample and the subsequent ZLB period. Table 1 reports estimates for before (2000:Q1 through 2008:Q3) and during the ZLB period (2008:Q4 through 2015:Q4). Making this sub-sample distinction is important because, before the ZLB period, monetary-policy-induced changes in the term spread were largely attributed to changes in short-term rates (which comove strongly with the federal funds rate), whereas during the ZLB period, (unconventional) monetary policy operated largely through influencing long-term rates—the long end of the yield curve. Hence, the same change in the term spread, in fact, corresponds to different mechanisms and thus may well lead firms to react differently. Before the ZLB, the term spread tended to rise due to a decline in the federal funds rates (that is, an unexpected easing); during the ZLB, the term spread tended to rise due to an increase in the long yields (that is, an unexpected tightening).

Based on this sample split, we find that effects on maturity adjustments and credit spread changes are larger during the ZLB period, although the difference is not statistically significant. For the period before the ZLB, reported in columns (1) through (3), we estimate an average maturity shortening of about 2.8 years and a 1.7 percentage point decrease in the credit spread in response to a 1 percentage point flattening of the yield curve. During the ZLB, in columns (4) and (5), the same yield curve flattening results in a significant maturity extension of 3.9 years. The credit spread decreased by 7.9 percentage points during the ZLB period. We do not find a volume response during either period.

On the other hand, as Table A.3 in the Appendix shows, much of this stronger reaction in maturity and credit spread during the ZLB is driven by the peak quarter of the crisis, 2008:Q4. Once that quarter is removed from the sample, the estimated maturity response falls to 0.7 and, in fact, carries the wrong sign, but the response is insignificant. The change

Table 1: Average Effects of Term Spread on Bond Issuance Before and During ZLB

VARIABLES	(1) Maturity	(2) Volume	(3) Credit Spread	(4) Maturity	(5) Volume	(6) Credit Spread
Term Spread	-2.808**	0.113	1.691***	-3.903***	-0.088	7.922***
	(1.169)	(0.270)	(0.618)	(1.177)	(0.330)	(1.339)
Log Assets	-0.414	0.481***	0.237	-0.528*	0.509***	0.232
	(0.344)	(0.051)	(0.230)	(0.270)	(0.076)	(0.295)
Cash to Assets	-0.065	0.689***	-0.181	0.064	0.193	-2.260**
	(1.721)	(0.232)	(0.608)	(1.011)	(0.344)	(0.956)
Intangibles to Assets	-0.260	-0.383*	0.740	0.564	-0.616**	-1.097
	(1.853)	(0.218)	(1.095)	(0.757)	(0.246)	(0.704)
L/T Debt to Total Assets	-1.271	-0.047	1.801**	-0.008***	0.000	0.001
	(1.233)	(0.171)	(0.731)	(0.002)	(0.000)	(0.003)
S/T Debt to Total Assets	-6.746**	0.509	0.829	-1.492	0.791	0.405
	(2.861)	(0.480)	(1.195)	(1.908)	(0.510)	(1.848)
Observations	2,796	2,796	2,796	4,657	4,657	4,657
R-squared	0.455	0.442	0.412	0.456	0.551	-0.253
Firm-Security FE	Yes	Yes	Yes	Yes	Yes	Yes
IV	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Sample Period	Pre-ZLB	Pre-ZLB	Pre-ZLB	ZLB	ZLB	ZLB
Kleibergen Paap Stat	20.49	20.49	20.49	10.57	10.57	10.57
Kleibergen Paap p-value	0.00227	0.00227	0.00227	0.103	0.103	0.103

Note: Our data cover the period from 2000:Q1 through 2015:Q4. Pre-ZLB refers to the sample period of 2000:Q1 through 2008:Q3, and ZLB refers to the sample period of 2008:Q4 through 2015:Q4. Firm*security-type clustered standard errors in parentheses. ***, **, *, denote 1, 5, and 10 percent significance, respectively.

in credit spread falls to 3.5 and is no longer significant either. One likely reason for the outsize influence of a single quarter is that 2008:Q4 accounts for a large fraction of the variation and, hence, power of the instruments during the ZLB period. The largest LSAP shocks, along with the funds-rate and forward-guidance shocks, occurred in 2008:Q4 (as can be seen in the fitted values of the term spread in Figure A.1).[6]

In unreported analysis, we find that, in contrast to their effect on bond issuance behavior, the policy-induced term spread changes have essentially no effect on the maturity of loans. This is not surprising, since most of the syndicated leveraged loans in this data set have a maturity of five years. It is interesting, though, that the credit spreads on loans also respond

[6]The first-stage results, where we regress the term spread on the monetary policy shocks identified in GSS and Swanson (2017) are shown in Table A.1 in the Appendix. Predicted values of the term spread from the first stage are plotted in Figure A.1 along with its actual values.

minimally to term spread changes.

