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The supply-side effect on the use of debt with very short and very long maturities

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Abstract

We find that the pre-documented factors influence debt maturity contingent upon credit accessibility and economic conditions. Firms reliant on bank loans avoid employing short-maturity debts even though they face severe information and agency problems. By contrast, firms with sufficient access use very short debt maturities to mitigate agency issues. When credit condition deteriorates, the former has no choice but borrow at the very short end of the maturity spectrum, whereas the latter evades refinancing risk more readily by borrowing at the end. Taken together, these findings indicate a vital role of capital supply in determining debt maturity.

Introduction

A recent paper of Badoer and James (2015) highlights the fact that although the average debt maturities of U.S. firms are about five years, a substantial number of firms issue very long-term bonds with maturities of more than 20 years. On the other hand, Custȯdio *et al.* (2013) documents a downward trend in debt maturities of U.S. firms over the last three decades. Especially, we show that one out of ten U.S. non-financial non-utility firms during the period 1986-2014 adopts extremely short debt maturity policies, with their assets totally financed by short-term debt maturing in one year. Which economic forces do firms take more seriously or which constraints are more binding when firms decide about different maturity levels of debts? Financial literature has identified a group of factors that are associated with corporate debt maturity decisions, accounting for relevant financial frictions faced by firms such as agency conflicts, asymmetric information, credit risk and taxation. However, the implications of most research, if not all, are drawn for the typical/average firm. How conclusive is the existing evidence for those who adopt very short and very long maturities of corporate borrowings?

The existing evidence points to the supply-side effect characterized by severe information asymmetry or/and credit rationing in driving short debt maturities. For example, Custȯdio *et al.* (2013) own the debt maturity shortening phenomenon to the booming new listings in the 1980s and the 1990s, representing a group of small firms suffering from high information asymmetry. Sufi (2007) finds that the shortening of debt maturities is due to the growth of the syndicated loan market. The arrangement of a syndicated debt shares the risk across multiple creditors, leading to a shorter maturity. Based on an equilibrium model of bank runs (i.e., the dynamic coordination among multiple creditors concerning the decisions of debt rollovers and liquidations), Brunnermeier and Oehmke (2013) derive that short debt maturity is a result of maturity rat race among multiple banks, which is eventually

inefficient. A borrower who cannot commit to an aggregate maturity structure has an incentive to shorten the maturity of an individual creditor's loan for it dilutes the value of the remaining creditors, which make all the creditors shorten maturity dates of their contacts in equilibrium.
As is well documented in the literature, shifting credit conditions impact the supply of capital in an important way. Despite its ability to dictate corporate finance and investment decisions, supply effects have received less attention. To fill the void, we investigate two major supply-driven forces in debt maturity decisions: credit access and changes in economic cycles. We address the question of whether these forces play a role in moderating the effects of previously identified factors along the maturity spectrum. Specifically, we examine the supply-side effects by i) comparing firms with and without credit access; ii) examining how economic recessions, which frequently results in credit rationing, affect debt maturity determination.

Overall, our analyses suggest the vital role of capital supply in affecting debt maturity choices of firms. There are substantial differences between firms using bank loans and those using public debts in terms of dealing with supply-side constraint. Tight credit supply makes debt maturity choices of the former firms become passive, whereas firms with access to public credits are likely to hedge from liquidity risk in a more active manner. Especially, we show that firms reliant on bank loans are more likely to have their debt maturities shortened when their assets become volatile, while firms with flexible credit access tend to issue more long-term debt in the similar situation. Further evidence suggests that refinancing risk is a secondary concern for firms with flexible credit access, who deal with incentive provision actively by employing exclusively short-term debts.
Our paper fits well into the line of literature which emphasizes the significance of credit access in influencing firms' financial decisions (Faulkender and Petersen, 2006; Rauh and Sufi, 2010; Sufi, 2007; Sufi, 2009). Also, our results in terms of the effect attenuation in the conventional factors at the lower debt maturity quantiles corroborate the recent research Brunnermeier and Oehmke (2013) which derives that short debt maturities of firms are results of bank runs and that the observed debt maturity structure does not necessarily reflect the real intentions of firms.

II. Related Literature

Graham and Leary (2011) underline the non-monotonic effects of conventional financial structure determinants. "A given market friction may be a first-order concern for some type of firms, but of little relevance to others". Distinct risk structures are likely to be embedded across the debt maturity distribution. Existing studies have estimated the average (mean) effects of debt maturity factors combining inherently the magnitudes of effects upon various parts of the debt maturity distribution. We believe that this kind of analyses is likely to overlook important implications in the factors which have heterogeneous impacts along the maturity spectrum.

To mitigate the incentive provisions, firms match the maturities of assets with those of debts or finance the assets-in-place with debts maturing before the growth options will be exercised (Myers, 1977). Reputable big firms with close firm-bank ties are less likely to be severely affected by asset substitution, thus able to obtain more long-term loans. Short-term debt is less sensitive to information asymmetry as it provides lenders with the possibility of frequently updating a firm's credit information. Therefore, high quality firms will issue short-term debts in order to send favorable signals. Low quality firms have no choice but to borrow at the short-end of the maturity spectrum due to the fact that they are screened out of the long-term debt market. As a result, only medium-quality firms employ long-term debts in equilibrium.

From the liquidity risk perspective, high debt burdens bring firms to favor long-term debts for the sake of hedging against liquidity risk, while large cash reserves allow firms to use more short-term debts as firms are able to pay down maturing debts with reserved cash without tapping capital markets when debt market deteriorates (Harford *et al.*, 2014). Faulkender and Petersen (2006), Sufi (2007) and Sufi (2009) maintain that firms with access to the public credit market have tendency to use more public debts. Due to the fact that the maturities of public debts are generally longer than those of bank loans, debts issued by firms with access to public credit should have relatively longer maturities than their counterparts. Moreover, firms with commercial paper programs would have an inclination towards short-term debts. Furthermore, market conditions model establishes that for the purpose of seizing opportunity windows of favorable financing conditions, firms issue short-term debts "when short-term interest rates are low compared to long-term interest rates".

