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The Determinants of Long-Term Corporate Debt Issuances

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ABSTRACT

A significant proportion of the debt issued by investment-grade firms has maturities greater than 20 years. In this paper we provide evidence that gap-filling behavior is an important determinant of these very long-term issues. Using data on individual corporate debt issues between 1987 and 2009, we find that gap-filling behavior is more prominent in the very long end of the maturity spectrum where the required risk capital makes arbitrage costly. In addition, changes in the supply of long-term government bonds affect not just the choice of maturity but also the overall level of corporate borrowing.

WHILE THE AVERAGE MATURITY of corporate borrowing is about five years, companies sometimes issue very long-term bonds not tied to a particular tangible asset. Perhaps the best known example is Walt Disney Company's 100-year (callable after 30 years) $300 million senior subordinated debenture issue in 1993 dubbed "Sleeping Beauty" bonds.[1] More recently, Apple issued $3 billion in 30-year fixed rate bonds in 2013.[2] While 100-year bonds are rare, unsecured bond offerings with maturities of more than 20 years are common. For example, between 1987 and 2009, 472 firms covered by Compustat made 1,620 unsecured bond offerings with maturities of more than 20 years and a total face

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[1] While the offering was well received, some analysts voiced concerns over the risk associated with long-term issues. For example, William Gross of Piper Capital Management was quoted as saying "It's crazy, look at the path of Coney Island over the last fifty years and see what happens to amusement parks" (Thomas T. Vogel, "Disney amazes investors with sale of 100-year bonds" The Wall Street Journal, July 21, 1993, p.61). More recently, in mid-2010 several 100-year bonds were issued purportedly in response to very low long-term rates. See http://www.bloomberg.com/news/2010–08–23/yield-hunt-driving-demand-for-longest-maturity-debt-sales-credit-markets.html.

[2] *The Wall Street Journal* commented on Apple's offering, stating "Thirty years ago, the internet was in its infancy, the Macintosh didn't exist, and you might have purchased a handful of Porsche 944s for the cost of one gigabit worth of computer storage. Thirty years from today, it's pretty much impossible to project what the technology landscape will look like" (Rolfe Winkler, "Even Apple's crystal ball has clouds", May 1, 2013, p. 46).

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value (in 2009 dollars) of $590 billion (the median maturity of these long-term offerings was just over 30 years). Virtually all of these issuers were also active in the short end of the maturity spectrum and regularly issued debt with maturities of less than five years. As we outline below, very long-term unsecured debt issues and significant year-to-year variation in the maturity of issues are difficult to explain in the context of contracting cost theories of maturity choice in which the average maturity of assets and the importance of growth options drive debt maturity choice.[3]

In this paper we examine the determinants of long-term debt issues using a data set of bond issues and bank borrowing by public firms during the 1987 through 2009 period. We address three related questions. First, to what extent are very long-term corporate debt issues a response to changes in credit market conditions, such as changes in the maturity composition of U.S. Treasury debt or changes in the term structure of interest rates? Second, what types of borrowers have the greatest supply elasticity with respect to changes in credit market conditions? Third, to what extent do changes in the maturity composition of Treasury bonds and the term structure of interest rates affect the propensity of firms to issue debt?

Our analysis is motivated by recent work by Greenwood, Hanson, and Stein (2010, hereafter GHS) on "gap filling" and corporate debt maturity choice. GHS develop a theory in which corporate issuers respond to shocks in the supply of short- and long-term Treasury bonds. The basic idea is that important classes of investors, such as pension funds and insurance companies, have a preference for relatively safe long-term assets. Given a shock to the supply of long-term government bonds, the cost and availability of risk capital limits the ability of arbitrageurs to fill the gap. As a result, bond yields can stray from the yields implied by the expectations hypothesis. Corporate issuers, particularly those with investment-grade credit ratings, attempt to exploit differences in the expected return on short- versus long-term bonds leading to supply shifts in the long-term corporate market offsetting changes in the supply of long-term government bonds.

We hypothesize that gap filling is likely to be a more important determinant of very long-term corporate borrowing (20 years or more) than shorter-term borrowing, for at least two reasons. First, the gap-filling hypothesis is based on highly rated corporate issuers having a comparative cost advantage in arbitraging rate differences arising from shifts in the maturity composition of government debt. An important factor affecting the cost of arbitrage activity is the amount of capital arbitrageurs must commit to a position and the amount of capital available to them. Capital constraints include limits on leverage and costs of raising external equity.[4] Given capital constraints, arbitrage costs are likely to vary directly with the amount of risk capital needed. The amount of

[3] See, for example, Myers (1977), Barclay and Smith (1995), and Guedes and Opler (1996) for discussions of agency cost explanations of maturity choice.

[4] See Gromb and Vayanos (2010) for a survey of the theoretical literature on financing constraints and the limits of arbitrage.

Table I
Annual Implied Price Volatilities

This table presents the annual means of daily implied volatilities associated with the corresponding futures on U.S. Treasury securities. Daily implied volatilities for the underlying securities are calculated from a weighted average of the volatilities of the two closest call options. For all securities, the contract used is the closest pricing contract month that is expiring at least 20 business days from the corresponding observation date. 20-year Treasury bond futures refer to U.S. Treasury bonds that, if callable, are not callable for at least 15 years from the first day of the delivery month or, if not callable, have a maturity of at least 15 years from the first day of the delivery month. 10-year Treasury note futures refer to futures on notes maturing at least 6 1/2 years, but not more than 10 years, from the first day of the delivery month. 5-year Treasury note futures refer to U.S. T-notes that have an original maturity of not more than five years and three months and a remaining maturity of not less than four years and two months as of the first day of the delivery month. 2-year Treasury note futures refer to futures on U.S. Treasury notes that have an original maturity of not more than five years and three months and a remaining maturity of not less than one year and nine months from the first day of the delivery month but not more than two years from the last day of the delivery month.

	20-Year	10-Year	5-Year	2-Year
1994	10.42	7.45	4.95	1.94
1995	9.41	6.65	4.59	2.17
1996	9.98	6.75	4.72	2.03
1997	8.83	5.48	3.73	1.68
1998	8.66	5.71	4.09	2.06
1999	8.82	6.05	4.18	3.05
2000	9.32	6.52	4.13	1.60
2001	9.46	7.10	4.76	2.19
2002	10.98	7.93	5.47	2.15
2003	12.04	8.04	5.38	2.02
2004	10.01	6.92	4.70	1.87
2005	8.08	5.10	3.41	1.42
2006	6.79	4.25	2.86	1.26
2007	7.32	5.10	3.74	1.78
2008	13.5	9.22	6.68	3.00
2009	15.6	8.95	5.46	1.76
Total Average	9.97	6.71	4.56	1.97
N	3,969			

risk capital needed is likely to vary in turn with the price volatility associated with a position. As shown in Table I, the average daily implied price volatility of Treasury bonds increases with their maturity, with the implied price volatility associated with 20-year Treasury bonds averaging over five times the daily price volatility of two-year bonds. Thus, for any value at risk (VAR) level the amount of risk capital required for trades in very long-term Treasuries is orders of magnitude larger than in the short end of the market.

The second reason we expect gap filling to be an important determinant of long-term issues is that very long-term issues are difficult to explain in the context of agency cost theories of maturity choice, which predict that issuers will match the maturity of their liabilities to the maturity of their assets (see Myers (1977)). In our sample, long-term issues (20+years) average 30 years while the average maturity of long-term issuers' assets is about eight years—a mismatch of over 20 years. Moreover, for long-term issuers we find little evidence that the maturity of debt issues is related to within-firm variation in asset maturity. In contrast, maturity matching appears more prevalent for short-term issuers. For example, among firms that never issue very long-term debt, the median maturity of assets matches closely the median maturity of debt issued (three years versus 4.19 years).

Our analysis is based on a detailed sample of individual corporate loans and debt security issues collected from the SDC and Dealscan databases. These data allow us to focus on the determinants of debt maturity choice at the individual firm level rather than on time-series variation in aggregate debt issuance. This distinction is important, since information and agency costs potentially limit the ability of many firms to exploit perceived gap-filling opportunities. Moreover, gap filling predicts that corporations will issue forms of debt that are close substitutes to Treasury securities. By using firm-level panel data on issuances rather than aggregated data we are better able to identify the effects of state variables that vary over time. Moreover, using firm-level data we can examine how changes in market conditions affect not only the choice of debt maturity but also the propensity to borrow at long maturities.

Issuance data also enable us to measure the maturity of debt offerings more precisely. Previous studies of corporate maturity choice generally classify debt as either short-term (under one or five years in maturity) debt or long-term (over one or five years) debt.[5] This choice is motivated in part by data limitations since Compustat classifies debt according to maturity but only up to five years, and the Federal Reserve's Flow of Funds allows one to identify debt issues under or over one year. Using more granular data on maturity choice allows us to examine whether gap filling occurs within specific segments of the term structure.

We begin by discussing why the cost of arbitrage is likely to be greater in the very long-term segment of the market. We show that price volatility and margin requirements suggest that the amount of risk capital needed for arbitrage trades in the long end of the market is significantly greater than in the shorter end of the term structure.

We next examine the characteristics of long-term debt issuers. Given the potential agency costs associated with issuing long-term debt, it is perhaps not surprising that we find that all but a few long-term (20+ years) bond issues are by firms with investment-grade ratings. Offerings by these issuers are distributed fairly uniformly over the maturity spectrum. For example, in our sample, firms rated AA or higher issue about as many bonds with maturities under five years as they do bonds with a maturity of 20 years or more. The fact that investment-grade issues are not clustered in a particular segment of the maturity spectrum is consistent with the hypothesis that the maturity choice of these firms is more sensitive to market conditions than for lower-rated firms.

[5] For example, see GHS (2010) and Barclay and Smith (1995).

We examine the determinants of maturity choice by estimating models relating maturity choice to market conditions, including the maturity composition of Treasury debt. Controlling for firm characteristics, we find a negative and significant relationship between the maturity composition of corporate debt issues and the maturity composition of outstanding Treasury debt. More importantly, consistent with the idea that arbitrage costs are higher in the long-term segment of the market, we find that gap filling is a significant determinant of maturity choice only in the 20-year plus segment of the corporate market. In addition, we find that the supply elasticity is greatest for securities that are closer substitutes for long-term Treasury bonds. For instance, we find that the supply elasticities are greatest for issues by highly rated firms and for fixed rate noncallable bonds.

For highly rated firms we find that their long-term bond issues are quite sensitive to changes in the supply of long-term Treasuries. For example, we find that a 1% *decrease* in the proportion of outstanding Treasury issues with maturities of 20 years or more is associated with a 2.6% *increase* in the likelihood of a highly rated corporate issue of 20 years or more. Our results are consistent with those of Krishnamurthy and Vissing-Jorgensen (2011, 2012), who find little effect of changes in supply of Treasuries on corporate yields except for bonds rated A or better, as well as with Graham, Leary, and Roberts (2014), who document a negative relationship between government net debt issuances and corporate net debt issuances with maturities of over one year by financially unconstrained firms.

We conduct an analysis of covariance (ANCOVA) to decompose variation in maturity choice attributable to different factors. We find that the majority of the variance in long-term debt issues over time for highly rated firms that is not attributable to industry fixed effects is attributable to gap-filling measures, which explain about 12% of the variation, and not to changes in credit risk premia or the term structure of interest rates, which explain about 8% and 0.9% of the total variation, respectively. For firms rated BBB, changes in credit risk premia explain the majority of variance in maturity choice, after industry fixed effects, and gap-filling measures only account for a relatively small portion of the overall variance (about 2.1%).

We also find evidence that the supply of long-term Treasury debt predicts corporate long-term debt issuances and does not just lead to a substitution between long-term debt and short-term debt issues. Consistent with the gap-filling argument, we find a relationship between changes in firm borrowing and the supply of long-term Treasury debt only for investment-grade issuers.