These results together suggest that corporations are more likely to adjust their bond maturity to optimize funding costs in response to monetary policy during times of market dysfunction and when the Fed can adjust the short-term rates more freely and thus influence the term spread more through moving short rates.[7] We also find a significant effect of term spread changes due to forward guidance on corporate maturity structure and credit spreads during the pre-ZLB period and when we exclude the 2001 recession period (results are presented in Table A.4 in the Appendix). By comparison, our estimates suggest that balance sheet operations were not as effective in influencing firm financing decisions, at least not through changes in the term spread, outside of periods of extreme market distress.

Based on the expectation hypothesis, the term spread can be decomposed as the sum of expected future short rates and a term premium. In Table 2, we report evidence that during the ZLB period, changes in the attributes of bond issuance in response to a flattening of the yield curve were mostly due to changes in the term premia, and not due to changes in the expectations about future short rates, especially when firm characteristics are controlled for. Using the term premium estimates from the Kim-Wright model, we find that a 1 percentage point reduction in the maturity-matched term premium results in a maturity extension of 3.3 years and a credit spread decrease of 5.2 percentage points. The expected-short-rate component shows no statistically significant effect on either the maturity or credit spread of newly issued corporate debt. In other words, corporate credit spreads decrease and corporate bond maturity increases when investors require a low price for holding the term risk embedded in long-dated Treasuries.[8]

By comparison, we find no significant effect of the Treasury term premia before the ZLB period. (For brevity, the estimates are not reported.) This contrast is perhaps not surprising, because the term premium accounted for much more of the variation in the term

[7]Mechanically this overall pattern is perhaps not surprising, since, outside of downturns or market turmoil, monetary-policy shocks generally explain a rather small fraction of the variation in Treasury term spread.

[8]We find similar but slightly smaller effects using term premium estimates by Adrian et al. (2013).

Table 2: Differential Impact of Term Premia and Expectations of Future Short Rate During ZLB Period

VARIABLES	(1) Maturity	(2) Volume	(3) Credit Spread
Expectation Part	1.056	-0.014	-0.306
	(0.662)	(0.105)	(1.019)
Term Premia	-3.292**	-0.025	5.192**
	(1.578)	(0.229)	(2.079)
Log Assets	0.289	0.513***	-0.639
	(0.340)	(0.066)	(0.618)
Cash to Assets	0.319	0.194	-2.803**
	(1.132)	(0.352)	(1.165)
Intangibles to Assets	-0.052	-0.621**	-0.473
	(0.724)	(0.244)	(0.888)
Long Term Debt to Total Assets	0.006	0.000	-0.014*
	(0.004)	(0.001)	(0.007)
Short Term Debt to Total Assets	-1.310	0.786	-0.073
	(1.747)	(0.514)	(1.738)
Observations	4,657	4,657	4,657
R-squared	0.491	0.551	-0.223
IV	Yes	Yes	Yes
Firm*Bond-Type FE	Yes	Yes	Yes
Sample Period	ZLB	ZLB	ZLB

Note: The sample period runs from 2008:Q4 through 2015:Q4. The term spread decomposition into expectation part and term premia is based on the Kim-Wright model. Firm*security-type clustered standard errors in parentheses. ***, **, *, denote 1, 5, and 10 percent significance, respectively.

spread during the ZLB period compared with the pre-ZLB period, likely because during the ZLB, market participants anticipated much less room for short rates to move in the future, given the persistent low interest rates and the heightened probability of hitting the ZLB again in the future.

To allow for the likely situation in which the features of a debt contract are jointly decided, we directly include the credit spread change from the previous debt issuance as an explanatory variable and instrument it (along with the term spread) with the policy shocks. Table A.2 in the Appendix presents the estimates. Interestingly, the coefficient on the term spread shrinks in magnitude and becomes insignificant. At the same time, there is suggestive

evidence of maturity extension in response to a decline in the credit spread; this effect is marginally significant during the ZLB period, when the effect of the Treasury term spread, in fact, has the wrong sign. Since the credit spread is firm specific, as opposed to the Treasury term spread, which is an aggregate measure, it is perhaps not surprising that the coefficient on the credit spread is more significant. Nonetheless, it suggests that compression in the credit spread is at least as important a driver of a firm's decision to issue longer-maturity bonds.