The existing evidence is, however, far from conclusive. Researchers disagree over basis facts and we believe that the inconsistencies stem from the fact that the relationship between debt maturity and the previously identified factors are heterogeneous along the maturity spectrum and contingent upon the supply-side effect, suggesting the importance of debt fund availability to financing decisions.

In a world without supply constraint, as assumed in the previous papers, a firm who finances a large portion of their assets with short-term debts should be much more concerned about the agency or information issues, while a firm who finances a large portion of their assets with long-term debts should be much more concerned about the liquidity issue (Myers, 1977; Flannery, 1986; Diamond, 1991; Diamond, 1993). It implies that the predicted direct effects of firm age, size, asset maturity, leverage and long-term public credit access as predicted by classical models should increase along the debt maturity spectrum, while the inverse impacts of growth option, asset volatility, future abnormal earnings, term structure, and short-term public credit access should decrease along with the debt maturity level.

In reality, channels between the capital suppliers and the corporate capital users are not perfectly competitive, which leads to effect contingency of financial frictions. As an example, researchers usually model the average effect of growth options as a negative function of debt maturity. If agency problems are prevalent in all situations, there is a reason to believe that the negative effect of growth option is substantially higher at the lower debt maturity percentiles than on average or at median. Yet, it is also likely that the negative effect of growth option is attenuated in the lower part of the debt maturity distribution if the refinancing cost, dominates over the agency cost, most probably for constrained firms. Truly, Leland and Toft (1996) infer that firms with more growth opportunities do not necessarily employ short term debt, since in most cases they have not only greater operating risk but also higher bankruptcy costs. The effect of asset volatility is also contingent upon fund availability. For hedging purpose, firms tend to issue more long-term debts when facing high asset volatility. Yet the increasing liquidity risk may impede creditors' willingness in granting more long-term funds (Kane *et al.*, 1985; DeMarzo and Sannikov, 2006). From firms' perspective, high rollover risk is also likely to slow down firms' incentives to issue short-term debts despite the fact that they may face severe agency problems. Taken together, it points to a supply-side effect.

Firms heavily reliant on short-term debts are likely to have more complications. Especially, it is likely that the refinancing risk outweigh or/and intensify the other frictions such as agency dilemma in short debt maturity firms. Long debt maturity firms can be considered as the opposite to short debt maturity firms in terms of refinancing risk exposure. Intuitively, firms with low refinancing needs should show stronger incentives of borrowing at lower rates through "cheap" commercial paper and/or revolving credit programs.

In this paper, we investigate three drivers of supply effects: credit access, financial constraint and economics conditions.

Firstly, there are essential differences between bank loans and public debt in terms of the exposure to supply-side constraint. Firms borrowing from banks and other private financial institutions are more likely to be strictly monitored and suffer enormously from lending barriers if the credit deteriorates (Faulkender and Petersen, 2006; Sufi, 2007; Sufi, 2009). Firms heavily reliant on bank loans are supposed to be affected by credit rationing more than firms who have flexible access to both bank and public credits.

Secondly, constrained firms are more likely to face difficulties in raising funds for their operations and they may not be able to borrow as much and as long as they want (Faulkender and Petersen, 2006). That is, the observed debt maturity structure may not reflect the actual needs of firms but a result of passive choice. The expected pattern of a debt maturity factor may alter if firms face supply constraint from their creditors or from the separation of credit markets, therefore make decisions in a passive or indifferent manner.

Lastly, shocks in an economy make financial frictions more binding (Almeida *et al.*, 2009; Gomes *et al.*, 2006; Campello and Chen, 2010). During recessions, the fundamental threshold of a firm's default probability increases, resulting in higher credit risk and higher cost of information asymmetry (Korajczyk and Levy, 2003; Hackbarth *et al.*, 2006; Levy and Hennessy, 2007; Bhamra *et al.*, 2010).

III. Methodology and Data

Methodology

To achieve our purpose, we refer ourselves to the quantile regression technique (hereafter QR) developed by Koenker and Bassett (1978). For comparison purpose, OLS regression results are also presented in the preliminary test.

The most promising feature for QR is that it provides a more complete picture of relationship, which sets it apart from the conventional OLS method. An alternative is the threshold-crossing approach. Although instructive, this approach is suspicious to "selection bias" as it pre-sets unconditional thresholds, whereas QR investigates the conditional quantiles. In this regard, the QR approach suits our research context better. Further, as we investigate a panel of firm-year observations, a related concern is the possible time-series residual dependence. In other words, debt maturities of a given firm can be correlated across time due to unobservable firm-level fixed effect. Given this specificity, we estimate Machado and Silva (2013) asymptotically valid standard errors under heteroscedasticity and intra-cluster correlation.

We investigate a set of previously identified factors influencing corporate debt maturity choices, including firm size, age, leverage, asset maturity, growth options, future abnormal earnings, asset volatility, credit access, cash holdings and the term structure of interest rate (all defined in Table 1). Examples of empirical papers on debt maturity determination are (Mitchell, 1993; Barclay and Smith, 1995; Guedes and Opler, 1996; Stohs and Mauer, 1996; Barclay *et al.*, 2003; Johnson, 2003; Datta *et al.*, 2005; Billett *et al.*, 2007; Brockman *et al.*, 2010; Custȯdio *et al.*, 2013). All the explanatory variables are lagged one period allowing for delays in firms' financing decisions. The only exception is firms' future abnormal earnings, on the grounds that it proxies for managerial anticipation for future prospect rather than past return.