One concern with using shifts in the composition of Treasury debt to analyze gap filling is that changes in the supply of Treasury debt may not be exogenous in the context of corporate debt maturity choice. Specifically, it might be the case that changes in the supply of Treasury debt respond endogenously to the same factors that influence corporate maturity choice (albeit in the opposite direction). Our ability to focus on narrow segments of the term structure and on issuers with different credit ratings mitigates endogeneity concerns. Nevertheless, we address these concerns by examining the impact of the U.S.

government's decision to suspend the issuance of 30-year bonds in 2001 on 30-year corporate bond issues. As discussed later, this decision was not expected by investors and thus serves as a natural experiment to examine the effect of a supply shock on the issuance of long-term corporate bonds. Consistent with the announcement being unexpected, we find a positive and significant decrease in yields of long-term Treasury bonds when the suspension is announced. Moreover, consistent with gap filling, we find a significant increase in the issuance of highly rated 30-year corporate bonds, relative to 20-year bond issues, subsequent to the suspension of 30-year Treasury bond issues.

Our analysis contributes to the literature in several ways. First, using issuance data we provide evidence that corporate gap filling is limited to the very long end of the term structure. Second, using individual firm issuance data we examine in a rigorous way the extent to which gap filling varies with the firm's credit quality and the type of debt issued. Third, our analysis provides insights into the effects of policy initiatives such as the recent Federal Reserve Board large-scale asset purchases (LSAPs), also referred to as quantitative easing. The various stages of recent LSAPs, referred to as "QE1," "QE2" etc., have focused on the purchase of long-term Treasury bonds and mortgage backed securities (MBS).[6] These policies were designed to spur long-term borrowing by increasing reserves and changing the relative supply of long-term government bonds available to private investors.[7] Several recent papers (see Swanson (2011) and Krishnamurthy and Vissing-Jorgensen (2011)) provide evidence that the spillover effect on the prices of other assets has been limited. For example, Krishnamurthy and Vissing-Jorgensen (2011) find that the impact of the Federal Reserve's purchase of long-term Treasury bonds on corporate yields has been limited to the yield on very high-grade corporate debt. We provide firm-level evidence that suggests that the spillover effects of these programs affect both the maturity choice as well the propensity of highly rated firms to borrow. We find no evidence that changes in the supply of long-term Treasury bonds are related to the likelihood of issuing long-term debt or the borrowing propensity of firms with below A credit ratings.

The remainder of this paper is organized as follows. In Section I we motivate our analysis by providing evidence that the costs of arbitrage are significantly greater in the long end of the market. In Section II we describe our sample selection. Section III presents our empirical analysis of the determinants of

[6] See Krishnamurthy and Jorgensen (2012) for a discussion of these initiatives. These initiatives are similar in many respects to the Federal Reserve's "Operation Twist" in the early 1960's.

[7] Fed Funds and short-term Treasury rates were near zero between December 2008 and the end of 2013. As a result, further monetary accommodation through lowering short-term target interest rates was not feasible. The Fed thus attempted to provide further stimulus through the purchase of long-term Treasury bonds and debt as well as private sector MBSs. For example, the FOMC announced in March of 2009 that "to help improve conditions in private credit markets, the Committee decided to purchase up to $300 billion of longer-term Treasury securities over the next six months." See Board of Governors of the Federal Reserve System, 2009, Press release, March 18. Online at www.federalreserve.gov/newsevents/press/monetary/20090318a.htm. See Swanson (2011) and Krishnamurthy and Vissing-Jorgensen (2011) for a description and analysis of these programs.

maturity choice. In Section IV we examine the impact of the suspension of 30-year Treasury bonds on corporate bond issues. Section V provides a summary and conclusions.

I. Background: Corporate Maturity Choice and the Limits of Arbitrage

Our analysis is motivated by two strands of the literature on corporate maturity choice. The first is based on agency and information problems. As discussed in Guedes and Opler (1996), the risk of being unable to roll over short-term debt because of adverse economic shocks or a deterioration of firm quality provides an incentive for firms to issue long-term debt (see also Diamond (1991)). While rollover risk creates a preference for long-term borrowing, adverse selection and agency costs screen low-quality firms out of the long end of the market.[8] Indeed, agency costs, particularly debt overhang and asset substitution problems, create incentives for lower quality firms to match the maturity of their borrowing to the maturity of their assets (see Myers (1977)).

The second strand of the literature comprises recent work on market segmentation and the effects of changes in the supply of Treasury securities on corporate borrowing costs (see, for example, Vayanos and Vila (2009), Greenwood and Vayanos (2010), GHS (2010), and Krishnamurthy and Vissing-Jorgensen (2011, 2012, hereafter KVJ)).[9] This literature is based on the idea that bond markets are segmented and that this segmentation is a result of investors' demand for fixed income securities with specific attributes. For example, Vayanos and Vila (2009) develop a model in which investor preferences lead to risk premia that vary with bond maturity. GHS (2010) extend Vayanos and Vila's model by introducing firms that respond to excess demand in segments of the term structure by issuing bonds with durations that offset changes in the supply of Treasury securities with the same duration. Krishnamurthy and Vissing-Jorgensen (2012) argue that bond markets are more narrowly segmented and that only the highest-rated corporate bonds provide viable substitutes for Treasury securities in meeting the demand for safe, long-term assets. These models predict that corporate gap filling will be positively related to the cost of arbitrage and limited to highly rated firms either because of investors' preference for relatively safe long-term assets (as in KVJ (2012)), or because high agency costs limit the supply response of less creditworthy borrowers (as in GHS)).[10]

[8] In a recent paper, He and Xiong (2012) present a model in which debt maturity plays an important role in determining a firm's roll-over risk. They show that, while shorter-term individual bonds are less risky, a shorter maturity for all bonds issued by a firm can exacerbate roll-over risk and thus overall credit risk. The basic idea is that shorter overall maturity of debt forces equity holders to absorb losses more quickly, thus reducing the default threshold.

[9] Our analysis is also motivated by the market timing literature. See, for instance, Baker and Wurgler (2002) and Baker, Greenwood, and Wurgler (2003), who argue that limits to arbitrage create opportunities for firms to profit by timing their debt and equity issues.

[10] Our study is also related to recent empirical work by Graham, Leary, and Roberts (2014, 2015), who document a significant negative relationship between the supply of government debt

Krishnamurthy (2010) identifies three considerations for every debt market purchase: risk capital, haircuts in the repo market, and counterparty risk. The amount of risk capital and repo haircuts are likely to be higher for trades involving long-term Treasury securities for at least two reasons. First, unless changes in short-term spot rates are negatively correlated with expected future spot rates, price volatility will increase with the duration of the bond. Consistent with this expectation, we find that the daily implied price volatility of Treasury bonds increases with the maturity of the bonds. Specifically, we compute the annual averages of daily implied price volatilities from call options on futures contracts associated with Treasury bonds with maturities of 2, 5, 10, and 20 years over the 1994 to 2009 period.[11] As shown in Table I, the average daily implied price volatility of 20-year Treasury bonds is nearly 10% during the 1994 to 2009 period while the average daily implied volatility of two-year Treasury bonds is less than 2%. Moreover, the range of annual average volatilities is much greater in the long end than in the short end of the market. The higher price volatility of long-term Treasuries implies that more risk capital must be devoted to trades involving long-term Treasuries.

Second, and consistent with the greater price volatility of long-term Treasuries, margin requirements (i.e., liquid capital requirements) are higher for positions in long-dated Treasuries. For example, as outlined in 17 CFR 402.2, the required margin, or market risk haircut, for broker-dealers in Treasury securities is increasing in the duration and term to maturity of their bond holdings. For example, the net position haircut factor for coupon bonds with a maturity of over 15 years is 4.5% versus 0.12% for three-month Treasuries.[12]

A recent example of the limits of arbitrage in the very long end of the term structure is the negative 30-year swap spread that developed in November 2008. The 30-year swap spread measures the difference between the rate on 30-year Treasury bonds and the fixed rate associated with a 30-year fixed-for-floating (LIBOR) swap. Negative spreads are anomalous since arbitrageurs can essentially enter into zero-interest-rate-risk transactions by purchasing

and corporate leverage ratios, as well as a significant negative relationship between government net debt issuances and corporate investment activity.

[11] We obtain similar results if we compute the average of annual realized 90-day volatilities of the corresponding Treasury bond futures. Information on Treasury bond futures and call options on Treasury bond futures is available from Bloomberg beginning in 1994.

[12] See Code of Federal Regulations, Title 17: Section 402.2 – Capital requirements for registered government securities brokers and dealers. Specifically, 17 CFR § 402.2(f)(1) for the haircut schedule. Note that repo haircuts also tend to be higher when collateral consists of long-term Treasury bonds. As discussed in Copeland, Martin, and Walker (2010), haircuts in the repo market and in particular in the tri-party repo market reflect primarily the strength of the counterparty and secondarily the price risk of the underlying collateral. Repo haircuts set by clearing houses reflect the market risk of the underlying collateral. Clearing houses such as LCH.Clearnet sit in the middle of a trade, assuming the counterparty risk involved when two parties (or members) trade. When the trade is registered with LCH.Clearnet, it becomes the legal counterparty to the trade, ensuring the financial performance. LCH.Cleanet sets haircuts based in part on the duration of the collateral. For a schedule of margin requirements see www.lchclearnet.com/risk_management/sa/margining_methodology/margin_parameters_bonds_and_repos.asp.

Treasuries financed by repos and then entering into a swap to pay fixed and receive floating. Krishnamurthy (2010) attributes the negative spread to the amount of risk capital needed to support such a trade until convergence. What is interesting in the context of our analysis is that, during the period from 2006 to 2009, negative swap spreads only appeared for 30-year Treasuries (and not for example for 10- or 5-year Treasuries). This finding is consistent with the hypothesis that arbitrage costs are higher in the very long end of the market.[13]

Previous empirical studies on the relationship between corporate debt maturity choice and government debt maturity measure government debt maturity as the share of government debt outstanding with a maturity of one year or more or, to address endogeneity concerns, the ratio of total government debt to GDP (see GHS and KVJ (2012)). A potential concern with using these broad measures when analyzing corporate maturity is that they may not capture changes in the supply of Treasury debt in the very long end of the term structure (where we argue corporate issuers are likely to have the greatest comparative advantage in exploiting arbitrage opportunities created by changes in the supply of Treasury securities). More important, as discussed later, using more granular data to measure the maturity composition allows us to address concerns that broad measures may be correlated with other factors, such as credit spreads, that may affect corporate maturity choice.

To illustrate the concern with using the proportion of Treasury debt maturing in over one year as a proxy for changes in the supply of long-term Treasury debt, we calculate monthly series of the proportion of total outstanding Treasury debt in various maturity buckets using CRSP's Treasury database.[14] As shown in Figure 1, the fraction of Treasury debt over one year (TSY1) and the fraction of Treasury debt over five years (TSY5) exhibit a very different pattern over time from both the weighted-average maturity of Treasury debt or the fraction of Treasury debt over 20 years (the segment of the term structure frequently associated with institutional demand by insurance companies and pension plans).[15] Indeed, over the 2001 to 2006 period (which coincides with the moratorium of Treasury bond issues over 20 years), the fraction of total Treasury debt over one year increased while the average maturity of Treasury

[13] In untabulated results we show that, while swap spreads contracted for five- and 10-year Treasuries between 2006 and 2009, they were consistently positive except in the very long end of the market.

[14] CRSP reports monthly pricing information, the remaining outstanding principal amounts, and the remaining time to maturity for most outstanding marketable Treasury securities over our sample period. Since CRSP provides outstanding principal amounts that have been adjusted for repurchases and follow-on offerings of existing securities by the Treasury, we are able to create monthly series of the fraction of outstanding principal in various maturity buckets. For a small number of observations during our sample period, the outstanding principal amounts are missing in the CRSP database. Therefore, where necessary we follow Greenwood and Vayanos (2008) and replace missing outstanding principal amounts with the amounts observed in the previous month.

[15] Pension fund demand for long-term assets has been cited as one factor contributing to relatively low long-term interest rates in the United States and Europe since 2001. See Ahrend, Catte, and Price (2006). See also Greenwood and Vanyanos (2010) for evidence concerning UK pension fund demand for long-term assets.