3.2 Heterogeneous Effects across Firms

This section explores whether—especially during the ZLB period—the magnitude of firms' changes in bond-maturity preference in response to changes in the term spread differs across firms with different characteristics. We mainly consider two dimensions of firm characteristics: large versus small and high-risk versus low-risk, as well as the interaction between these two dimensions. Given data limitations, we use market-based measures of risk (that is, credit spread) to gauge the risk of those firms whose credit rating information is not available (which is more than half of the issuers in our data) and use total assets as the measure of size. In particular, we define high-risk firms as firms whose bond issues carry a credit spread greater than the average BBB credit spread.[9] For our size measure, we consider as "large" those firms whose total asset value in the quarter before the current bond issuance is greater than the median of all firm-quarters (thus, a firm may switch from large to small or vice versa during our sample period).

The results in Table 3 show important heterogeneity depending on size and riskiness around the average effects estimated above. Panel (a) presents results for the pre-ZLB period, and Panel (b) shows results for the ZLB period, which is the focus of the discussion in this paragraph. During the ZLB period, small, low-risk firms increase their debt maturity

[9]It is the yield spread of BBB corporate bonds with 10-year maturity over 10-year Treasury yield. The data are obtained from the macro-scenario data for the 2019 Comprehensive Capital Analysis and Review, or CCAR.

Table 3: Firm Heterogeneity in Response to Term Spread Changes.

(a) Pre-ZLB Sample.

Firm Type	Maturity	Volume	Credit Spread	Avg. Maturity	Obs.
Small, Low Risk	-5.327*	-0.252	1.670	11.11	461
	(2.831)	(0.431)	(1.049)	[5.863]	
Small, High Risk	-2.257	-0.485	2.167	8.625	751
	(1.892)	(0.452)	(1.849)	[3.601]	
Large, Low Risk	0.0780	0.625*	0.627	9.346	790
	(1.973)	(0.345)	(0.431)	[4.819]	
Large, High Risk	0.385	0.203	0.662	8.926	511
	(1.803)	(0.585)	(0.867)	[4.685]	

(b) ZLB Sample.

Firm Type	Maturity	Volume	Credit Spread	Avg. Maturity	Obs.
Small, Low Risk	-3.946	-0.555	5.131***	8.566	798
	(3.055)	(0.475)	(1.740)	[4.152]	
Small, High Risk	3.611	-0.392	-0.200	7.677	1,293
	(3.455)	(0.861)	(3.275)	[2.560]	
Large, Low Risk	-3.547***	0.0730	8.314***	8.667	1,338
	(1.174)	(0.370)	(1.239)	[4.011]	
Large, High Risk	-2.350	-0.495	9.167***	8.631	873
	(2.930)	(0.578)	(0.995)	[3.591]	

Note: The table shows the estimates corresponding to equation 1 by firm type. Pre-ZLB refers to the sample period of 2000:Q1 through 2008:Q3, and ZLB refers to the sample period of 2008:Q4 through 2015:Q4. The "Average Maturity" column presents the mean and standard deviation (in brackets) of debt maturity for each group. Firm*security-type clustered standard errors in parentheses. ***, **, *, denote 1, 5, and 10 percent significance, respectively.

the most, with a maturity extension of nearly four years per 1 percentage point reduction in the term spread, although this effect is statistically insignificant.[10] Small, low-risk firms' credit spread, however, responds significantly (a decline of 5 percentage points) to a decrease in the credit spread during the ZLB period. In contrast, we estimate smaller and insignificant effects for small, risky firms, likely because these firms are constrained in their choice of bond attributes (for example, shorter maturities). Large, low-risk firms extend their bond maturity

[10]During the pre-ZLB period the effect for this group is stronger, with a significant increase of about 5.3 years.

significantly, about 3.5 years, in response to a lower term spread, whereas the responses of large, risky firms is small and insignificant. By comparison, all large firms (low- or high-risk) benefit from a particularly strong reduction in the credit spread of 8.3 and 9.2 percentage points, respectively.

3.3 Choice between Bonds and Loans

Since bond maturities tend to be longer than loan maturities, we may expect firms to switch between these two instruments when they want to alter the maturity of their debt financing. However, corporate loans and bonds differ along other dimensions besides maturity. In particular, loans are more likely to have variable rates, while bonds are more likely to have fixed rates, and loan contracts can be made more flexible through covenants. These differences may also influence whether borrowing in the equilibrium shifts from one market to the other. For example, if investors prefer to hold variable-rate debt when the Fed is raising the funds rate, then we may observe an increase in the share of loans in new borrowing even without a significant difference between the maturity of these loans and that of the bonds they replace. This can help explain our findings regarding the share of bonds in new borrowing.