To measure debt maturity, we construct a value weighted debt maturity structure in the spirit of Stohs and Mauer (1996), as illustrated in the formula below.

$$DMAT=\sum_{i=1}^{5}\frac{Debt_i}{Tdebt}\times Duration_i+\frac{\left(T\,debt-\sum_{i=1}^{5}Debt_i\right)}{Tdebt}\times Duration_r$$

Where DMAT represents the value weighted average debt maturity structure of a firm. $Debt_i$ represents the amount of financial debts payable in year i for i≤5. Tdebt refers to the amount of total financial debt, which is calculated as the sum of total long-term debts and debts in current liabilities. We exclude operating and miscellaneous liabilities. To calculate duration, we follow Jun and Jen (2003) and Chen et al. (2012) to assume the average durations of a firm's debts payable in year 1,2,3,4,5 (denoted by $Debt_1$, $Debt_2$, $Debt_3$, $Debt_4$, $Debt_5$) of 0.5, 1.5, 2.5, 3.5 and 4.5 years respectively, denoted by $Duration_i$ for i ≤5. For the rest of debts, we assign them an average duration of 10 years, denoted by $Duration_r$.

A further concern is that debt maturity decisions are potentially endogenously determined with leverage decisions. We therefore employ the two-stage instrumental variable quantile regression, where predicted leverage is incorporated instead of actual leverage ratio. As Johnson (2003), the variables used to predict book leverage are tangibility, profitability, firm size, asset volatility, abnormal earnings, a dummy variable for net operating loss carry forwards and a dummy variable for investment tax credits.

The ultimate specification to estimate is as follows,

$$\begin{aligned}Q_\theta\left(DMAT_{i,t}\middle|X_{i,t-1}\right)\\ &=\alpha_\theta+\beta_{1\theta}NYP_{i,t-1}+\beta_{2\theta}AGE_{i,t-1}+\beta_{3\theta}LEV\left(Predicted\right)_{i,t-1}\\ &+\beta_{4\theta}AMAT_{i,t-1}+\beta_{5\theta}MTB_{i,t-1}+\beta_{6\theta}R\&D_{i,t-1}+\beta_{7\theta}ABNEARN_{i,t}\\ &+\beta_{8\theta}VOLAT_{i,t-1}+\beta_{9\theta}ACCESS_{Li,t-1}+\beta_{10\theta}ACCESS_{Si,t-1}\\ &+\beta_{11\theta}CASH_{i,t-1}+\beta_{12\theta}TERM_{i,t-1}+\varepsilon_{i,t}\, i=1,\ldots,n;t=1,\ldots,T\end{aligned}$$

Specifically, we test the null versus alternative hypotheses as follows

$$H_0:\beta_{l_1}=\beta_{l_2}=\beta_{l_3}=\ldots=\beta_{l_n}\quad\text{versus}\quad H_A:\beta_{l_1}\neq\beta_{l_2}\neq\beta_{l_3}\neq\ldots\neq\beta_{l_n}$$

Our main purpose is to see if the heterogeneous effects can be explained by supply effects. To do so, we subsequently i) check the coefficients illustrated in (3) for firms with and without credit access; ii) examine the role of financial constraint in low and high debt maturity quantiles; iii) check how conventional debt maturity determinants affect debt maturity changes following an economic recession.

Data

Our sample is drawn from CRSP and Compustat for the period from 1986 to 2014. Market-specific information is acquired from the Federal Reserve Bank of St. Louis database. Similar to other debt maturity studies, we confine our sample to U.S. publicly traded non-financial non-utility firms. Precisely, we exclude financial and utility firms with primary Standard Industrial Classification codes 6000-6999 and 4900-4999.

To avoid noisy findings due to the existence of non-U.S. based firms in the sample, we eliminate firms which are listed on U.S. stock exchanges but incorporate and operate in other countries.

To concentrate on firms' debt maturity decisions, we discard firm-year observations with zero debt outstanding and observations with incomplete debt maturity information. Further, we remove observations where leverage values are inferior to 0 or superior to 1. Note that quantile regression is robust to extreme points in the response variable rather than in the covariates. We thereby winsorize all the explanatory variables at the 1^{st} and 99^{th} percentiles.

The final sample is comprised of 7885 firms with 50191 firm-year observations. The panel is unbalanced and not all firms are present in all the observation years.

Variables	Abbreviation	Expected Sign	Measurement
Size	NYP	+	Relative Size = the percentage of NYSE firms that have the same or smaller market capitalization
Age	AGE	+	Listing Age = the number of years and months elapsed since a firm's first CRSP listing date
Leverage	LEV	+	Book Leverage = the ratio of a firm's total debt outstanding to the book value of total assets
Asset Maturity	AMAT	+	Weighted Average Maturity of Assets = (current assets ÷ total book assets) × (current assets ÷ cost of goods sold) + (net property plant and equipment ÷ total book assets) × (net property plant and equipment ÷ depreciation and amortization)
Growth Option	MTB	-	Market-to-Book Ratio = (book value of total assets – book value of common equity + market value of common equity) ÷ book value of total assets
	R&D	-	R&D Ratio = the ratio of a firm's R&D expenses to the book value of total assets
Abnormal Earnings	ABNEARN	-	Future Abnormal Earnings = the difference of the income before extraordinary items adjusted for common stock and equivalent between year t+1 and t divided by market capitalization in calendar year t
Volatility	VOLAT	-	Relative Asset Volatility = asset volatility of a firm - asset volatility of the industry = monthly stock return standard deviation during a firm's fiscal year × (market value of common equity ÷ market value of total assets) – median (asset volatilities of firms in the industry)
Credit Access	ACCESS_L	+	Long-term Public Credit Market Access = a dummy variable which takes a value of one if Standard and Poor's domestic long-term issuer rating is available and 0 otherwise
	ACCESS_S	-	Short-term Public Debt Market Access = a dummy variable which takes a value of one if Standard and Poor's domestic short-term issuer rating is available and 0 otherwise
Cash	CASH	-	Cash Holdings = The ratio of a firm's cash and short-term investment to total assets
Term Structure	TERM	-	Yield Spread between Long- and Short-term Debt = the difference of month-end yields on 10-year U.S. treasury bond and 3-month U.S. treasury bill, averaged over a firm's fiscal year period

Table 1: Variable definitions.