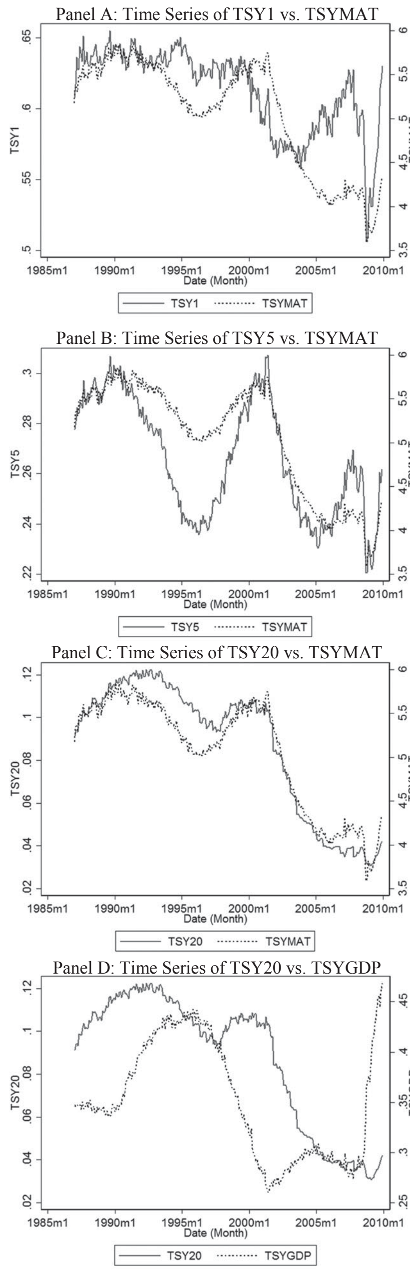

Figure 1. Treasury maturities, 1987–2009. This figure presents the monthly time series of various variables associated with the supply of Treasury securities. *TSYMAT* is defined as the average maturity of outstanding Treasury debt value-weighted by outstanding principal. *TSY1* is defined as the fraction of outstanding Treasury debt maturing in [1, . . .) years, *TSY5* is defined as the fraction with maturities in [5, . . .) years, and *TSY20* is defined as the fraction with maturities in [20, . . .) years. *TSYGDP* is defined as total Treasury debt, as measured by outstanding principal, divided by GDP.

debt (as well as the fraction of Treasury debt over 20 years) declined substantially. In contrast, as shown in Panel C of Figure 1, the share of Treasury debt over 20 years (TSY20) tracks both the weighted-average maturity of Treasury debt (TSYMAT) as well as total Treasury debt to GDP (TSYGDP) very closely. To isolate changes in the supply of Treasury debt in the very long-term segment of the term structure, we focus our analysis on changes in the supply of Treasury debt greater than 20 years. However, given endogeneity concerns we also instrument the fraction of long-term Treasury debt with total Treasury debt to GDP and exploit a natural experiment involving the suspension of 30-year Treasury bond issues.[16]

II. Data

We examine these issues using a database of corporate borrowing by public U.S. companies over the 1987 to 2009 period, which we describe in detail in the Internet Appendix. We collect information on individual corporate debt issues from the Thomson Reuters LPC Dealscan and Thomson Reuters SDC Platinum databases. From Dealscan we obtain information on corporate loans originated by bank and certain nonbank lenders, whereas from SDC we obtain information on new debt issues of nonconvertible debt securities, debt shelf registrations, U.S. Rule 144A nonconvertible debt, and medium-term note programs. Using a combination of data fields available from SDC as well as text searches on the issue description, we exclude from our analysis asset- or mortgage-backed debt, secured debt, pass-through securities, equipment trust certificates, lease obligations, convertible debt, preferred stock that has been misclassified as debt, equity-linked certificates, and perpetual debt. We exclude these issues because the maturity of the issue is likely to match the economic life of the underlying collateral (for example, the cash flows of the underlying assets determine the life of the pass-through securities).

We limit our sample to U.S. dollar-denominated debt issues and bank borrowing. Our choice of time period is driven by the fact that Dealscan's coverage of bank loans is limited prior to 1987 (see Chava and Roberts (2008) for a discussion). We focus on U.S. companies because of homogeneity with respect to tax laws, and because we would expect U.S. companies to be more susceptible to changes in the U.S. government's debt maturity structure than foreign issuers.[17] Furthermore, following prior literature on capital structure and maturity choice, we exclude financial firms (SIC codes 6000–6999) both to align

[16] As discussed later in the paper and in the Internet Appendix, which is available in the online version of the article on the *Journal of Finance* website, we instrument TSY20 with total Treasury debt to GDP in linear models of debt maturity choice.

[17] For example, U.S. tax law limits the tax deductibility of interest on perpetual bonds and for bonds in which the maturity date exceeds 40 years if payments are contingent on earnings. For tax purposes the hallmark of debt is an "unqualified obligation to pay a sum certain at a reasonably close fixed maturity date." See Gilbert v. Commissioner 248 F.2d 399, 404(2d Cir. 1957). See also Gregg Co of Delaware v. Commissioner 329 f.2d at 499, which held that a 50-year bond providing interest payable out of an issuer's earnings constituted equity for tax purposes.

our analysis with previous studies and because regulatory restrictions and capital requirements create incentives for asset and liability matching among financial firms.[18] As shown in the Internet Appendix, our results are robust to including financial firms in the sample. We account for inflation by adjusting all dollar amounts to 2009 dollars using the Bureau of Labor Statistics' consumer price index (all urban consumers), unless specifically mentioned otherwise.

We supplement our issuance database with firm-level financial data from Compustat for the fiscal year-end immediately prior to the date of debt issuance, which we describe in detail in the Internet Appendix, as well as with monthly data on the supply of long-term Treasury securities from CRSP and monthly data on credit market conditions from the Federal Reserve Board's website.[19] Our primary proxy for the supply of long-term Treasury securities is the fraction of outstanding Treasury debt maturing in over 20 years (*TSY20*), and our primary measures of credit market conditions are the spread between the percentage yields of Moody's 30-year BBB- and AAA-rated corporate bond indices and the term structure (or term premium) measured as the spread between the percentage yields of 10-year and six-month Treasury securities.

The advantage of using Moody's BBB-AAA yield spread is that it provides a measure of the credit risk premium in the long end of the term structure and is available on a monthly basis for our entire sample period. The disadvantage of this measure is that AAA bond yields and thus the BBB-AAA yield spread may reflect changes in the supply of long-term Treasuries, or more troubling, affect the government's maturity choice. Indeed, KVJ (2012) find that the BBB-AAA spread is negatively related to the ratio of Treasury debt to GDP (their proxy for the supply of safe long-term assets). Consistent with KVJ, we find a negative and statistically significant relationship between the BBB-AAA spread and the fraction of Treasury debt maturing in 20 years or more (*TSY20*) (the correlation is −0.422). However, we also find a negative correlation between credit spreads and the fraction of short-term Treasury debt (−0.589). Nevertheless, to address this concern we also measure credit risk premiums by the difference between the percentage yields of S&P's Creditweek Corporate Industrial Bond Indices for BB- and BBB-rated bonds with a maturity of 10 years. We obtain this measure on a monthly basis from Bloomberg over the February 1996 to April 2007 period. In contrast to the BBB-AAA spread results, we find a *positive* relationship between the BB-BBB spread and the fraction of Treasury debt maturing in 20 years or more. Additionally, when instrumenting *TSY20* with the ratio of total Treasury debt to GDP, there appears to be no statistically significant relationship between *TSY20* and the BB-BBB spread, mitigating

[18] See the bank regulatory agencies "Joint Agency Policy of Interest Rate Risk Policies" at www.fdic.gov/regulations/laws/rules/5000–4200.html. Unlike credit risk, under current bank capital regulation there is no formulaic relationship between interest rate risk and minimum capital requirements. However, interest rate risk is one factor used to determine a bank's examination ratings, which are used in turn to assess the adequacy of bank capital.

[19] We merged Dealscan with Compustat using a link-file program provided by Chava and Roberts (2008). We updated their program for our sample period.

concerns that the BB-BBB spread captures changes in the supply of long-term Treasuries.[20]

III. Empirical Evidence

A. Descriptive Statistics

Our sample consists of 29,110 corporate loans from Dealscan and 10,040 debt issues from SDC by 5,041 individual companies from 1987 to 2009. Table II provides descriptive statistics for deal characteristics and financial characteristics of the issuing firms in our sample for issues in various maturity buckets. The maturity buckets are similar to those used by Guedes and Opler (1996). Notice that the proportion of offerings that consist of bank loans declines with maturity. For example, virtually all borrowing under one year is from financial institutions, with the proportion declining to just over 3% for issues with maturities of 20 years or more. One reason why the proportion of intermediated debt is so large for offerings under one year is that we do not have information on commercial paper issued by firms in our sample. However, even in the one- to five-year bucket the percentage of intermediated debt is greater than 90%. Finally, notice that just over half the issues with maturities greater than five years are callable.

Turning to issuer characteristics, as shown in Panel B of Table II, with the exception of issues that are under a year, issuer size (measured by assets or market value of equity), age, and the weighted-average maturity of issuer assets all increase with the term to maturity of the issue.[21] For firms with issues of between 1 and 10 years their leverage is generally higher, whereas the frequency of dividend payments and the fraction of issuers with an investment-grade rating are lower than for issues with under 1 year or over 20 years in maturity. Consistent with agency and information problems limiting very long-term issues, 92% of 20-plus-year issues were made by firms with investment-grade ratings and 89% of issues in this maturity bucket were made by dividend paying firms. Overall, these results suggest that better quality issuers inhabit the very short- and very long-term portion of the maturity spectrum.

If agency and information costs limit maturity choice, we would expect higher-grade issuers to distribute their offerings more widely across the maturity spectrum than unrated firms or firms with more speculative-grade ratings. To further examine this issue we group individual debt issues by the issuing firm's credit rating and by maturity bucket. The results are reported in

[20] These results are available in the Internet Appendix.

[21] We measure asset maturity using the same methodology as Stohs and Mauer (1996). Specifically, we define the value-weighted average asset maturity as the book-value-weighted average maturity of current assets and long-term assets. The maturity of current assets is measured as current assets divided by costs of goods sold and the maturity of long-term assets is measured as net property, plant, and equipment divided by depreciation expense. Alternatively, we have also excluded cash from current assets to measure the maturity of current assets. Our main results remain robust to this alternative specification. The corresponding tables can be found in the Internet Appendix.

Table II

Summary Statistics by Final Maturity of Issue, 1987–2009

This table presents issue-level summary statistics for the full sample by different maturity buckets. The sample consists of all U.S. dollar–denominated debt issues by public companies between 1987 and 2009 and is obtained from SDC and Dealscan. Panel A displays summary statistics for the individual debt issues, while Panel B presents summary statistics for the issuing firms in our sample. Panel C summarizes credit market conditions at the time of issuance and Panel D displays the number of unique issuing firms by S&P rating. All variables are defined in the Appendix. To mitigate the influence of extreme outliers, continuous variables have been winsorized at the 1st and 99th percentiles and debt fractions have been winsorized at zero and one, where indicated by †.