Table 4 presents estimates of the change in the share of bonds in a firm's debt issuance in response to policy-induced changes in the term spread for different subsamples of the data. Since Capital IQ data contain only syndicated leverage loans, which are comparable in credit quality to high-yield bonds, the bond share here is based on high-yield bonds. We find that during the pre-ZLB sample, the share of bonds rises 5.1 percentage points in response to a 1 percentage point increase in the term spread, although this response is insignificant.[11] This maturity extension effect is of a similar size and is statistically insignificant over the ZLB period, even though the mechanism for a rise in the term spread in one period differs from the mechanism in the other period. Hence, it appears that firms do not switch between bonds and loans, at least not in response to policy-induced changes in the term spread. This

[11]We also estimate the same regressions excluding unrated bonds (unreported) and find the effect is statistically the same regardless of whether unrated bonds are considered.

Table 4: Share of High-Yield Bonds versus Loans in New Debt Issuance

VARIABLES	(1) Bond Share	(2) Bond Share
Term Spread	5.116	7.615
	(19.992)	(5.394)
Log Assets	3.102	2.513
	(3.245)	(1.718)
Cash to Assets	-1.086	4.628
	(33.105)	(11.522)
Intangibles to Assets	37.261**	15.213
	(16.666)	(9.380)
Long Term Debt to Total Assets	37.942***	0.017
	(10.507)	(0.011)
Short Term Debt to Total Assets	-1.604	-53.920
	(29.183)	(44.523)
Observations	1,151	1,554
R-squared	0.022	0.003
IV	Yes	Yes
Firm FE	Yes	Yes
Sample Period	Pre-ZLB	ZLB
Include Unrated Bonds	Yes	Yes

Note: Pre-ZLB refers to the sample period of 2000:Q1 through 2008:Q3, and ZLB refers to the sample period of 2008:Q4 through 2015:Q4. Firm*security-type clustered standard errors in parentheses. ***, **, *, denote 1, 5, and 10 percent significance, respectively.

lack of switching could be because bonds and loans differ along enough dimensions (besides maturity) that they are not considered close substitutes, and so policy-induced changes in term spreads are considered too small to be worth the switch.

3.4 Debt Maturity and Investors' Preference

So far in our empirical analysis, we have measured the impact of exogenous term spread changes on equilibrium credit market conditions. We next provide evidence that those adjustments are not supply driven through changes in investors' maturity preference in response to monetary policy.

To test this conjecture, we include as an additional instrument the average maturity of

Table 5: Average Effect of Term Spread on Bond Maturity Supply.

VARIABLES	(1) Maturity	(2) Volume	(3) Credit Spread	(4) Maturity	(5) Volume	(6) Credit Spread
Term Spread	-2.981**	-0.106	0.586	-4.557***	0.143	6.704***
	(1.144)	(0.267)	(0.642)	(1.188)	(0.349)	(2.055)
Log Assets	-0.406	0.470***	0.203	-0.670*	0.575***	0.264
	(0.348)	(0.051)	(0.233)	(0.365)	(0.106)	(0.451)
Cash to Assets	-0.101	0.694***	-0.075	0.819	0.288	-2.695**
	(1.720)	(0.233)	(0.592)	(1.174)	(0.413)	(1.203)
Intangibles to Assets	-0.315	-0.379*	0.777	0.961	-0.674**	-1.045
	(1.877)	(0.216)	(1.048)	(0.804)	(0.301)	(0.961)
Long Term Debt to Total Assets	-1.297	-0.042	2.055***	-0.038***	-0.002	-0.002
	(1.244)	(0.165)	(0.714)	(0.011)	(0.002)	(0.019)
Short Term Debt to Total Assets	-6.759**	0.636	1.337	0.140	0.718	0.056
	(2.987)	(0.504)	(1.242)	(2.002)	(0.573)	(2.164)
Observations	2,783	2,783	2,783	3,766	3,766	3,766
R-squared	0.451	0.447	0.463	0.448	0.559	0.061
Firm-Security FE	Yes	Yes	Yes	Yes	Yes	Yes
IV	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Sample Period	Pre-ZLB	Pre-ZLB	Pre-ZLB	ZLB	ZLB	ZLB

Note: Pre-ZLB refers to the sample period of 2000:Q1 through 2008:Q3, and ZLB refers to the sample period of 2008:Q4 through 2015:Q4. Firm*security-type clustered standard errors in parentheses. ***, **, *, denote 1, 5, and 10 percent significance, respectively.

bonds held in the bond portfolio of insurance firms, and report the estimates in Table 5.[12] For each firm-quarter, this added IV is calculated as the average maturity of corporate bonds in the corresponding risk rating class held by insurance companies. The resulting coefficient for maturity remains about the same for the full sample.[13] By comparison, instrumenting with the maturity of insurers' bond holdings shrinks the effect of the term spread change on the credit spread to the point where it is no longer statistically significant. This suggests that insurers' risk preference partly accounts for the credit spread change. Specifically, insurers reaching for risk by investing in longer maturities may help reduce the credit spread, and vice versa.