Table 2 reports the descriptive statistics of debt maturity structure and firm characteristics measured as of the fiscal year end. Similar to previous studies (Billett *et al.*, 2007; Custódio *et al.*, 2013; Chen *et al.*, 2012), the average firm of our sample has 72% of total debts maturing in more than one year, 48% of total debts maturing in more than three years, and 31% of total debts maturing in more than five years. For our weighted average debt maturity measure, the mean value is 4.37 years. Further, the standard deviation and inter-quartile range suggest substantial cross-sectional variation in debt maturities of U.S. firms. It's worth noting that the 90th percentile of DMAT is roughly 14 times the 10th percentile, indicating the significant debt maturity disparity between firms. Similarly, summary statistics for key firm features show no divergence against previous literature.

Variable	Mean	STD	P10	P25	Median	P75	P90
Proportion of debts with maturities of more than							
1 Year	0.72	0.32	0.06	0.57	0.86	0.96	1.00
2 Years	0.59	0.35	0.00	0.31	0.70	0.89	0.98
3 Years	0.48	0.35	0.00	0.12	0.53	0.79	0.95
4 Years	0.39	0.33	0.00	0.03	0.37	0.68	0.88
5 Years	0.31	0.31	0.00	0.00	0.22	0.54	0.79
DMAT	4.37	2.78	0.62	1.96	4.11	6.58	8.39
NYP	35.41	32.02	0.65	4.19	27.60	62.55	85.52
AGE	17.34	16.17	2.67	5.58	12.63	23.67	38.00
LEV	0.27	0.19	0.03	0.12	0.25	0.38	0.52
LEV (Predicted)	0.26	0.07	0.19	0.22	0.26	0.31	0.35
AMAT	4.63	5.44	1.06	1.74	2.95	5.38	9.75
MTB	1.74	1.34	0.89	1.07	1.36	1.90	2.89
R&D	0.03	0.08	0.00	0.00	0.00	0.03	0.10
ABNEARN	0.18	6.48	-0.74	-0.06	0.00	0.10	1.03
VOLAT	0.00	0.06	-0.05	-0.03	-0.01	0.02	0.06
ACCESS_L	0.33	0.47	0.00	0.00	0.00	1.00	1.00
ACCESS_S	0.11	0.32	0.00	0.00	0.00	0.00	1.00
CASH	0.13	0.16	0.01	0.02	0.06	0.17	0.33
TERM	1.85	1.01	0.39	1.06	1.80	2.83	3.08

Table 2: Descriptive statistics.

Note: This table documents descriptive statistics of long-term debt proportion (one through five years), weighted average debt maturity structure (DMAT), size (NYP), age (AGE), book leverage (LEV), the predicted book leverage (LEV_Predicted), asset maturity (AMAT), market-to-book ratio (MTB), R&D ratio (R&D), abnormal earnings (ABNEARN), volatility (VOLAT), long-term public credit access (ACCESS_L), short-term public credit access (ACCESS_S), cash holdings (CASH) and term structure of interest rate (TERM). The sample consists of 7885 U.S. listed & based non-financial non-utility firms in the CRSP and Compustat Merged database over the period 1986-2014. The weighted average debt maturity structure is calculated according to the Formula (1). Other variables are defined in Table 1 and are winsorized at the 1^{st} and 99^{th} percentiles.

IV. Empirical Results

Effects of conventional factors along the maturity spectrum

Table 3 reports the baseline regression results. To avoid drawing biased inferences due to mechanical reversion (Shyam-Sunder and Myers, 1999; Chang and Dasgupta, 2009), we interpret our results mainly based on the 25th (for short debt maturity) and the 75th quantiles (for long debt maturity). Then to check whether coefficient estimates between quantiles are different in statistical terms, we report in Panel B, Table 3 the interquantile regression results.

Regularities emerge from the OLS results. Specifically, debt maturity is found positively associated with firm size, leverage, asset maturity, long-term public credit access, cash holdings, and negatively associated with market-to-book ratio, R&D ratio, asset volatility, short-term public credit access and the term structure of interest rate.

However, the quantile regressions indicate significant heterogeneous effects along the spectrum of the debt maturity distribution. Notably, the estimated coefficients differ in size, significance and even in sign. There is a prominent pattern of effect attenuation at the two ends of the debt maturity distribution for leverage, size, asset maturity and long-term public debt access. The debt maturities of firms with long-term public credit access are 2.46 years longer than those of firms without long-term public credit access at the 50th quantile. Yet at the 10th and 90th quantiles, the disparities are only 1.80 and 1.74 years. In line with the agency, information asymmetry and market condition hypotheses, we find negative coefficients for R&D ratio, asset volatility, short-term public debt access and term structure of interest rates at all the quantiles. But the effect appears less remarkable at the lower tail. For instance, the effect of short-term public credit access is considerably smaller in the left tail of the distribution than in the right tail, suggesting weaker incentives of firms to cut down long-term debt usage when refinancing frequencies are high. OLS estimator suggests negligible effect of firm age on debt maturity. Yet, the quantile regression results show that age positively affect debt maturity at the lower part of the distribution. It is further confirmed by the interquantile regression results that the impact of firm age varies in a distinctive manner along the debt maturity spectrum. For instance, the difference of AGE's estimates between the 25th-50th quantiles is positive (0.002) and significantly different from zero. Yet, the difference turns negative (-0.005, -0.007) between the 75th-50th and the 90th-50th quantiles. Previous studies (Harford *et al.*, 2014) argue that firms with large cash holdings are relatively low in refinancing risk, therefore able to use more debts with short maturities. Our results show consistent evidence in the significantly negative estimates for cash at the lower quantiles (10th and 25th). Yet, at the longer debt maturity quantiles, the estimates for cash change signs. Specifically, a one-unite change of cash holdings shortens debt maturity by 0.53 years at the 25th percentile while lengthens debt maturity by 3.27 years at the 90th percentile.

To conclude, the above results exhibit significant disparities of the conventional determinants across the debt maturity distribution. It implies that another economic force, most probably the potential supply-side effect, is taking place, especially at the two ends of the maturity distribution. In the following sections, we investigate two drivers of supply effects, that is, credit access and economics conditions.