	(0,1) Years			[1,5) Years			[5,10) Years			[10,20) Years			[20, . . .) Years		
	Mean	Median	*N*	Mean	Median	*N*	Mean	Median	*N*	Mean	Median	*N*	Mean	Median	*N*
Panel A: Deal Characteristics															
Years to Final Maturity	0.867	0.997	5,453	3.370	3.006	18,051	6.619	6.345	10,158	11.060	10.031	3,868	31.226	30.010	1,620
Deal Amount	553.309	155.404	5,453	273.982	93.728	18,051	349.738	176.786	10,158	323.354	233.458	3,868	364.987	266.049	1,620
Bank Debt Dummy	0.997	1.000	5,453	0.906	1.000	18,051	0.662	1.000	10,158	0.138	0.000	3,868	0.034	0.000	1,620
SDC Call Flag	0.000	0.000	18	0.196	0.000	1,692	0.547	1.000	3,431	0.623	1.000	3,334	0.560	1.000	1,565
Panel B: Issuer Characteristics															
Total Assets†	9,939	2,095	5,448	6,080	667	18,030	7,551	1,419	10,151	13,490	4,056	3,865	26,217	10,424	1,620
Market Value of Equity†	10,409	1,553	5,323	5,303	563	17,455	6,989	1,059	9,773	13,386	3,287	3,772	21,189	8,370	1,601
Market-Debt Ratio†	0.297	0.255	5,323	0.316	0.269	17,455	0.344	0.315	9,773	0.317	0.295	3,772	0.295	0.274	1,601
Fraction of ST and LT Debt due 1Y†	0.280	0.182	5,438	0.231	0.121	17,952	0.167	0.082	10,133	0.165	0.100	3,855	0.180	0.131	1,619
Fraction of ST and LT Debt due 2Y†	0.367	0.279	5,442	0.344	0.241	17,963	0.252	0.164	10,135	0.233	0.174	3,856	0.239	0.198	1,619
Fraction of ST and LT Debt due 3Y†	0.439	0.371	5,442	0.435	0.365	17,963	0.337	0.259	10,135	0.306	0.257	3,856	0.297	0.275	1,619

(Continued)

Table II—*Continued*

	(0,1) Years			[1,5) Years			[5,10) Years			[10,20) Years			[20, . . .) Years		
	Mean	Median	N	Mean	Median	N	Mean	Median	N	Mean	Median	N	Mean	Median	N
Panel B: Issuer Characteristics															
Fraction of ST and LT Debt due 4Y†	0.499	0.453	5,442	0.511	0.481	17,963	0.423	0.375	10,135	0.378	0.348	3,856	0.357	0.348	1,619
Fraction of ST and LT Debt due 5Y†	0.558	0.546	5,442	0.580	0.605	17,963	0.509	0.498	10,135	0.459	0.459	3,856	0.430	0.440	1,619
Market to Book Ratio†	1.773	1.396	5,323	1.639	1.332	17,455	1.631	1.360	9,773	1.664	1.396	3,772	1.625	1.347	1,601
Dividend Dummy	0.555	1.000	5,448	0.414	0.000	18,030	0.470	0.000	10,151	0.679	1.000	3,865	0.891	1.000	1,620
IG Rating Dummy	0.466	0.000	5,453	0.252	0.000	18,051	0.301	0.000	10,158	0.580	1.000	3,868	0.915	1.000	1,620
Com. Paper Rating Dummy	0.352	0.000	5,453	0.179	0.000	18,051	0.224	0.000	10,158	0.440	0.000	3,868	0.693	1.000	1,620
Value Weighted Asset Maturity†	5.713	3.409	5,161	5.036	3.018	16,951	5.892	4.001	9,541	7.334	5.050	3,588	8.406	6.275	1,528
Firm Age	25.302	16.775	5,365	19.476	12.052	17,879	20.107	12.225	10,058	27.057	21.618	3,837	38.606	34.939	1,614
EBIT to Total Assets†	0.062	0.083	5,443	0.066	0.082	18,005	0.085	0.088	10,121	0.095	0.097	3,859	0.106	0.099	1,620
Panel C: Market Characteristics															
Moodys BBB-AAA 30Y	0.926	0.840	5,453	0.883	0.820	18,051	0.875	0.830	10,158	0.904	0.830	3,868	0.855	0.780	1,620
Termstructure 10y-6mth	1.504	1.410	5,453	1.441	1.270	18,051	1.301	1.050	10,158	1.413	1.160	3,868	1.373	1.150	1,620
TSY20	0.091	0.102	5,453	0.087	0.100	18,051	0.088	0.102	10,158	0.089	0.100	3,868	0.092	0.100	1,620
Panel D: Number of Individual Firms															
Number of Firms			2,067			4,156			2,861			1,408			472
Number of LT-Firms			341			412			427			404			472
Number of AA-AAA Firms			68			98			93			81			68
Number of BBB-A Firms			514			706			650			544			372

Table III

Maturities by S&P Issuer Rating, 1987–2009

This table presents the frequency distribution of individual debt issues by S&P issuer rating and maturity bucket. Panel A displays the frequencies for the full sample of all U.S. dollar–denominated debt issues by public U.S. companies between 1987 and 2009, which are obtained from SDC and Dealscan. Panel B excludes credit lines from the full sample.

	(0,1) Years	[1,5) Years	[5,10) Years	[10,20) Years	[20, . . .) Years	Total
Panel A: Full Sample Frequencies						
AAA Rated	75	69	96	78	48	366
AA Rated	252	397	298	274	210	1,431
A Rated	1,071	1,749	1,192	958	690	5,660
BBB Rated	1,088	2,258	1,405	909	522	6,182
BB Rated	270	1,942	1,728	541	45	4,526
B Rated	201	1,168	1,193	260	4	2,826
CCC Rated	32	97	70	10	0	209
CC Rated	3	15	14	2	0	34
Default	15	39	23	0	0	77
Unrated	2,446	10,317	4,139	836	101	17,839
Total	5,453	18,051	10,158	3,868	1,620	39,150
Panel B: Frequencies Excluding Credit Lines						
AAA Rated	4	45	84	78	48	259
AA Rated	7	233	247	273	210	970
A Rated	84	856	933	957	688	3,518
BBB Rated	123	715	1,025	899	521	3,283
BB Rated	65	506	1,179	537	45	2,332
B Rated	54	300	824	255	4	1,437
CCC Rated	10	35	50	10	0	105
CC Rated	1	8	9	2	0	20
Default	4	18	16	0	0	38
Unrated	486	2,433	2,419	806	98	6,242
Total	838	5,149	6,786	3,817	1,614	18,204

Table III. Panel A consists of all issues in our sample while Panel B excludes revolving credit facilities. As shown, issuers with credit ratings lower than investment-grade (BB or below) and nonrated issuers tend to cluster their issues in the middle part of the term structure. Notice that very long-term issues (20+ years) are almost the exclusive providence of investment-grade issuers. Only 49 out of a total of 1,620 long-term issues were made by firms with credit ratings below BBB. Moreover, as shown in Panel B, 20-plus-year bond issues make up about 18% of the nonrevolving debt of these issuers.

As we discuss in the next section, we find evidence of a corporate supply response with respect to 20-plus-year bond issues. Based on these findings, we divide firms in our sample into two groups: (i) short-term issuers, that is, firms that only issue debt with maturity of less than 20 years, and (ii) long-term issuers, that is, firms that have at least one issue with a maturity of more than

20 years.[22] We find that only about 12% of the debt issued by these firms is long-term debt. Indeed, long-term issuers spread their issuance across the maturity spectrum, issuing more frequently in the under-one-year maturity bucket than short-term issuers. Long-term issuers are larger, less levered, have higher ROA (EBIT/Assets), and are more likely to have an investment-grade rating than short-term issuers. Overall, the evidence suggests that long-term issuers have greater flexibility in their choice of maturity than short-term issuers.[23]

B. Empirical Models of Debt Maturity Choice

As discussed earlier, we examine three questions related to gap filling. The first is whether long-term debt issues are more sensitive to market conditions, and in particular the supply of long-term Treasury securities, than short- and intermediate-term debt issues. The second is whether the maturity choice for high-quality issuers is more sensitive to changes in the supply of Treasury securities than for lower-rated issuers. The third is whether changes in the supply of Treasuries affect the propensity of firms to borrow.

Previous studies of maturity choice typically estimate a linear model relating debt maturity to firm characteristics and controls for credit and term structure spreads (see, for example, Guedes and Opler (1996)). When examining gap-filling behavior, estimating a linear model raises concerns because the relationship between the maturity of debt issued and shifts in the supply of Treasury securities is likely to be highly nonlinear. Nevertheless, to facilitate comparison to previous studies we estimate a linear model of maturity choice using panel data on monthly debt issues and bank borrowing including controls for firm characteristics, credit spreads, term structure spreads, and the maturity composition of Treasury debt. The maturity measures used are *TSY1*, the average maturity of Treasury debt (*TSYMAT*), and the fraction of Treasury debt with maturities of 20-plus-years (*TSY20*).

The estimates of the linear model are available in the Internet Appendix. Our results can be summarized as follows. We find no significant relationship between the maturity of corporate debt issues and *TSY1*. However, consistent with gap filling we find a negative and significant relationship between the maturity of corporate issues and both the average maturity of Treasury debt (*TSYMAT*) and the fraction of Treasury debt with maturities of 20-plus-years (*TSY20*). To address endogeneity concerns, we also use the ratio of Treasury debt to GDP as an instrument for *TSY20* and find a negative and significant relationship between the maturity of the debt issues and our instrument for *TSY20*.

[22] Our findings concerning long-term issuers are not sensitive to whether we define long-term issuers based on issuance activity during the entire sample period or whether we limit the sample of firms to those that issue within the prior five years.

[23] The corresponding table is in the Internet Appendix.

C. Multinomial Logit Models of Debt Maturity Choice

As discussed earlier, given market segmentation we would expect corporate gap filling to be most prevalent in the very long end of the term structure where the demand for safe long-term assets is relatively constant and where arbitrage costs are high (see KVJ (2012) and Greenwood and Vayanos (2010)). To investigate this issue we estimate a multinomial logit model, relating the likelihood of debt issuances in various segments of the term structure to market conditions and the supply of Treasury bonds. The advantage of the multinomial model is that it allows us to account for nonlinear effects of both firm characteristics and gap filling on maturity choice. The disadvantage is that it provides an estimate of the supply response conditional on the issuance of debt. However, as we discuss below a shift in Treasury supply may not be limited to substituting away from short-term debt to long-term debt.

In estimating the multinomial model, we model the decision to issue short-term debt with maturities in (0,1) years, short-term to medium-term debt with maturities in [1,5) years, medium-term debt with maturities in [5,10) years, medium to long-term debt with maturities in [10,20) years, and very long-term debt with maturities in [20, ...) years.[24] To estimate a multinomial logit model one needs to select a base or reference category to which the coefficient estimates relate. While theoretically it does not matter which of the alternative maturity choices we use, we select the [5,10) year segment since this is the segment associated with the most issuance activity and the segment that most closely matches the average asset maturity for the firms in our sample. Interpretation of coefficient estimates is in relation to the chosen base category. To control for potential shifts in demand for long-term safe assets and other macro factors, we include indicator variables corresponding to five-year intervals in our sample.[25,26]

Panel A of Table IV presents the estimates of the multinomial logit model. The specification is similar to the one used by Guedes and Opler (1996). For brevity we report estimates using *TSY20* to measure the supply of long-term Treasury bonds, but our results are similar if we use *TSYMAT* to measure changes in the supply of long-term Treasuries. As shown, we find that changes in the supply of long-term Treasuries affect maturity choice in a nonlinear fashion. Note that the coefficient estimate on *TSY20* is negative and statistically significant only for maturities in [20, ...) years relative to the base category. This indicates that the likelihood of firms issuing long-term debt relative to medium-term debt decreases as the fraction of long-term Treasury debt increases. However, as the estimated coefficients only allow us to make statements in relation to the assumed base case, we also estimate a series of

[24] We also estimate a set of logit models. For the logit models we divide the term structure into intervals reflecting short-term maturities in (0,1] and long-term maturities in [20, ...) years. The results of the logit estimates are similar to the multinomial logit regressions.

[25] The time dummies correspond to 1991 to 1995, 1996 to 2000, 2001 to 2005, 2006 to 2009 with the omitted time period being 1987 to 1990.

[26] See, for instance, Cameron and Trivedi (2005) for more on multinomial models.