[12]We thank Ali Ozdagli and Charles Perkins for providing the data.

[13]If we instead assume that investors' preference directly affects the observed attributes of newly issued corporate bonds, and thus include the insurance companies' average maturity of bond holdings as a control variable, we find that term spread changes have no effect on the corporate debt issuance characteristics, while the effect of exogenous changes in the term spread remains largely unchanged. (For brevity, the results are not shown.)

4 Conclusion

This paper explores whether firms alter the properties of their debt issuance in response to policy-induced changes in the slope of the Treasury yield curve, and if they do, by how much. We study this question separately for the pre-ZLB and the ZLB periods, because we recognize that a flattening of the Treasury yield curve generally corresponds to an economic boom and tightening monetary policy over the years when interest rates were not constrained by the ZLB, but that it corresponds to economic slack and easing policy over the years with a binding ZLB. We find, on average, a modest effect of the Treasury term spread on the maturity of newly issued corporate bonds over the pre-ZLB period; firms extended their bond maturity by about 2.8 years per 1 percentage point reduction in the maturity-matched Treasury term spread (instrumented by monetary policy shocks). A reduction in the term spread also reduced the credit spread paid by corporate issuers (by 1.7 percentage points) over the pre-ZLB period, but it had little effect on the size of the issuance throughout the sample years.

The effects on maturity and credit spread were both greater during the ZLB period, but this finding is mostly driven by the financial crisis quarters (2008:Q4 in particular). The effect became much smaller and insignificant during the rest of the ZLB period, possibly because a reduction in the Treasury yield curve slope is associated more with the economy operating below potential during the ZLB period and thus inducing different firm behavior. Another contributing factor may be that there was a lack of variation in policy shocks over the ZLB years outside of the financial crisis quarters. It is also possible that, for some reason, a term spread increase (decrease) due to a rise (fall) in long-term rates as a result of tightening (easing) of unconventional policy during a ZLB period is not as effective as a term spread increase (decrease) due to a fall (rise) in short-term rates resulting from easing (tightening) of the policy rate over the pre-ZLB years.

Accounting for possibly exogenous changes in investors' preference regarding the maturity of their bond holdings reduces the magnitude of our estimates somewhat, particularly the

effects on credit spreads. By comparison, we observe insignificant reactions in the maturity or credit spread of loans.

Moreover, we find noticeable and robust cross-sectional heterogeneity in these effects. Low-risk firms adjust their maturity the most in response to a change in the term spread, although only the response of the large, low-risk firms is significant. Large, risky firms adjust their maturity less, but they do so more consistently throughout the sample. It is likely that all large firms, regardless of risk, benefit from any decline in long yields, since they tend to issue long-maturity bonds. Moreover, they benefit the most in terms of the reduction in the credit spread resulting from a lower term spread. In contrast, small, risky firms appear constrained in their ability to adjust the maturity of their issuance. We find tentative evidence that the share of bonds in firms' new debt financing rises in response to an increase in the term spread, although this effect is statistically insignificant.

The maturity-choice reactions we study in this article constitute but one step in the chain of reactions transmitting policy actions to the real economy. An equally, if not more, important question is whether firms alter their real investment in conjunction with adjusting the terms of their debt financing. For example, in response to a lower term spread, do firms that lengthen the maturity of their bonds also increase capital expenditures more than otherwise when compared with those that keep the same maturity? Our finding regarding the insignificant change in issuance size suggests that they don't. Nevertheless, firms may make other real adjustments, such as not laying off as many workers or hiring more or distributing dividends, which help boost consumption or are used to fuel investment by other firms. We plan to explore in the future such changes in the real activity of firms and their potential aggregate effects.