	Panel A: OLS & Quantile Regression											
	OLS		10th Quantile		25th Quantile		50th Quantile		75th Quantile		90th Quantile	
	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.
Intercept	2.26***	0.09	0.05	0.05	0.28***	0.07	1.44***	0.10	3.73***	0.16	6.79***	0.20
NYP	0.02***	0.00	0.01***	0.00	0.01***	0.00	0.02***	0.00	0.02***	0.00	0.01***	0.00
AGE	0.003	0.00	0.003*	0.00	0.005**	0.00	0.003	0.00	-0.002	0.00	-0.004*	0.00
LEV(Predicted)	4.04***	0.29	2.65***	0.20	4.31***	0.27	4.82***	0.31	3.83***	0.48	0.68	0.59
AMAT	0.04***	0.01	0.02***	0.01	0.04***	0.01	0.06***	0.01	0.05***	0.01	0.04***	0.01
MTB	-0.08***	0.02	-0.06***	0.01	-0.09***	0.01	-0.08***	0.01	-0.07**	0.03	-0.02	0.05
R&D	-2.54***	0.33	-0.12	0.10	-0.60***	0.16	-2.30***	0.24	-5.42***	0.50	-3.17***	0.76
ABNEARN	-0.002	0.00	0.000	0.00	-0.002*	0.00	-0.005***	0.00	-0.006**	0.00	0.008***	0.00
VOLAT	-2.14***	0.32	-0.16	0.15	-0.96***	0.23	-2.69***	0.34	-3.64***	0.66	-2.72***	0.75
ACCESS_L	2.02***	0.06	1.80***	0.07	2.23***	0.07	2.46***	0.09	2.29***	0.09	1.74***	0.08
ACCESS_S	-0.98***	0.09	-0.31**	0.13	-0.69***	0.11	-1.06***	0.10	-1.23***	0.11	-1.16***	0.11
CASH	0.54***	0.18	-0.53***	0.08	-0.81***	0.11	-0.27	0.19	2.50***	0.32	3.27***	0.26
TERM	-0.04***	0.01	-0.01*	0.01	-0.01	0.01	-0.03**	0.01	-0.06***	0.02	-0.08***	0.02
R^2	0.25		0.23		0.24		0.24		0.23		0.18	

Table 3: The Effects of Debt Maturity Determinants across the Maturity Spectrum.

Panel B: Interquantile Regression												
	10th-50th		25th-50th		10th-25th		90th-50th		75th-50th		90th-75th	
	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.
Intercept	-1.39***	0.06	-1.16***	0.07	-0.23***	0.04	5.35***	0.15	2.28***	0.08	3.07***	0.11
NYP	-0.01***	0.00	-0.003***	0.00	-0.01***	0.00	-0.01***	0.00	-0.003***	0.00	-0.01***	0.00
AGE	0.001	0.00	0.002**	0.00	-0.001	0.00	-0.007***	0.00	-0.005***	0.00	-0.002*	0.00
LEV(Predicted)	-2.17***	0.20	-0.51***	0.20	-1.67***	0.19	-4.14***	0.43	-0.99***	0.26	-3.15***	0.38
AMAT	-0.04***	0.00	-0.02***	0.00	-0.02***	0.00	-0.02***	0.00	-0.005**	0.00	-0.02***	0.00
MTB	0.02*	0.01	-0.01	0.01	0.03***	0.01	0.06**	0.03	0.02	0.02	0.05***	0.02
R&D	2.17***	0.10	1.70***	0.09	0.47***	0.09	-0.87*	0.49	-3.13***	0.29	2.25***	0.60
ABNEARN	0.005***	0.00	0.003*	0.00	0.002*	0.00	0.01***	0.00	-0.001	0.00	0.01***	0.00
VOLAT	2.54***	0.27	1.74***	0.15	0.80***	0.11	-0.02	0.45	-0.95**	0.48	0.92**	0.45
ACCESS_L	-0.66***	0.05	-0.23***	0.04	-0.43***	0.04	-0.72***	0.06	-0.17***	0.05	-0.55***	0.06
ACCESS_S	0.75***	0.05	0.38***	0.05	0.37***	0.07	-0.10	0.07	-0.17***	0.04	0.07	0.06
CASH	-0.25**	0.11	-0.54***	0.11	0.29***	0.06	3.54***	0.20	2.78***	0.17	0.77***	0.17
TERM	0.01*	0.01	0.02	0.01	-0.002	0.01	-0.05***	0.02	-0.03**	0.01	-0.03*	0.01

Table 3 continued: The Effects of Debt Maturity Determinants across the Maturity Spectrum

Note: This table documents the OLS results (in the first column of Panel A), the 10^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th} quantile regression results (in the second to the sixth columns of Panel A) and the 10^{th}-50^{th}, 25^{th}-50^{th}, 10^{th}-25^{th},90^{th}-50^{th}, 75^{th}-50^{th}, 75^{th}-25^{th} and 90^{th}-75^{th} interquantile regression results (in Panel B) for the effects of conventional debt maturity determinants. The sample consists of 7885 U.S. listed & based non-financial non-utility firms in the CRSP and Compustat Merged database over the period 1986-2014. The empirical model for the quantile regressions is specified as follows,

$$Q_\theta\left(DMAT_{i,t}\middle|X_{i,t-1}\right) = \alpha_\theta + \beta_{1\theta} NYP_{i,t-1} + \beta_{2\theta} AGE_{i,t-1} + \beta_{3\theta} LEV\left(Predicted\right)_{i,t-1} + \beta_{4\theta} AMAT_{i,t-1} + \beta_{5\theta} MTB_{i,t-1} + \beta_{6\theta} R\&D_{i,t-1} + \beta_{7\theta} ABNEARN_{i,t} + \beta_{8\theta} VOLAT_{i,t-1} + \beta_{9\theta} ACCESS_{Li,t-1} + \beta_{10\theta} ACCESS_{Si,t-1} + \beta_{11\theta} CASH_{i,t-1} + \beta_{12\theta} TERM_{i,t-1} + \varepsilon_{i,t} \qquad i=1,\ldots,n;\, t=1,\ldots,T$$

The weighted average debt maturity structure (DMAT) is calculated according to the Formula (1). Other variables are defined in Table 1 and are winsorized at the 1^{st} and 99^{th} percentiles. Clustered standard errors by firm are reported for OLS& quantile regressions. Interquantile regressions are computed using the bootstrapping method. ***, ** and * show that the coefficient is significantly correlated at 1%, 5% and 10% level respectively.