Table IV

Multinomial Logit Model of Debt Maturity Choice, 1987–2009

Panel A of this table presents coefficient estimates of a multinomial logit model of debt maturity choice. The sample consists of all U.S. dollar–denominated debt issues (excluding credit lines) by public companies between 1987 and 2009 and is obtained from SDC and Dealscan. The dependent variable is categorized according to (0,1), [1,5), [5,10), [10,20), and [20, . . .) years to maturity. The base category comprises maturities in [5,10) years and is excluded for brevity. Panel B presents marginal effects estimated at the mean values for firms rated A to AAA. All variables are defined in the Appendix. To mitigate the influence of extreme outliers, continuous variables have been winsorized at the 1st and 99th percentiles and debt fractions have been winsorized at zero and one, where indicated by †. Absolute values of t-statistics are in parentheses below the corresponding coefficient estimates. *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

	(1) (0,1) Y	(2) [1,5) Y	(3) [10,20) Y	(4) [20, . . .) Y
Panel A: Multinomial Logit Estimates				
TSY20	13.9845***	0.5231	−0.6458	−16.6114***
	(3.90)	(0.29)	(0.32)	(5.07)
Moodys BBB-AAA 30Y	0.7744***	0.2962***	−0.0944	−1.1015***
	(4.11)	(2.93)	(0.90)	(6.72)
Termstructure 10y-6mth	−0.0987**	−0.0491*	0.0365	0.1331***
	(1.97)	(1.93)	(1.35)	(3.46)
Total GDP 4Q Growth	9.0564**	2.4891	−3.8288*	−12.4283***
	(2.24)	(1.20)	(1.76)	(4.11)
Log(Deal Amount)	0.1116***	−0.3378***	0.0073	0.0659**
	(3.29)	(21.28)	(0.40)	(2.50)
Log(MV of Equity)†	−0.3414***	0.0392**	0.1052***	0.2002***
	(9.34)	(2.24)	(5.50)	(7.07)
Market-Debt Ratio†	−1.1241***	−0.0377	−0.5732***	−0.7657***
	(5.43)	(0.33)	(4.03)	(2.84)
EBIT to Total Assets†	−3.0495***	−1.6670***	0.0555	0.6743
	(9.92)	(7.96)	(0.19)	(1.14)
Value Weighted Asset Maturity†	0.0089	−0.0184***	0.0255***	0.0477***
	(1.22)	(4.45)	(6.60)	(8.71)
Market to Book Ratio†	0.1373***	−0.0077	−0.0497	−0.1794***
	(2.74)	(0.27)	(1.51)	(3.20)
Dividend Dummy	−0.0806	−0.1895***	0.2025***	0.3923***
	(0.78)	(3.52)	(3.45)	(3.57)
IG Rating Dummy	0.6963***	0.3290***	0.5321***	2.2878***
	(5.32)	(4.94)	(7.86)	(17.70)
STD EBIT Growth 2DSIC†	0.5454*	0.3386**	−0.4343***	−0.1325
	(1.84)	(2.19)	(2.60)	(0.54)
Constant	−1.8490***	0.7041**	−1.3296***	−1.6521***
	(3.13)	(2.36)	(4.05)	(3.24)
5-Year FE	Yes	Yes	Yes	Yes
Pseudo R^2	0.104			
Observations	16,440			

(*Continued*)

Table IV—*Continued*

	(1) (0,1) Y	(2) [1,5) Y	(3) [10,20) Y	(4) [20, . . .) Y
Panel B: Marginal Effects Evaluated at the Mean for Firms Rated A-AAA				
TSY20	0.3439***	0.6736**	0.6919*	−2.5687***
	(4.70)	(2.42)	(1.74)	(5.46)
Moodys BBB-AAA 30Y	0.0190***	0.0894***	0.0205	−0.1764***
	(4.98)	(5.92)	(1.01)	(7.58)
Termstructure 10y-6mth	−0.0025**	−0.0144***	0.0037	0.0204***
	(2.53)	(3.77)	(0.70)	(3.72)
Observations	4,287	4,287	4,287	4,287

marginal effects in Panel B of Table IV estimated at the mean firm characteristics for A- to AAA-rated firms. The marginal effects estimated with respect to the fraction of long-term government debt are negative and highly statistically significant for the likelihood of issuing debt with a maturity greater than 20 years. The marginal effect estimates indicate the economic magnitude of gap filling is significant. For a 1% decrease in the fraction of 20-year Treasuries, we find a 2.6% increase in the likelihood of 20-year bond issues.[27] The estimated marginal effects indicate that, conditional on issuing debt, an increase in the Treasury's long-term borrowing leads to highly rated firms substituting away from long-term bonds into short- and medium-term borrowing.

We also estimate the multinomial logit model separately for A- to AAA-rated firms and BBB-rated firms, as highly rated firms are expected to be more actively engaged in gap filling. In the interest of brevity we describe the results here and refer the reader to the Internet Appendix. Similar to the results reported in Table IV, the estimated marginal effect on the fraction of long-term government debt is negative and statistically significant for the likelihood of issuing 20-plus-year corporate debt for A- to AAA-rated issuers. Moreover, we find that the economic magnitude of the effect of *TSY20* on the likelihood of issuing 20-plus-year corporate debt is over two times greater for A- to AAA-rated issuers than for BBB-rated issuers.

If the negative relationship between the maturity of corporate debt issues and the maturity of Treasury debt is the result of gap filling, we would expect the supply response to be greater for issues that are closer substitutes for Treasury debt. We therefore expect the supply elasticity to be greater for firms rated A or better than for firms with a BBB rating (recall virtually all 20-plus-year debt is issued by investment-grade rated firms). Also, since bank and institutional term loans are typically floating rate, they are not likely to be close substitutes for fixed rate Treasury debt. Thus, we would expect a greater supply response if we exclude term loans from the sample. We also expect noncallable bonds

[27] Because we estimate the model with five-year fixed effects, the variation in TSY20 should be interpreted as variation within the corresponding five-year periods. The standard deviations of the monthly TSY20 within five-year intervals ranged from 0.003 to 0.021 over our sample period.

to be closer substitutes for noncallable Treasury bonds than callable corporate debt.

Table V provides estimates of logit models for the likelihood of long-term debt issuances (greater than 20 years) estimated over different subsamples of our data. To facilitate comparison we focus on subsamples of firms with rated debt. For brevity we only report the coefficient estimates for the credit market variables and only using *TSY20* as a measure of shifts in Treasury supply (we obtain similar results using *TSYMAT*). Column (1) presents estimates of the logit model estimated for all firms with rated debt. As shown in column (1) we find a significantly greater supply response for A-rated firms than other rated firms. In particular, *TSY20* interacted with the dummy variable for whether the firm is rated A or better is negative and statistically significant at the 1% level. In column (2) we distinguish between bond issues and bank loans and find a significantly greater supply response for bonds over bank debt (the coefficient estimate on *TSY20* interacted with the bond dummy variable is significant at the 1% level). Additionally, we find a significantly greater supply response, in terms of magnitude, when we estimate the regression using samples that exclude term loans (no bank) and control for callable debt as shown in column (3) (the coefficient on *TSY20* interacted with a dummy variable for whether the bond issue is noncallable is negative and significant at the 1% level).

How important are gap filling and credit market conditions generally in explaining maturity choice? One way to gauge the importance of gap filling is through an analysis of covariance (ANCOVA). This involves decomposing the variation in long-term debt issues over time attributable to various factors. In this analysis we use the same methodology as Lemmon, Roberts, and Zender (2008) to compute the fraction of the total Type III partial sum of squares associated with each factor in a linear probability model of long-term debt issues similar to those displayed in Table V. In other words, we compute the fraction of each model's sum of squares attributable to particular "effects" (firm, year, *TSY20,* etc.) by dividing the partial sum of squares for each effect by the aggregated partial sum of squares across all effects in the model. Our findings can be summarized as follows. In all of the models industry fixed effects account for most of the explained variation in long-term debt issues. In terms of credit market factors, *TSY20* explains the greatest amount of within-firm variability in long-term debt issues (about 12%) for highly rated issuers.[28]

D. Gap Filling and the Propensity to Borrow Long-Term Debt

Our analysis thus far focuses on the relationship between maturity choice and changes in the relative supply of long-term Treasury debt. Specifically, we focus on maturity choice conditional on issuing debt. However, gap filling is not necessarily limited to substitution effects between corporate short- and long-term debt with respect to the supply of long-term Treasuries.

[28] The corresponding tables can be found in the Internet Appendix.

Table V

Logit Models of Long-Term Debt Issues (Different Subsamples), 1987–2009

This table presents logit models of long-term debt issues where the dependent variable takes a value of one if the debt issue had a maturity of [20, ...) years, and zero otherwise. For brevity only the independent variables of interest are displayed. The sample consists of all U.S. dollar–denominated debt issues (excluding credit lines) by public companies with a long-term S&P credit rating between 1987 and 2009 and is obtained from SDC and Dealscan. Panel A displays the coefficient estimates of the logit model. Columns (1) and (2) show the results for the rated sample. Column (3) excludes bank loans from the sample. Panel B displays marginal effects for *TSY20* where the other covariates are evaluated at the mean values of the indicated subsamples. All variables are defined in the Appendix. Absolute values of t-statistics are in parentheses below the corresponding coefficient estimates. *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

	(1) Rated	(2) Rated	(3) No Bank
Panel A: Logit Models of Issuance			
TSY20	−11.3480***	23.1494	−11.4117***
	(3.29)	(1.55)	(3.34)
TSY20 × A-Rated	−7.5578***		
	(3.00)		
TSY20 × Bonds		−40.5254***	
		(2.76)	
TSY20 × No Call			−14.1447***
			(4.08)
Termstructure 10y-6mth	0.1318***	0.2257	0.1370***
	(2.62)	(1.19)	(3.02)
Termstructure 10y-6mth × A-Rated	0.0114		
	(0.19)		
Termstructure 10y-6mth × Bonds		−0.1443	
		(0.76)	
Termstructure 10y-6mth × No Call			−0.0903
			(1.34)
Moodys BBB-AAA 30Y	−1.6540***	−3.4979***	−1.1918***
	(6.71)	(2.98)	(7.23)
Moody BBB-AAA × A-Rated	0.5414**		
	(2.18)		
Moody BBB-AAA × Bonds		2.3235**	
		(1.99)	
Moody BBB-AAA × No Call			−1.4340***
			(4.60)
5-Year FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Pseudo R^2	0.142	0.178	0.129
Observations	10,670	10,670	7,946
Panel B: Marginal Effects Evaluated at Means for Different Subsamples			
	Rated BBB or lower	Bank debt	Callable
	−0.5251***	0.0430***	−1.4230***
	(3.23)	(2.77)	(3.33)
	Rated A or higher	Bonds	Noncallable
	−2.8064***	−2.0876***	−2.6494***
	(5.50)	(5.40)	(5.84)

Gap-filling incentives may also influence a firm's propensity to borrow.[29] Indeed, as discussed earlier, one of the primary objectives of recent Federal Reserve initiatives, such as QE2, is to induce long-term corporate borrowing through purchases of long-term Treasury bonds.

To address this issue, we obtain the full time series of annual Compustat data from 1986 to 2009 for all rated firms in our original sample of debt issuances. We then estimate a series of logit models where the dependent variable takes a value of one if the fiscal year in Compustat was one in which long-term (20+ years) debt was issued by the corresponding firm (as identified in our original data set) and zero otherwise, as well as logit models where the dependent variable takes a value of one if short-term (one year or less) debt was issued and zero otherwise. The independent variables for our logit models are the same as for our previous models of debt maturity choice in Table IV and Table V but are lagged by one period. We also include 12-month averages of the credit market variables and, depending on the model, either *TSY1* or *TSY20*. Because the Compustat data are annual, we do not include year fixed effects, but we do use indicator variables for five-year time periods to control for changes in other unobserved macro variables. This specification allows us to examine whether changes in Treasury supply predict corporate debt issues and if so in what segment of the term structure.

The first two columns of Panel A of Table VI provide logit regression results on the relationship between corporate debt issues and changes in the relative supply of short- and long-term Treasury debt. As shown in column (1), we find no significant relationship between short-term debt issues and changes in the supply of short-term Treasury debt. In contrast, and consistent with our findings concerning maturity choice, we find a negative and significant relationship between long-term debt issues and the fraction of long-term Treasury debt outstanding in column (2). Specifically, as shown in column (2) of Panel B, the marginal effect estimated for changes in *TSY20* implies that a 1% decrease in *TSY20* increases the likelihood of issuing long-term debt by about 0.6% for highly rated firms. Moreover, as can be seen in columns (3) and (4) of Table VI, when we include interaction terms for highly rated issuers or restrict our sample to rated firms that issued long-term debt at any point in time, the marginal effects of a change in long-term Treasuries outstanding on the likelihood of issuing long-term debt increase both in significance and magnitude. For instance, a 1% decrease in *TSY20* (within a five-year interval) increases the likelihood of issuing long-term debt by about 1.4% for highly rated long-term issuers.