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Appendix

A A Simple Model of Corporate Debt Maturity Choice

This appendix details the simple two-period model that highlights the key factors influencing firms' choice of maturity when issuing debt. Note, though, that each period in the model can correspond to 5 to 10 years, or even longer, since corporate bonds in our sample have a maturity of close to 10 years on average. Consider a firm that needs to finance a project that pays off at the end of period two. The firm can borrow either by issuing a two-period bond or by issuing a one-period bond that rolls over at the beginning of $t = 2$. If the firm issues a one-period bond, it pays an interest rate r_1, which can be decomposed into a risk-free rate and a credit spread: $r_1 = r_1^F + r_1^P$. In the second period, the firm expects to pay $\tilde{r_2} = \tilde{r}_2^F + \tilde{r}_2^P$, with $\sim$ denoting that these are random variables unknown at $t = 1$. If the firm instead issues a two-period bond, then it pays a rate of $R = R^F + R^P$. Then, all else being equal and ignoring discounting, the firm should choose the long bond if

$$r_1^F + r_1^P + \mathbb{E}(\tilde{r}_2^F + \tilde{r}_2^P) > 2(R^F + R^P). \tag{A.1}$$

$\mathbb{E}(\cdot)$ denotes expectation at $t = 1$. Equation (A.1) can be rearranged to show that the firm chooses to issue a long bond if the term spread of either the risk-free term structure or the credit-spread term structure is small relative to expected future short rates (again of both the risk-free and the risky components):[1]

$$(R^F - r_1^F) + (R^P - r_1^P) < \mathbb{E}[(\tilde{r}_2^F - R^F) + (\tilde{r}_2^P - R^P)]. \tag{A.2}$$

Denote the risk-free term premium as tp, then the risk-free term spread can be expressed as the sum of the expected future change in the short rate and the term premium:

[1]Note that the RHS of (A.2) is not a proper term spread because R^F is defined only for $t = 1$ in this model. For models with $t > 2$, the long yield at $t = 2$ does not equal R^F and must be redefined.

$$R^F - r_1^F = \mathbb{E}(\tilde{r}_2^F - R^F) + tp. \tag{A.3}$$

Plugging equation (A.3) into (A.2), we observe that the condition for choosing the long bond becomes whether the risky term spread plus the risk-free term premium are exceeded by the expected future risky one-period credit spread (relative to the current long credit spread):

$$(R^P - r_1^P) + tp < \mathbb{E}(\tilde{r}_2^P - R^P). \tag{A.4}$$

Equation (A.4) makes clear that a decline in the term premium makes it more likely for the firm to choose to borrow long. In fact, if we define a term premium corresponding to the credit spread term structure and denote it as tp^r, we have an equation that is analogous to equation (A.3): $R^P - r_1^P = \mathbb{E}(\tilde{r}_2^P - R^P) + tp^r$. We can then further simplify the condition for borrowing through long bonds to be that as long as the overall corporate term premium, equal to the sum of the risk-free term premium and the risky term premium, is negative:

$$tp + tp^r < 0. \tag{A.5}$$

This is a stark but intuitive result from this simple model: The term premium corresponds to the extra a firm has to pay to borrow long, and so the firm would borrow long only if it does not have to pay extra to do so. In reality, several omitted factors, as well as omitted constraints, are likely also important. All these lead to some degree of inertia in firms' maturity choice, or a "habitat effect."

In this highly simplified setup, the firm would switch issuance toward longer debt only if the overall term premium, due to a change in either component or both components, turns from positive to negative. The term premium turning more negative further lowers the financing cost for the firm but causes no apparent additional change in the debt maturity. In reality, due to cross-firm heterogeneity, we would expect an increase (a decrease) in the

corporate term premium to make some firms less (more) likely to extend the maturity of their borrowing. It should also be noted that equation (A.5) shows that the risk-free component and the risky component of the term premium matter equally.

In reality, there may also be an "inaction zone" for maturity adjustment, which is not considered in the model. That is, firms may not alter the maturity of their issuance in response to a small change in the term premium if they have to pay a fixed cost to effect the change due to reasons such as those enumerated above (for example, having to negotiate a different contract with a group of investors, or even contracting with different investors).