The Role of Credit Access

Recent research emphasizes that the relevance of financial frictions is contingent upon credit supply. We therefore investigate debt maturity decisions of firms with flexible access to public credits separately from those with limited access in Table 4. The classification is made based on Standard & Poor's long- or short-term bond ratings. Reconciling with Whited (1992) and Faulkender and Petersen (2006), we consider firms who have positive debt outstanding and Standard & Poor's long- or short-term bond ratings as possessing access to public credits. Then we re-estimates equation (2) for each group of firms (without versus with public credit access), by excluding short-term and long-term public credit access.

Notably, a clear distinction between the two types of firms unfolds. On the one hand, our results suggest that firms who have limited credit access strive to protect themselves from liquidity and refinancing problems by borrowing more long-term when they grow and take on more debts and that firms who have sufficient credit access seem indifferent to refinancing risk.

As shown in Table 4, the coefficients of size, asset maturity and leverage are positive and significant for firms reliant on bank loans, and are higher at the right part of the maturity distribution. For firms with public credit access, the estimates are either insignificant or negative at the upper tail. For example, the estimate for asset maturity at the 90^{th} quantiles are marginal (0.01), suggesting severe mismatching between asset and debt maturities.

On the other hand, it implies that firms who are able to borrow from the public market generally treat information and agency frictions more readily relative to firms who exclusively rely on bank credit. Specifically, the regression coefficients of market-to-book, R&D and abnormal earnings at the lower quantiles are much higher for the former firms compared to the latter (-0.24 versus -0.04 at the 10^{th} quantile for MTB, -0.03 versus -5.15 at the 10^{th} quantile for R&D, and -0.002 versus -0.014 at the 25^{th} quantile for ABNEARN).

Another point worth noting is that asset volatility is found positively associated with debt maturity for firms with public access at all the quantiles, and the effect is more prominent at the higher part (the 75^{th} and the 90^{th} quantiles) of the maturity distribution. This result points to the fact that although refinancing risk is typically a secondary concern for firms with flexible credit access, they are likely and able to take actions to hedge high asset volatility by borrowing long-term. By contrast, bank-loan-reliant firms are less likely to borrow long-maturity debts when their assets become volatile (the estimates for VOLAT are all negative). In this sense, the debt maturities of bank-loan-reliant firms are possibly a result of passive choice due to credit constraint. But still, they tend to do their best not to cut down debt maturity dramatically in the short run. Note that the magnitude of the negative coefficients of VOLAT is much lower at the 10^{th} and the 25^{th} quantile.

Above all, the empirical findings in this exercise indicate that firms relying on bank borrowings care more about refinancing risk although sometimes they are impotent when facing asset price shocks. Conversely, firms who are able to borrow from the public market are less likely subject to this constraint. Refinancing need is most probably not a priority for these firms. As a result, they show disinclinations to pursue hedging strategies, as indicated in the attenuated or reversed effects of asset maturity, leverage, and size. Instead, they are likely to deal with incentive provisions more actively by employing exclusively short-term debts.

	Panel A. Firms without Public Access									
	10th Quantile		25th Quantile		50th Quantile		75th Quantile		90th Quantile	
	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.
Intercept	0.22***	0.04	0.26***	0.07	0.88***	0.11	2.50***	0.18	5.31***	0.28
NYP	0.01***	0.00	0.02***	0.00	0.03***	0.00	0.03***	0.00	0.03***	0.00
AGE	0.000	0.00	0.005*	0.00	0.013***	0.00	0.010**	0.00	0.007	0.01
LEV (Predicted)	1.83***	0.17	4.22***	0.24	5.61***	0.33	6.29***	0.52	3.45***	0.81
AMAT	0.01**	0.00	0.03***	0.01	0.06***	0.01	0.08***	0.01	0.06***	0.01
MTB	-0.04***	0.01	-0.08***	0.01	-0.08***	0.02	-0.09***	0.03	-0.08***	0.03
R&D	-0.03	0.06	-0.35**	0.14	-1.32***	0.25	-3.43***	0.52	-2.04**	0.99
ABNEARN	0.000	0.00	-0.002	0.00	-0.002	0.00	-0.004*	0.00	0.008*	0.00
VOLAT	-0.32***	0.09	-1.24***	0.19	-2.25***	0.31	-3.78***	0.51	-3.71***	0.83
CASH	-0.31***	0.05	-0.76***	0.10	-0.49***	0.18	2.03***	0.36	3.95***	0.28
TERM	-0.01*	0.01	-0.02	0.01	-0.04**	0.02	-0.12***	0.03	-0.15***	0.03

Table 4: The Role of Credit Access (panel A).

	Panel B. Firms with Public Access									
	10th Quantile		25th Quantile		50th Quantile		75th Quantile		90th Quantile	
	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.
Intercept	0.00	0.46	0.00	0.39	2.33	5.35	7.10***	2.41	9.45***	1.07
NYP	0.01***	0.00	0.01***	0.00	-0.00	0.01	-0.02***	0.00	-0.02***	0.00
AGE	0.010***	0.00	0.007***	0.00	0.002	0.00	-0.002	0.00	-0.005**	0.00
LEV (Predicted)	8.26***	1.27	12.31***	1.13	11.71	13.18	3.94	6.06	0.42	2.75
AMAT	0.05***	0.01	0.03***	0.01	0.01	0.04	0.02	0.02	0.01	0.01
MTB	-0.24***	0.06	-0.05	0.08	0.18	0.27	0.18	0.17	0.18*	0.11
R&D	-5.15***	1.45	-7.00***	1.91	-6.12	4.18	-3.70**	1.76	-2.29***	0.76
ABNEARN	-0.010	0.01	-0.014***	0.00	-	0.01	0.000	0.01	0.003	0.01
VOLAT	0.63	1.25	2.09	1.42	2.93	2.02	4.40***	1.25	3.75***	1.04
CASH	-1.14*	0.61	1.14*	0.61	3.13**	1.53	3.28***	0.96	2.69***	0.61
TERM	0.08***	0.03	0.13***	0.03	0.15	0.14	0.11	0.08	0.08**	0.04

Table 4 (Continued): TheRole of Credit Access (panel B).