The macro control variables are included in the logit model to mitigate concerns that *TSY20* may pick up the effects of shifts in the term structure of credit risk spreads or changes in overall economic activity on the decision to issue long-term debt. The coefficient estimates on the firm-specific control variables generally have the expected sign. For example, larger firms (as measured

[29] For instance, Graham, Leary, and Roberts (2014, 2015) document a significant negative relationship between government debt levels and corporate leverage levels.

Table VI

Logit Models of Issuance and Marginal Effects, 1987–2009

This table presents logit models for short-term and long-term debt issuance and the corresponding marginal effects. The sample is taken from Compustat for all rated U.S. firms that issued nonrevolving, U.S. dollar–denominated debt between 1987 and 2009 (as identified in our original sample). Capital structure variables and credit market variables are lagged by one year. Column (1) presents results where the dependent variable takes a value of one if the year was one in which short-term debt was issued ((0,1]Y) but not long-term debt ([20, . . .)Y). For columns (2) to (4) the dependent variable takes a value of one if the year was one in which long-term debt was issued. For column (4) the sample has been further reduced to firms that issued long-term debt at any point in our sample. All marginal effects are estimated at the mean values for firms rated A− or higher. All variables are defined in the Appendix. All variables have been winsorized at the 1% and 99% percentiles, where indicated by †. Absolute values of t-statistics are in parentheses below the corresponding coefficient estimates. *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

	(1) ST Rated	(2) LT Rated	(3) LT Rated	(4) LT Issuer
Panel A: Logit Estimates				
L1 TSY1 Avg. 12m	11.3063			
	(1.55)			
L1 TSY20 Avg. 12m		−6.9729*	−1.1786	−2.1439
		(1.80)	(0.29)	(0.51)
L1 A-Rating × TSY20 Avg. 12m			−7.7313***	−8.0225***
			(2.84)	(2.87)
L1 Termstructure 10y-6mth Avg. 12m	−0.0737	0.0668	0.1089*	0.0930
	(0.66)	(1.28)	(1.66)	(1.37)
L1 A-Rating × Termstructure 10y-6mth Avg. 12m			−0.0987	−0.0867
			(1.42)	(1.21)
L1 Moodys BBB-AAA30Y Avg. 12m	−0.1227	−0.9375***	−0.9381***	−0.9021***
	(0.23)	(3.57)	(3.03)	(2.83)
L1 A-Rating × Moodys BBB-AAA30Y Avg. 12m			0.2210	0.2668
			(0.74)	(0.87)
L1 Total GDP 4Q Growth	3.0529	−11.1871***	−10.6028***	−9.6432***
	(0.47)	(3.34)	(3.16)	(2.82)
L1 A Rating or Higher			0.9464**	0.7396*
			(2.28)	(1.74)
L1 IG Rating Dummy	−0.1312	1.4720***		
	(0.69)	(9.50)		
L1 Log(MV of Equity)†	0.0558	0.5987***	0.6733***	0.3647***
	(0.95)	(17.66)	(20.26)	(9.93)
L1 Market-Debt Ratio†	0.1263	0.5701*	−0.0142	−0.6095*
	(0.29)	(1.79)	(0.05)	(1.84)
L1 EBIT to Total Assets†	−0.5105	2.1859***	2.1951***	2.1079***
	(0.69)	(3.20)	(3.30)	(3.00)
L1 Value Weighted Asset Maturity†	−0.0099	0.0325***	0.0328***	0.0192**
	(0.63)	(4.00)	(4.07)	(2.29)
L1 Market to Book Ratio†	0.0223	−0.3438***	−0.4462***	−0.3505***
	(0.24)	(5.37)	(6.87)	(5.23)

(Continued)

Table VI—*Continued*

	(1) ST Rated	(2) LT Rated	(3) LT Rated	(4) LT Issuer
Panel A: Logit Estimates				
L1 Dividend Dummy	0.0797	0.2607**	0.6320***	0.1061
	(0.45)	(2.15)	(5.35)	(0.88)
L1 STD EBIT Growth 2DSIC†	0.6833	0.5955	0.5493	0.3549
	(0.95)	(1.48)	(1.35)	(0.85)
Constant	Yes	Yes	Yes	Yes
5-Year FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Pseudo R^2	0.027	0.198	0.188	0.065
Observations	17,765	18,170	18,170	7,134
Panel B: Marginal Effects Evaluated at the Mean for Firms Rated A-AAA				
L1 TSY1 Avg. 12m	0.1395			
	(1.54)			
L1 TSY20 Avg. 12m		−0.6111*	−0.7929**	−1.3683**
		(1.80)	(2.15)	(2.40)
L1 Termstructure 10y-6mth	−0.0009	0.0059	0.0009	0.0008
Avg. 12m	(0.66)	(1.28)	(0.17)	(0.10)
L1 Moodys BBB-AAA30Y	−0.0015	−0.0822***	−0.0638**	−0.0855**
Avg. 12m	(0.23)	(3.59)	(2.44)	(2.12)
Observations	4,761	4,879	4,879	3,548

by the market value of equity), more profitable firms, and firms with longer-term assets are more likely to issue long-term debt. Firms with stronger growth options, as measured by the market-to-book ratio, are less likely to issue long-term debt. This last result is consistent with Myers's (1977) argument that long-term debt exacerbates underinvestment problems for firms with significant growth options. Overall, these results are consistent with agency cost theories of corporate debt maturity.

To further examine the impact of shifts in Treasury supply on borrowing, we estimate a linear model with firm fixed effects of the annual changes in total debt outstanding for the rated firms in our sample. The dependent variable in these models is the annual change in total debt outstanding scaled by the lagged book value of assets.[30] We include the same macro control variables as in the previous regressions to mitigate concerns that *TSY20* is picking up the effects of changes in term structure or credit risk premiums. In addition, since we are examining the change in total debt outstanding, we include controls for firm profitability, leverage, investment spending, firm size, and asset tangibility in the regression.[31] Estimates of these models are reported in Table VII. As shown

[30] Specifically, we define total debt outstanding as the sum of the Compustat variables DLTT (Total Long-Term Debt) and DLC (Debt in Current Liabilities).

[31] These are controls that are typically included in empirical studies of debt issuance. See, for example, Leary and Roberts (2005). Since we examine changes in total debt rather than maturity

Table VII

Annual Change in Total Debt – Compustat Sample, 1987–2009

This table presents linear models that account for firm fixed effects, where the dependent variable is the change in total debt over lagged total assets ($\frac{D_t - D_{t-1}}{A_{t-1}}$), winsorized at the 1% and 99% levels. The sample is annual data taken from Compustat for all rated U.S. firms that issued nonrevolving, U.S. dollar–denominated debt between 1987 and 2009 (as identified in our original sample). Capital structure variables and credit market variables are lagged by one year. Columns (1) to (3) present results with credit market variables averaged over the 12 months preceding the Compustat reporting date for all firms with an S&P credit rating. Column (3) presents results for firms with an S&P credit rating that issued long-term debt at any point in our sample period. All variables are defined in the Appendix. All variables have been winsorized at the 1% and 99% percentiles, where indicated by †. Absolute values of t-statistics are in parentheses below the corresponding coefficient estimates and standard errors have been clustered by firm. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

	(1) Rated	(2) Rated	(3) LT Issuer
L1 TSY20 Avg. 12m	-0.1835^{**}	0.1056	0.1226
	(2.30)	(1.16)	(1.12)
L1 A-Rating × TSY20 Avg. 12m		-1.0687^{***}	-0.7081^{***}
		(7.75)	(5.06)
L1 Termstructure 10y-6mth Avg. 12m	-0.0105^{***}	-0.0107^{***}	-0.0112^{***}
	(8.17)	(6.50)	(4.66)
L1 A-Rating × Termstructure 10y-6mth Avg. 12m		0.0015	0.0023
		(0.66)	(0.80)
L1 A-Rating × Moodys BBB-AAA30Y Avg. 12m		−0.0145	-0.0235^{*}
		(1.33)	(1.71)
L1 Moodys BBB-AAA30Y Avg. 12m	0.0144^{*}	0.0179^{**}	0.0186
	(1.93)	(2.01)	(1.45)
L1 Total GDP 4Q Growth	0.7237^{***}	0.6988^{***}	0.5709^{***}
	(8.09)	(7.65)	(5.34)
L1 A Rating or Higher		0.1092^{***}	0.0941^{***}
		(5.96)	(4.54)
L1 IG Rating Dummy	−0.0032		
	(0.53)		
L1 Market to Book Ratio†	0.0407^{***}	0.0406^{***}	0.0194^{***}
	(9.00)	(9.06)	(3.67)
L1 EBIT to Total Assets†	0.1094^{***}	0.1068^{***}	0.1343^{***}
	(4.73)	(4.62)	(3.82)
L1 PPE to TA†	0.0019	0.0114	−0.0450
	(0.07)	(0.42)	(1.44)
L1 Book-Debt Ratio†	-0.5816^{***}	-0.5895^{***}	-0.3731^{***}
	(24.15)	(24.47)	(11.28)
L1 Dividend Dummy	0.0307^{***}	0.0298^{***}	0.0079
	(4.02)	(3.95)	(0.59)
L1 Log(Sale)†	-0.0936^{***}	-0.0932^{***}	-0.0522^{***}
	(16.84)	(17.06)	(7.46)
L1 CAPEX to Total Assets†	0.4447^{***}	0.4475^{***}	0.4638^{***}
	(8.87)	(8.93)	(6.15)
Constant	0.8693^{***}	0.8381^{***}	0.5118^{***}
	(16.99)	(16.54)	(6.54)
Adj. R^2	0.097	0.097	0.037
Observations	19,182	19,182	7,397

in columns (2) and (3), consistent with the results from the logit models, we find a significant relationship between changes in corporate borrowing and the relative supply of long-term Treasury bonds when firms are highly rated and when they have issued long-term debt at any point in our sample. Indeed, we find no significant relationship between corporate borrowing and the supply of long-term Treasury bonds when firms are rated BBB or less.

Finally, the estimated signs on the firm-specific control variables are generally as expected. In particular, we find a positive relationship between changes in total debt and both investment spending (measured by net capital expenditures relative to total assets) and firm profitability. In addition, we find a negative relationship between changes in total debt and firm overall leverage.[32]

IV. Endogeneity Concerns

A. Event Study

Although our data allow us to focus our tests with respect to gap filling on narrow segments of the term structure and on issuers with different credit ratings, endogeneity concerns might remain. In this section we address these concerns by examining the impact of the U.S. government's decision to suspend the issuance of 30-year bonds in 2001. Based on news articles and press statements by the U.S. Treasury around the announcement of the suspension, it does not appear that the suspension was motivated by shifts in investors' relative demand for long-term corporate and government debt. Rather, it appears that the foremost reason for the suspension was to reduce the Treasury's borrowing costs and reduce long-term interest rates.[33]

To examine the impact of the suspension on Treasury yields, we conduct an event study on daily relative changes in yields of Treasury securities using a constant-mean return model (see Campbell, Lo, and MacKinlay (1997)). If the suspension of 30-year Treasury bonds constituted an unexpected supply

choice, we do not include average asset maturity as a control variable. Including average asset maturity as a control variable yields results similar to those reported in Table VII.

[32] While our findings are consistent with government long-term borrowing influencing corporate borrowing, variation in long-term government borrowing may also be picking up variation in corporate investment opportunities not captured by our other control variables. Investigating the channels through which government borrowing affects broader corporate financial policies is beyond the scope of our paper.