Table A.1: First Stage of the Instrumental Variable Estimates

VARIABLES	(1) Term Spread Full Sample	(2) Term Spread Pre-ZLB	(3) Term Spread ZLB
FFR Factor	-0.027***	-0.011**	-0.084***
	(0.004)	(0.006)	(0.009)
FG Factor	-0.012***	-0.008	-0.001
	(0.003)	(0.005)	(0.004)
LSAP Factor	-0.009***	-0.036***	-0.003
	(0.003)	(0.008)	(0.004)
Lagged FFR Factor	-0.022***	-0.028***	-0.016**
	(0.003)	(0.005)	(0.006)
Lagged FG Factor	0.002	0.003	-0.004
	(0.003)	(0.005)	(0.003)
Lagged LSAP Factor	0.002	0.015	-0.002
	(0.003)	(0.010)	(0.003)
Log Assets	-0.011***	0.006	-0.021***
	(0.003)	(0.006)	(0.003)
Cash to Assets	-0.073*	-0.096	-0.016
	(0.042)	(0.080)	(0.049)
Intangibles to Assets	-0.002	-0.023	0.014
	(0.015)	(0.032)	(0.016)
Long Term Debt to Total Assets	-0.000	0.075**	-0.001
	(0.001)	(0.033)	(0.001)
Short Term Debt to Total Assets	0.196***	0.278**	0.094
	(0.069)	(0.118)	(0.083)
L_maturity	-0.000	-0.005***	0.004***
	(0.001)	(0.001)	(0.001)
L_log_total_debt	-0.001	0.002	-0.000
	(0.004)	(0.007)	(0.004)
L_maturity_matched_credit_spread	-0.004***	-0.006**	-0.005***
	(0.001)	(0.003)	(0.002)
Constant	0.133**	-0.048	0.181**
	(0.064)	(0.129)	(0.073)
Observations	7,843	2,796	4,657
R-squared	0.026	0.050	0.039

Note: Our data cover the period of 2000:Q1 through 2015:Q4. Pre-ZLB refers to the sample period of 2000:Q1 through 2008:Q3, and ZLB refers to the sample period of 2008:Q4 through 2015:Q4. Firm*security-type clustered standard errors in parentheses. ***, **, *, denote 1,5, and 10 percent significance, respectively.

Table A.2: Joint Determination of Maturity and Credit Spread

VARIABLES	(1) Maturity	(2) Maturity	(3) Maturity
Term Spread	-1.689	-4.635	2.885
	(1.309)	(3.241)	(3.675)
Credit Spread	-0.434	1.022	-0.857*
	(0.271)	(1.558)	(0.433)
Log Assets	-0.412***	-0.667	-0.317
	(0.147)	(0.666)	(0.293)
Cash to Assets	-0.348	0.051	-1.631
	(0.950)	(2.070)	(1.548)
Intangibles to Assets	0.056	-1.053	-0.424
	(0.615)	(2.531)	(0.881)
Long Term Debt to Total Assets	-0.008***	-3.202	-0.007***
	(0.001)	(3.362)	(0.002)
Short Term Debt to Total Assets	-3.156*	-7.483**	-1.034
	(1.773)	(3.381)	(1.526)
Observations	7,789	2,783	4,616
R-squared	0.445	0.257	0.498
Firm-Security FE	Yes	Yes	Yes
IV	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Sample Period	Full Sample	Pre-ZLB	ZLB

Note: Our data cover the period of 2000:Q1 through 2015:Q4. Pre-ZLB refers to the sample period of 2000:Q1 through 2008:Q3, and ZLB refers to the sample period of 2008:Q4 through 2015:Q4. Firm*security-type clustered standard errors in parentheses. ***, **, *, denote 1,5, and 10 percent significance, respectively.