Note: This table shows the 10th, 25th, 50th, 75th and 90th quantile regression results for firms without public credit access and firms with public credit access separately. Firms with positive debt outstanding while lack of Standard and Poor's long- or short-term bond ratings are considered to have no access to public credit and the remainder is considered to have access to public credit. The empirical model is specified as follows,

$$Q_\theta\left(DMAT_{i,t}\middle|X_{i,t-1}\right) = \alpha_\theta + \beta_{1\theta} NYP_{i,t-1} + \beta_{2\theta} AGE_{i,t-1} + \beta_{3\theta} LEV\left(Predicted\right)_{i,t-1} + \beta_{4\theta} AMAT_{i,t-1} + \beta_{5\theta} MTB_{i,t-1} + \beta_{6\theta} R\&D_{i,t-1} + \beta_{7\theta} ABNEARN_{i,t} + \beta_{8\theta} VOLAT_{i,t-1} + \beta_{9\theta} CASH_{i,t-1} + \beta_{10\theta} TERM_{i,t-1} + \varepsilon_{i,t} \quad i=1,\ldots,n; t=1,\ldots,T$$

The weighted average debt maturity structure (DMAT) is calculated according to the Formula (1). Other variables are defined in Table 1 and are winsorized at the 1st and 99th percentiles. Clustered standard errors by firm are computed. ***, ** and * show that the coefficient is significant at 1%, 5% and 10% level, respectively.

The Impact of Economic Cycles

Shocks in an economy make financial frictions more binding. To examine the impact of business cycles on debt maturity choices of firms, we subsequently check how conventional debt maturity determinants affect debt maturity changes following an economic recession. Specifically, we regress changes in firms' debt maturities the year and one-year after the attack of a NBER recession on the previously investigated factors, along with a dummy variable for high external finance dependence (using the 70% cutoff, denoted by EFD) and the interaction items of this dummy with asset volatility and cash reserves of firms. The term structure of interest rate is excluded. Our rational to include external finance dependence in this analysis instead of alternative financial constraint proxies (e.g. SA index) is that firms highly dependent of external funds are likely to suffer more from a sudden tightening of credit conditions. The quantile regression results are reported in Table 5, for firms with and without public credit access separately.

Our results show that refinancing risk becomes more binding in hard periods, which inclines firms highly dependent of external bank loans towards borrowing both short-term and long-term debts. The intercepts are significantly negative at the lower quantiles and significantly positive at the 75th quantile. These firms strive to borrow long-maturity debts in the short term right after a recession (the estimate for External Finance Dependence is positive and significant at the 50th quantile in the regressions for $\Delta DMAT_{i,t,t-1}$), yet fail to do so thereafter (EFD at the 50th quantile is insignificant for $\Delta DMAT_{i,t,t-2}$). Additionally, firms who depended heavily on external finance are more likely to cut down long-term debt usage after the onset of a recession. EFD×VOLAT is significantly negative (-2.23) at the 25th quantile for firms without public credit access. For firms with access to public credit, the maturity shortening occurs more eminently at the median (-5.90 at the 50th Quantile). Keefe and Kieschnick (2011) document that the market value of cash is lower during economic contractions than in economic expansions. We provide relevant evidence in the negative sign of CASH at the 75th quantile for both firms. Note that the estimates for CASH at the higher debt maturity quantiles are positive in the whole sample as shown in the previous analyses. It means that the effect of cash collateral is weakened after a firm suffer a recession.

	Panel A. Firms without Public Access											
	$\Delta\, DMAT_{i,t,t-1}$						$\Delta\, DMAT_{i,t,t-2}$					
	25th Quantile		50th Quantile		75th Quantile		25th Quantile		50th Quantile		75th Quantile	
	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.
Intercept	-0.63***	0.12	-0.11*	0.06	0.28***	0.09	-1.39***	0.24	0.01	0.11	0.95***	0.20
NYP	-0.001*	0.00	-0.000	0.00	0.001	0.00	-0.002	0.00	-0.001	0.00	0.004**	0.00
AGE	-0.003	0.00	-0.003**	0.00	0.00	0.00	0.001	0.00	-0.002	0.00	-0.004	0.01
LEV (Predicted)	-0.30	0.35	-0.17	0.16	0.24	0.28	0.92	0.76	-0.50	0.36	-0.21	0.59
AMAT	-0.01	0.01	-0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.01
MTB	0.00	0.03	0.01	0.01	0.01	0.02	-0.04	0.04	0.02	0.02	-0.01	0.04
R&D	0.15	0.27	-0.11	0.11	-0.43***	0.12	0.89	0.60	-0.55	0.37	-0.94**	0.46
ABNEARN	0.000	0.00	-0.002**	-0.004	0.00***	0.00	0.004	0.01	0.001	0.00	-0.005	0.01
VOLAT	0.20	0.48	-0.13	0.28	-0.14	0.42	2.21**	0.98	0.25	0.42	-0.16	0.95
CASH	-0.08	0.21	-0.07	0.18	-0.55***	0.13	-1.30**	0.58	-0.77**	0.33	-1.45***	0.35
EFD	0.00	0.06	0.13***	0.04	-0.01	0.07	0.22*	0.11	0.10	0.07	-0.11	0.13
EFD×VOLAT	0.12	0.67	0.02	0.35	-0.39	0.49	-2.23**	1.09	-0.53	0.68	-0.41	1.05
EFD×CASH	0.24	0.24	-0.12	0.19	0.28*	0.16	0.27	0.72	0.24	0.42	0.75	0.47

Table 5: The Impact of Economic Cycle.