[33] In the U.S. Treasury press release from 10/31/2001 on the November Quarterly refunding, Peter Fisher, the undersecretary of the Treasury, argued that maintaining the issuance levels of 30-year bonds would be unnecessary and expensive to taxpayers. See U.S. Department of the Treasury, 2001, Press release, October 31. Online at www.treasury.gov/press-center/press-releases/Pages/po749.aspx See also coverage by *CNN Money* and *The Economist*. See, CNN Money, 2001, U.S. kills 30-year bond, *CNN Money*, October 31. Online at money.cnn.com/2001/10/31/markets/longbond/, See *The Economist*, 2001, "CutShort", November 1. Online at www.economist.com/node/843681. As discussed in the *Economist* article, critics of the Treasury's decision argued that, because the United State has returned to a net borrower position and given forecasts of an economic downturn, it was the wrong time to suspend long-term Treasury issues.

Table VIII

Event Study – Relative Changes in Yields around Treasury Announcement

This table presents results from an event study on the relative changes in daily yields ($-\frac{Y_t - Y_{t-1}}{Y_{t-1}}$) of various U.S. Treasury securities. The event study is conducted following Campbell, Lo, and MacKinlay (1997) (Chapter 4) and estimates cumulative abnormal returns for constant-return models. The estimation window is 10/31/2000 to 10/26/2001 and the event window is 10/29/2001 to 11/02/2001. The constant-return models are estimated for 10-, 20- and 30-year constant-maturity Treasury rates as indicated in the corresponding columns. $^*p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

	(1) TSY 10Y	(2) TSY 20Y	(3) TSY 30Y
Estimation Window	247	247	247
Event Window	5	5	5
CAR Event	0.0304	0.0217	0.0561
t-stat	1.103	1.0673	2.9966***
p-value	0.2711	0.2869	0.003

shock, then we would expect to find a statistically significant decrease in yield relatives.

For our event study we obtain data on daily yields for constant-maturity Treasury securities from the Federal Reserve's website. We define the event window as the period 10/29/2001 to 11/02/2001, the week in which the Treasury announced the suspension, and the estimation window as the one-year period prior to the event 10/31/2000 to 10/26/2001. We denote the daily relative change in yield to maturity for a Treasury security as

$$\Delta TSY_{t,t-1} = -\frac{TSY_t - TSY_{t-1}}{TSY_{t-1}}. \tag{1}$$

We then estimate the following constant-mean return model over the estimation window using OLS,

$$\Delta TSY_{t,t-1} = \mu + \xi_t, \tag{2}$$

and calculate the daily abnormal relative changes in yields as the sample residuals ξ_t over the event window.

Table VIII summarizes the results of the event study. The cumulative abnormal returns (CAR) for 10-, 20- and 30-year Treasury bonds are reported in columns (1), (2), and (3), respectively. Consistent with a supply shock, we find a positive and statistically significant abnormal return on 30-year Treasuries. Consistent with market segmentation, the decline in yields is significant only for 30-year Treasury bonds. Specifically, the weekly return for the 30-year bond is 5.61%, which is significantly different from zero at the 1% level, while the return on 20-year Treasury bonds is 2.17%, which is not significant at the 10% level.

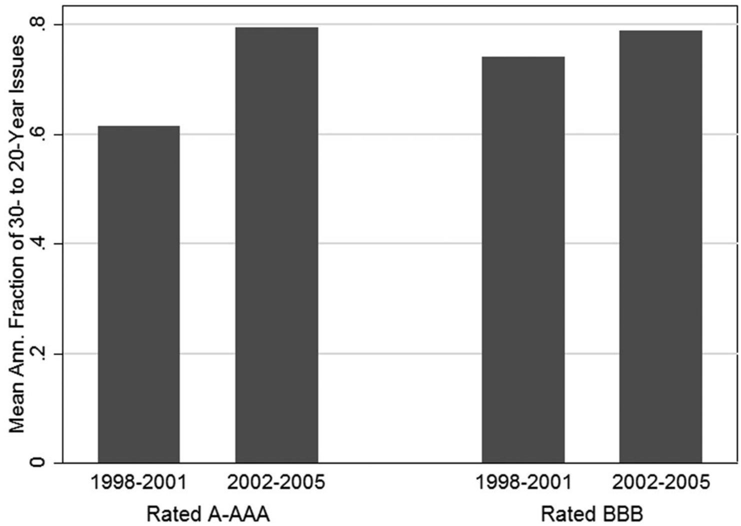

Figure 2. Four-year average composition of long-term debt around Treasury event. This figure depicts the four-year means for the annual fraction of total debt issued with maturities in [30, . . .) years to total debt issued with maturities in [20, . . .) years. The sample is broken down into debt issues with a rating between A to AAA and issues with a rating of BBB. Means are calculated over the period 1998 to 2001 and over the period 2002 to 2005, respectively.

B. Corporate Supply Response

We next examine the corporate supply response to the suspension of 30-year Treasuries by examining changes in the fraction of corporate long-term issues with original maturity of 30 years or more. We calculate the annual fraction of total debt issued with maturities in [30, . . .) years to total debt issued with maturities in [20, . . .) years for each year in our sample for debt issues rated between A and AAA and for issues rated BBB. Figure 2 illustrates the mean fractions for the four years prior to the Treasury's suspension of 30-year bonds as well as the mean fractions for the four years following the suspension. As expected, the increase in the proportion of issues exceeding 30 years relative to issues exceeding 20 years is far greater for A- to AAA-rated bonds than for BBB-rated bonds. Specifically, the increase for issues rated A to AAA was about 20% in absolute terms while for issues rated BBB it was approximately 5% in absolute terms.

To examine the corporate supply response to the suspension of 30-year Treasury bond issues, we conduct a simple regression discontinuity analysis on the quarterly fraction of total debt issued with maturities in [30, . . .) years to total debt issued with maturities in [20, . . .). The results of this analysis are reported in Table IX.[34] Consistent with gap filling, we find positive and

[34] Recall that the BBB-AAA spread is calculated for 30-year bonds, and the term premium is the yield difference between 10-year and six-month Treasuries. In simple univariate regressions

Table IX

Natural Experiment

This table presents results of ordinary least squares regressions on the long-term debt composition of new debt issues to estimate the effect of the U.S. Treasury's decision to suspend the issuance of long-term bonds. The dependent variable is the quarterly fraction of total proceeds raised from new issues with maturities of [30, . . .) years to total proceeds raised from new issues with maturities of [20, . . .) years. *Time Trend* is calculated as (issue quarter – 187). The sample consists of all U.S. dollar–denominated debt issues (excluding credit lines) by public U.S. companies and is obtained from SDC. Panel A presents results for all long-term issues in the sample, Panel B presents results for long-term issues with a rating between A and AAA, and Panel C presents results for long-term issues with an issue-level rating of BBB. All variables are defined in the Appendix. All models calculate heteroskedasticity-robust standard errors. Absolute values of t-statistics are presented in parentheses below the corresponding coefficient estimates. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

	(1)	(2)	(3)	(4)
Panel A: All Issues				
Qtr. Mean TSY20	0.0387	0.9645	−0.6538	0.4711
	(0.02)	(0.44)	(0.28)	(0.18)
Qtr. Mean Spread Moodys BBB-AAA 30Y			0.0217	0.0325
			(0.38)	(0.58)
Qtr. Mean Termstructure 10y-6mth			0.0168	0.0178
			(0.64)	(0.67)
Year [2002, . . .) Dummy	0.2445**	0.2351**	0.1875	0.1714
	(2.22)	(2.11)	(1.32)	(1.17)
Time Trend		0.0014		0.0017
		(0.69)		(0.85)
Constant	0.5686***	0.4268	0.6027**	0.4199
	(3.14)	(1.51)	(2.40)	(1.30)
R^2	0.2304	0.2365	0.2385	0.2472
Observations	92	92	92	92
Panel B: Issues Rated A-AAA				
Qtr. Mean TSY20	1.2018	0.4884	1.0229	0.5461
	(0.73)	(0.25)	(0.41)	(0.21)
Qtr. Mean Spread Moodys BBB-AAA 30Y			0.0603	0.0559
			(0.98)	(0.92)
Qtr. Mean Termstructure 10y-6mth			0.0086	0.0081
			(0.27)	(0.25)
Year [2002, . . .) Dummy	0.2922***	0.2999***	0.2555*	0.2630*
	(2.69)	(2.71)	(1.78)	(1.77)
Time Trend		−0.0011		−0.0008
		(0.52)		(0.35)
Constant	0.4897***	0.5996**	0.4472*	0.5253*
	(2.75)	(2.32)	(1.70)	(1.73)
R^2	0.1728	0.1762	0.1840	0.1855
Observations	91	91	91	91

(Continued)

Table IX—*Continued*

	(1)	(2)	(3)	(4)
Panel C: Issues Rated BBB				
Qtr. Mean TSY20	−5.5158	−3.9114	−6.2737	−4.7142
	(1.62)	(1.01)	(1.47)	(1.02)
Qtr. Mean Spread Moodys BBB-AAA 30Y			−0.0409	−0.0295
			(0.48)	(0.35)
Qtr. Mean Termstructure 10y-6mth			0.0128	0.0144
			(0.36)	(0.41)
Year [2002, . . .) Dummy	−0.1259	−0.1431	−0.1599	−0.1841
	(0.56)	(0.65)	(0.60)	(0.70)
Time Trend		0.0025		0.0025
		(0.89)		(0.87)
Constant	1.1914***	0.9405**	1.2885***	1.0313*
	(3.30)	(2.00)	(2.83)	(1.90)
R^2	0.1350	0.1452	0.1375	0.1473
Observations	84	84	84	84

statistically significant coefficients on the post-event dummy variable for the sample consisting of highly rated debt issues, but not on the sample consisting of BBB-rated issues. Additionally, the coefficient estimates for the post-event dummy correspond to an increase of between 25% and 29% (in absolute terms) in the proportion of issues exceeding 30 years relative to issues exceeding 20 years, which is in line with the estimates from Figure 2. Overall, consistent with gap filling, we find that the elimination of 30-year Treasury bonds is associated with an increase in the proportion of long-term bonds with maturities of 30 years or more.

V. Conclusion

In this paper we examine the determinants of long-term debt issues. More specifically, we explain how variation in the supply of long-term Treasury bonds affects the issuance of long-term corporate bonds. Overall, we find that debt issues of 20 years or more are common for highly rated firms. Consistent with gap filling, we find that highly rated firms' issuance of long-term bonds is inversely related to the proportion of outstanding Treasury bonds with maturities of 20 years or more. Moreover, we find little evidence that issuances of shorter-maturity bonds are related to changes in the supply of short- or long-term Treasury bonds. Our evidence is consistent with recent work by KVJ (2012) that suggests a premium is associated with relatively safe long-term bonds that varies with the supply of highly rated long-term bonds. Our results suggest that shifts in the supply of long-term Treasuries impact corporate bond issues in a relatively narrow segment of the term structure.

where the dependent variable is the quarterly fraction of 30-plus to 20-plus-year debt, we find no statistically significant coefficients on the BBB-AAA spread and term premium variables.

Overall, our results suggest that market conditions, and in particular the supply of long-term Treasuries, are important determinants of high-grade issuers' timing of long-term debt issues. Moreover, consistent with agency theories of maturity choice, we find that very long-term unsecured debt issues are a choice available principally to A- or better-rated firms. Finally, we find that changes in the supply of long-term Treasuries are negatively related to the propensity of high-grade firms to borrow.