Figure A.1: Fitted First-Stage Term Spread

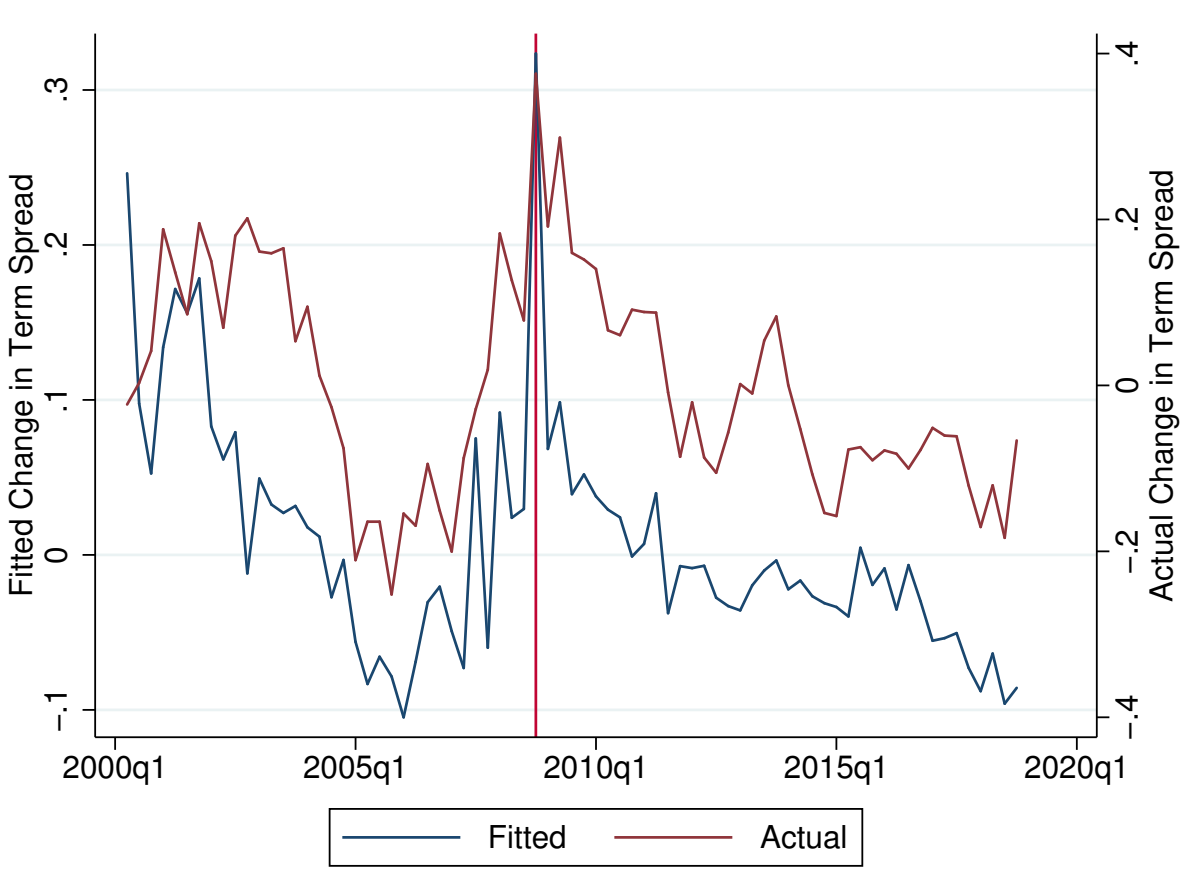

Table A.3: Average Effects of Term Spread on Bond Issuance During the ZLB Excluding 2008:Q4

VARIABLES	(1) Maturity	(2) Volume	(3) Credit Spread
Term Spread	0.744	-0.045	3.569
	(2.655)	(0.419)	(2.948)
Log Assets	0.194	0.520***	-0.409
	(0.414)	(0.078)	(0.444)
Cash to Assets	-0.361	0.185	-1.646*
	(1.175)	(0.359)	(0.911)
Intangibles to Assets	-0.153	-0.618**	-0.186
	(0.812)	(0.250)	(0.787)
Long Term Debt to Total Assets	-0.002	0.000	-0.004
	(0.003)	(0.001)	(0.004)
Short Term Debt to Total Assets	-2.084	0.915	1.717
	(1.359)	(0.571)	(1.128)
Observations	4,598	4,598	4,598
R-squared	0.525	0.554	0.408
Firm-Security FE	Yes	Yes	Yes
IV	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Sample Period	Since 2009Q1	Since 2009Q1	Since 2009Q1
Kleibergen Paap Stat	9.283	9.283	9.283
Kleibergen Paap p-value	0.158	0.158	0.158

Note: Sample period: 2009:Q1 through 2015:Q4. Firm*security-type clustered standard errors in parentheses. ***, **, *, denote 1, 5, and 10 percent significance, respectively.

Table A.4: Average Effects of Term Spread on Bond Issuance Before ZLB Excluding 2001 Recession

VARIABLES	(1) Maturity	(2) Volume	(3) Credit Spread
Term Spread	-1.849*	0.142	1.200**
	(1.005)	(0.223)	(0.580)
Log Assets	-0.341	0.530***	0.329
	(0.388)	(0.054)	(0.283)
Cash to Assets	-0.821	0.336	-0.575
	(2.467)	(0.313)	(0.911)
Intangibles to Assets	-0.004	-0.396	0.311
	(1.191)	(0.253)	(1.293)
Long Term Debt to Total Assets	-1.932*	-0.231	1.890**
	(1.055)	(0.187)	(0.784)
Short Term Debt to Total Assets	-6.568**	-0.032	1.437
	(2.793)	(0.440)	(1.335)
Observations	2,393	2,393	2,393
R-squared	0.531	0.477	0.471
Firm-Security FE	Yes	Yes	Yes
IV	Yes	Yes	Yes
Controls	Yes	Yes	Yes
Sample Period	Before 2008Q3	Before 2008Q3	Before 2008Q3
Kleibergen Paap Stat	17.32	17.32	17.32
Kleibergen Paap p-value	0.00818	0.00818	0.00818

Note: Sample period: 2002:Q1 through 2008:Q3. Firm*security-type clustered standard errors in parentheses. ***, **, *, denote 1, 5, and 10 percent significance, respectively.