	Panel B. Firms with Public Access											
	$\Delta DMAT_{i,t,t-1}$						$\Delta DMAT_{i,t,t-2}$					
	25thQuantile		50thQuantile		75thQuantile		25thQuantile		50thQuantile		75thQuantile	
	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.	Est.	Std.Err.
Intercept	0.00	0.24	0.00	0.18	0.00	0.09	-2.83***	0.39	0.63	0.38	3.70***	0.51
NYP	0.006***	0.00	0.002**	0.00	-0.000	0.00	0.016***	0.00	-0.005*	0.00	-0.028***	0.00
AGE	0.002	0.00	0.003**	0.00	0.003	0.00	0.003	0.00	0.002	0.00	-0.002	0.00
LEV (Predicted)	-2.89***	0.71	-0.37	0.54	2.76***	0.68	3.57***	1.08	0.39	1.06	-0.65	1.55
AMAT	0.02***	0.01	-0.01	0.01	-0.03***	0.01	0.00	0.01	-0.01	0.01	-0.02	0.01
MTB	-0.19**	0.09	-0.05	0.04	0.08	0.08	-0.22**	0.10	-0.06	0.06	0.17**	0.08
R&D	0.65	0.87	-0.17	0.79	1.16	1.77	2.01	1.87	1.15	1.47	0.57	2.69
ABNEARN	0.003	0.01	-0.005	0.05	0.046***	0.01	0.038*	0.02	-0.030	0.02	0.001	0.06
VOLAT	-0.28	0.90	-0.03	0.60	1.42	0.98	0.92	1.56	1.50	1.25	4.48**	2.05
CASH	-1.07***	0.30	-0.37	0.28	-1.06***	0.30	-0.30	0.81	-1.05	0.64	-0.55	1.01
EFD	-0.10	0.14	-0.06	0.11	0.24	0.67	0.02	0.24	-0.16	0.20	-0.15	0.20
EFD×VOLAT	-0.92	3.67	-1.69	1.28	2.03	11.04	-5.20	3.22	-5.90*	3.14	-4.52	3.21
EFD×CASH	-0.41	0.90	-0.25	0.77	-1.51	2.40	-0.33	1.86	-0.55	1.19	-1.58	1.32

Table 5 (continued): The Impact of Economic Cycle.

Note: This table shows the 25th, 50th, and 75th quantile regression results for debt maturity changes in hard economic times. Monthly NBER based Recession indicators are used to identify economic condition. Specifically, firms are considered as operating in hard economic times if their fiscal year periods overlap at least one NBER Recession month. The empirical model is specified as follows,

$$Q_\theta\left(\Delta DMAT_{i,t,t-s} \middle| X_{i,t-1}\right) = \alpha_\theta + \beta_{1\theta} NYP_{i,t-s} + \beta_{2\theta} AGE_{i,t-s} + \beta_{3\theta} LEV_{i,t-s} + \beta_{4\theta} AMAT_{i,t-s} + \beta_{5\theta} MTB_{i,t-s} + \beta_{6\theta} R\&D_{i,t-s} + \beta_{7\theta} ABNEARN_{i,t} + \beta_{8\theta} VOLAT_{i,t-s} + \beta_{9\theta} CASH_{i,t-s} + \beta_{10\theta} EFD_{i,t-s} + \beta_{11\theta} EFD \times VOLAT_{i,t-s} + \beta_{12\theta} EFD \times CASH_{i,t-s} + \varepsilon_{i,t} \qquad i=1,\dots,n;\ t=1,\dots,T$$

$\Delta DMAT_{i,t,t-s}$ stands for changes in firms' debt maturity structures s-year after a recession, s=1,2. Results are separately reported for firms with and without public credit access. The weighted average debt maturity structure (DMAT) is calculated according to the Formula (1). Other variables are defined in Table 1 and are winsorized at the 1st and 99th percentiles. Clustered standard errors by firm are computed. ***, ** and * show that the coefficient is significant at 1%, 5% and 10% level respectively.

V. Conclusion

We show that the previously identified factors affect debt maturity choices of the short maturity firms in a different way from the long maturity firms. This pattern is accentuated when we separate the analysis for firms with and without public credit access and further consider the influences of economic cycles. Firms who have limited access to bank-loan market are more concerned about refinancing risk, while firms who have sufficient credit access care more about incentive provisions such as information asymmetry and agency problems. During constrained periods, the former firms have no choice but to borrow at the short debt maturity end, whereas the latter firms are able to take timely actions to lengthen debt maturity for the purpose of mitigating refinancing risk. Furthermore, we provide evidence that cash not only plays a hedging role in alleviating refinancing risk, but also serves as an important form of collateral for long-term debt financing. However, when a firm experiences an economic recession, the value of cash in terms of providing hedging or collateral is likely to decline.

Some issues remain to be investigated. Firm-level shocks like mergers and acquisitions may radically change a firm's debt maturity structure; family firms may hold different debt maturity attitude; and debt characteristics such as callability and covenants would moderate the role of classical frictions in affecting debt maturity. A firm's board and governance structure may also affect the debt maturity structures of firms. Above all, all these aspects could serve as interesting directions for future research. Further, prior research documents that the financing structures of firms, in a dynamic economy, are likely to deviate from their expectation due to the presence of transaction cost (Leland, 1994; Leland, 1998; Fisher *et al.*, 1989; Goldstein *et al.*, 2001; Ju et *al.*, 2003; Strebulaev, 2007). As debt maturity theories are formulated according to the optimal logic, it is possible that the above-mentioned effect attenuation is driven in part by the prevalence of the off-the-optimum observations, especially at extremes. Research taking into account the dynamic properties of debt maturity decisions could therefore have profound implications for understanding the empirical results of the cross sections. Indeed, in the unreported cross-sectional quantile regressions using the time-series mean of each variable by firm, the above attenuation pattern is greatly flattened, particularly in the right tail. To put it another way, once the time-series property is suppressed, the attenuation pattern is likely to disappear.

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