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Appendix A

Variable List and Descriptions

Variable Label	Description
	Panel A: Deal Characteristics
Bank Debt Dummy	Indicator variable; takes a value of one if a debt issue is bank debt.
Deal Amount	Loan amount if the issue is in Dealscan, and total proceeds raised (incl. overallotment option) if the observation is in SDC. Measured in $mn.
Log(Deal Amount)	Natural logarithm of "Deal Amount."
SDC Call Flag	Indicator variable; takes a value of one if a debt issue is callable according to SDC. Only pertains to observations from SDC.
Years to Final Maturity	Years until final maturity of a debt issue.
	Panel B: Issuer Characteristics
A Rating or Higher	Indicator variable; takes a value of one if the firm has a long-term credit rating by S&P of A− or higher. Measured by the Compustat variable "splticrm."
Ann. Fract. Debt Issued (0,1)Y	Annual amount of debt issued with maturities less than one year, scaled by total annual amount of debt issued. Calculated from our sample of debt issuances.
Ann. Fract. Debt Issued [1,5)Y	Annual amount of debt issued with maturities in [1,5) years, scaled by total annual amount of debt issued. Calculated from our sample of debt issuances.
Ann. Fract. Debt Issued [5,10)Y	Annual amount of debt issued with maturities in [5, 10) years, scaled by total annual amount of debt issued. Calculated from our sample of debt issuances.
Ann. Fract. Debt Issued [10,20)Y	Annual amount of debt issued with maturities in [10, 20) years, scaled by total annual amount of debt issued. Calculated from our sample of debt issuances.
Ann. Fract. Debt Issued [20, . . .)Y	Annual amount of debt issued with maturities of at least 20 years, scaled by total annual amount of debt issued. Calculated from our sample of debt issuances.

(*Continued*)

Variable Label	Description
	Panel B: Issuer Characteristics
Book-Debt Ratio	Book-debt ratio. Measured by the Compustat variables ((dltt+dlc)/at).
Com. Paper Rating Dummy	Indicator variable for the presence of a commercial paper rating. Takes a value of one if the firm has a short-term credit rating by S&P. Measured by the Compustat variable "spsticrm."
Dividend Dummy	Indicator variable; takes a value of one if the firm declared dividends on common stock. Measured by the Compustat variable "dvc."
EBIT to Total Assets	Earnings before interest and taxes, scaled by total assets. Measured by Compustat variables ((ib+xint+txt)/at).
Firm Age	Years from the IPO date (Compustat variable "ipodate") or years from the first date in CRSP if "ipodate" is missing.
Fraction of ST and LT Debt due 1Y	Fraction of debt due within one year to total debt. Measured by Compustat variables ((dlc)/(dlc+dltt)).
Fraction of ST and LT Debt due 2Y	Fraction of debt due within two years to total debt. Measured by Compustat variables ((dlc+dd2)/(dlc+dltt)).
Fraction of ST and LT Debt due 3Y	Fraction of debt due within three years to total debt. Measured by Compustat variables ((dlc+dd2+dd3)/(dlc+dltt)).
Fraction of ST and LT Debt due 4Y	Fraction of debt due within four years to total debt. Measured by Compustat variables ((dlc+dd2+dd3+dd4)/(dlc+dltt)).
Fraction of ST and LT Debt due 5Y	Fraction of debt due within five years to total debt. Measured by Compustat variables ((dlc+dd2+dd3+dd4+dd5)/(dlc+dltt)).
Industry FE	Industry fixed effects according to Fama-French industry classification.
IG Rating Dummy	Indicator variable; takes a value of one if the firm has a long-term credit rating by S&P of BBB− or higher or if it has a short-term credit rating by S&P of A-3 or higher. Measured by the Compustat variables "splticrm" and "spsticrm."
Log(MV of Equity)	Natural logarithm of "Market Value of Equity."
Log(Sale)	Natural logarithm of "Sales."
Market to Book Ratio	Market-to-book ratio. Measured by Compustat variables ((lt-txditc+prcc_f*csho+preferred)/at). Where "preferred" is measured by "pstkl," "pstkrv," or "pstk."
Market Value of Equity	Market value of equity. Measured by Compustat variables (prcc_f*csho).
Market-Debt Ratio	Market-debt ratio. Measured by the Compustat variables ((dltt+dlc)/(dltt+dlc+prcc_f*csho)).
Past LT Issuer Flag	Indicator variable; takes on a value of one if the firm issued debt with at least 20 years to maturity in prior years. Calculated from our sample of debt issuances.

(*Continued*)

Variable Label	Description
	Panel B: Issuer Characteristics
PPE to TA	Property, plant, and equipment, scaled by total assets. Measured by Compustat variables (ppent/at).
R&D Missing	Indicator variable; takes a value one if research and development expense in Compustat ("xrd") is missing.
R&D to TA	Research and development expense, scaled by total assets. Measured by Compustat variables (xrd/at) and set to zero if (xrd) missing.
STD EBIT Growth 2DSIC	Industy earnings volatility measure; measured as the annual standard deviation of growth in "EBIT to Total Assets" by two-digit SIC codes.
Value Weighted Asset Maturity	Asset maturity measured as Stohs and Mauer (1996); book-value-weighted average maturity of current assets and long-term assets. Measured by Compustat variables (act/(act+ppent))*(act/cogs)+(ppent/(act+ppent))* (ppent/dp).
Value Weighted Asset Maturity (No Cash)	Same definition as "Value Weighted Asset Maturity" but with cash and short-term investments ("che") subtracted from current assets ("act").
5-Year FE	Time period fixed effects. Time periods: 1987 to 1990, 1991 to 1995, 1996 to 2000, 2001 to 2005, 2006 to 2009.
	Panel C: Market Characteristics
A-Rating x Moodys BBB-AAA30Y Avg. 12m	Interaction term between "A Rating or Higher" and "Moodys BBB-AAA30Y Avg. 12m."
A-Rating x Termstructure 10y-6mth Avg. 12m	Interaction term between "A Rating or Higher" and "Termstructure 10y-6mth Avg. 12m."
A-Rating × TSY20 Avg. 12m	Interaction term between "A Rating or Higher" and "TSY20 Avg. 12m."
Moodys BBB-AAA 30Y	Difference between the percentage yields of Moody's 30-year BBB- and AAA-rated corporate bond indices, measured monthly.
Moodys BBB-AAA30Y Avg. 12m	12-month average of the difference between the percentage yields of Moody's 30-year BBB- and AAA-rated corporate bond indices, measured monthly.
Moodys BBB-AAA 30Y × Bonds	"Moodys BBB-AAA 30Y" interacted with an indicator variable for whether a debt issue is a bond.
Moodys BBB-AAA 30Y × No Call	"Moodys BBB-AAA 30Y" interacted with an indicator variable for whether a debt issue noncallable (as measured by SDC).
SP 10Y Spread BB-BBB	Difference between the percentage yields of S&P Creditweek Corporate Industrial Bond Indices for BB- and BBB-rated bonds.
Termstructure 10y-6mth	Difference between the percentage yields of 10-year and six-month treasury securities, measured monthly.
Termstructure 10y-6mth Avg. 12m	12-month average of the difference between the percentage yields of 10-year and six-month Treasury securities, measured monthly.

(*Continued*)

Variable Label	Description
	Panel C: Market Characteristics
Termstructure 10y-6mth x Bonds	"Termstructure 10y-6mth" interacted with an indicator variable for whether a debt issue is a bond.
Termstructure 10y-6mth x No Call	"Termstructure 10y-6mth" interacted with an indicator variable for whether a debt issue is noncallable (as measured by SDC).
Total Assets	Total assets. Measured by Compustat variable "at."
Total GDP 4Q Growth	Growth in real GDP over the past four quarters (fraction), measured quarterly.
TSY1	Fraction of Treasury debt maturing in over a year, measured monthly.
TSY1 Avg. 12m	12-month average of the fraction of Treasury debt maturing in over a year, measured monthly.
TSY20	Fraction of Treasury debt maturing in over 20 years, measured monthly.
TSY20 Avg. 12m	12-month average of the fraction of Treasury debt maturing in over 20 years, measured monthly.
TSY20 × Bonds	"TSY20" interacted with an indicator variable for whether a debt issue is a bond.
TSY20 × No Call	"TSY20" interacted with an indicator variable for whether a debt issue is noncallable (as measured by SDC).
TSYMAT	Weighted average maturity of Treasury debt.
Qtr. Mean Moodys BBB-AAA 30Y	Quarterly average of "Moodys BBB-AAA 30Y."
Qtr. Mean Termstructure 10y-6mth	Quarterly average of "Termstructure 10y-6mth."
Qtr. Mean TSY20	Quarterly average of "TSY20."

REFERENCES

Ahrend, Rudiger, Pietro A. Catte, and Robert Price, 2006, Factors behind low long-term interest rates, OECD Working paper No. 2006/18.

Baker, Malcolm, Robin Greenwood, and Jeffrey Wurgler, 2003, The maturity of debt issues and predictable variation in bond returns, *Journal of Financial Economics* 70, 261–291.

Baker, Malcolm, and Jeffrey Wurgler, 2002, Market timing and capital structure, *Journal of Finance* 57, 1–32.

Barclay, Michael J., and Clifford W. J. Smith, 1995, The maturity structure of corporate debt, *Journal of Finance* 50, 609–631.

Cameron, Collin A., and Pravin K. Trivedi, 2005, *Microeconomics: Methods and Applications* (Cambridge University Press, New York).

Campbell, John Y., Andrew W. Lo, and A. C. MacKinlay, 1997, *The Econometrics of Financial Markets* (Princeton University Press, Princeton, NJ).

Chava, Sudheer, and Michael R. Roberts, 2008, How does financing impact investment? The role of debt covenants, *Journal of Finance* 63, 2085–2121.

Copeland, Adam, Antoine Martin, and Michael Walker, 2010, The tri-party repo market before the 2010 reforms, *Staff Report,* Federal Reserve Bank of New York. available at https://www.newyorkfed.org/medialibrary/media/research/staff_reports/sr477.pdf.

Diamond, Douglas W., 1991, Debt maturity structure and liquidity risk, *Quarterly Journal of Economics* 106, 709–737.

Graham, John R., Mark T. Leary, and Michael R. Roberts, 2014, How does government borrowing affect corporate financing and investment? NBER Working paper.

Graham, John R., Mark T. Leary, and Michael R. Roberts, 2015, A century of capital structure: The leveraging of corporate America, *Journal of Financial Economics* 118, 658–683.

Greenwood, Robin, Samuel Hanson, and Jeremy C. Stein, 2010, A gap-filling theory of corporate debt maturity choice, *Journal of Finance* 65, 993–1028.

Greenwood, Robin, and Dimitry Vayanos, 2008, Bond supply and excess bond returns, NBER Working paper.

Greenwood, Robin, and Dimitry Vayanos, 2010, Price pressure in the government bond market, *American Economic Review* 100, 585–590.

Gromb, Denis, and Dimitry Vayanos, 2010, Limits of arbitrage, *Annual Review of Financial Economics* 2, 251–275.

Guedes, Jose, and Tim C. Opler, 1996, The determinants of the maturity of corporate debt issues, *Journal of Finance* 51, 1809–1833.

He, Zhiguo, and Wei Xiong, 2012, Rollover risk and credit risk, *Journal of Finance* 67, 391–430.

Krishnamurthy, Arvind, 2010, How debt markets have malfunctioned in the crisis, *Journal of Economic Perspectives* 24, 3–28.

Krishnamurthy, Arvind, and Annette Vissing-Jorgensen, 2011, The effects of quantitative easing on interest rates: Channels and implications for policy, *Brookings Papers on Economic Activity*, Fall, 215–287.

Krishnamurthy, Arvind, and Annette Vissing-Jorgensen, 2012, The aggregate demand for Treasury debt, *Journal of Political Economy* 120, 233–267.

Leary, Mark T., and Michael R. Roberts, 2005, Do firms rebalance their capital structure? *Journal of Finance* 60, 2575–2619.

Lemmon, Michael L., Michael R. Roberts, and Jaime F. Zender, 2008, Back to the beginning: Persistence and the cross-section of corporate capital structure, *Journal of Finance* 63, 1575–1608.

Myers, Stewart C., 1977, Determinants of corporate borrowing, *Journal of Financial Economics* 5, 147–175.

Stohs, Mark H., and David C. Mauer, 1996, The determinants of corporate debt maturity structure, *Journal of Business* 69, 279–312.

Swanson, Eric T., 2011, Let's twist again: A high-frequency event-study analysis of Operation Twist and its implications for QE2, *Brookings Papers on Economic Activity*, spring, 151–207.

Vayanos, Dimitry, and Jean-Luc Vila, 2009, A preferred-habitat model of the term structure of interest rates, NBER Working paper.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Appendix S1: Internet Appendix.