Maturity Walls*

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Abstract

Maturity walls occur when a majority of a firm's debt comes due within a short period (1-2 years), increasing rollover risk. Despite this, 47% of non-financial firms have them. This paper understands why firms adopt maturity walls and its implications for the aggregate economy. Using Mergent FISD data, I provide evidence that firms incur substantial fixed costs in bond issuance. I develop a dynamic model where firms decide each period the level and dispersion of their debt payments. The main trade-off is rollover risk from maturity walls in the presence of costly equity injections, versus the lower issuance costs incurred from infrequent rollovers. I estimate the model to match both aggregate and distributional moments of firms' debt payment schedules. Maturity walls increase credit spreads by 21% (36 bps) and default rates by 25% (30 bps). Lowering issuance costs reduces the adoption of maturity walls, but increases firms credit risk. Moreover, omitting maturity walls could underestimate the transmission of a credit market freeze up to 60%.

Keywords: Maturity Wall, Firm Financing, Capital Structure, Firm Dynamics, Default
JEL: G32, G33, E32, E44

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1 Introduction

Large, infrequent debt payments increase a firm's rollover risk — the risk of being unable to raise enough external funds to cover current liabilities — especially in the face of negative shocks. When a significant portion of corporate debt is due within a short period (typically 1–2 years), these events, known as maturity walls, can expose firms to severe financial stress. Firms that fail to roll over their debt often cut investments, lay off workers, or default on their obligations (Almeida, Campello, Laranjeira, and Weisbenner, 2009; DeFusco, Nathanson, and Reher, 2023; Meeuwis, Papanikolaou, Rothbaum, and Schmidt, 2023). In fact, credit rating agencies take maturity walls seriously when analyzing firms. For instance, on April 2, 2020, Fitch Ratings downgraded Antero Resources, an oil and natural gas company, to "B". In their assessment, they noted:

> Antero Resources has a sizable large *maturity wall* due between 2021 and 2023 ($2.63 billion, starting with its 5.375% 2021 note, of which $953 million remains outstanding). The unsecured bond markets have remained closed to the company . . . which underscores the need to address the [*maturity*] *wall* (emphasis added).

Given that managing rollover risk is a key concern for corporate CFOs (Lins, Servaes, and Tufano, 2010), firms should want to disperse their debt maturities, rolling over smaller amounts more frequently to smooth interest rate risk. However, Antero Resources is not an outlier; maturity walls are a common feature of non-financial firms' capital structures. Using the universe of U.S. corporate bond issuances, I will show that 47 percent of firms have a maturity wall. Why, then, do we see so many firms facing maturity walls?

Existing frameworks in the literature often focus on total leverage or average debt duration when modeling firms' capital structure decisions, which is not suitable for capturing the risk caused by maturity walls. Moreover, little is known about why firms adopt maturity walls even though they are a significant source of risk. In this paper, I suggest fixed issuance cost of debt as the driving force for firms to hold maturity walls. Further, I extend the existing literature by introducing a framework that explicitly captures the timing and concentration of debt payments through maturity walls, providing a deeper understanding of firms' rollover risk. Finally, I use the framework to evaluate the importance of incorporating maturity walls when understanding how an aggregate shock, such as a credit market freeze, transmits to the aggregate economy.

In this paper, I use the standard deviation of weighted maturity dates to define maturity walls. This measure captures the concentration of a firm's debt payments over time. A maturity wall occurs when the standard deviation of weighted debt maturity dates is less than 1 year, meaning that once a firm begins repaying its debt, nearly all of it will be repaid within two years. The presence of maturity walls is indeed strongly correlated with negative outcomes for firms in the data. Firms with maturity walls have higher probabilities of default (97 bps), even after controlling for various firm characteristics. These firms also face higher credit spreads on newly issued bonds (34 bps), suggesting that lenders price in the additional default risk associated with maturity walls. The proposed measure is preferable to others in the literature, such as the Herfindahl index, which sums the squared share of debt due each year, because it captures debt concentration in two critical ways: (i) when a large share of debt is due in a single period and (ii) when debt is maturing over closely spaced periods[1].

To analyze the idiosyncratic and aggregate risks associated with maturity walls, I develop a structural credit risk model where firms jointly choose debt issuance amount and maturity wall adoption. Firms, which can strategically default, borrow debt primarily for the tax benefits. When issuing debt, they can choose between two types of securities that differ only in their repayment schedules: (i) a dispersed schedule or (ii) a concentrated schedule. A bond with a dispersed repayment schedule is similar to one with a sinking fund provision, where the firm makes fractional principal payments each period. In contrast, a bond with a concentrated schedule makes one payment at a random maturity date. This framework provides a tractable way to model firms' choices of payment schedules without needing to track each bond's maturity date, which would be computationally infeasible. When issuing debt, firms face a fixed issuance cost, similar to underwriting fees observed in the data. Additionally, firms incur quadratic costs when issuing equity, which increases the risk of being unable to roll over debt in public markets. Finally, debt is priced by a representative lender who expects to break even. In the event of default, the lender can only recover part of the firm's value, resulting in bankruptcy costs.

The key trade-off firms face when deciding whether to concentrate or disperse their debt payments is between the fixed issuance cost and the risk of costly equity issuance, which represents rollover risk in my framework. All else being equal, firms prefer to concentrate their debt into a few repayment dates to minimize issuance costs, effectively creating a maturity wall. However, if a firm experiences a negative shock when a large portion of its debt is due, it may be forced to raise equity at a high cost to repay its debt.

The model also captures the rich heterogeneity in firms' maturity wall choices observed in

[1]For example, suppose two firms each have \$100 million in debt due in Year 1. Firm A has an additional \$100 million due in Year 2, while Firm B has \$100 million due in Year 20. A measure like the Herfindahl index would treat these firms as having the same concentration of debt because it focuses only on the distribution of debt across periods, not the spacing of those periods. In contrast, the standard deviation of maturity dates accounts for the timing difference: Firm A's debt is concentrated in the near term, while Firm B's is more dispersed over time. This distinction is crucial for understanding rollover risk and default potential.

the data: smaller, younger, more leveraged, and higher revenue firms tend to hold maturity walls more frequently. The fact that smaller and younger firms more often hold maturity walls can be alarming and counterintuitive as they already face higher capital market costs compared to their larger counterparts. However, it is important to note that the decision to adopt a maturity wall is made *jointly* with the firm's leverage choice. When firms have low leverage, the risk of being unable to roll over their debt is minimal, making the cost of repeated issuance outweigh the benefits of dispersing payments. As firms increase their leverage, they shift to dispersed payments because the risk of rolling over concentrated debt grows, driven by the potential need for costly equity injections, while issuance costs remain fixed. This shift helps mitigate default risk, consistent with the data.

I estimate the model using the simulated method of moments (SMM). The model is estimated to match both the aggregate and distributional moments of firms' debt payment schedules, with empirical moments constructed from Mergent FISD and Compustat data. The fixed issuance cost of debt and equity injection cost parameters are estimated to match the average dispersion in maturity dates, average per unit underwriter fee, and the average debt to income ratio. The estimated model aligns well with the observed relationship between maturity walls and firm default risk. For a given level of debt, firms that concentrate their payments in a maturity wall face higher credit spreads and a greater risk of default. Using the estimated model, I address the following key questions.

First, I quantify how much maturity walls contribute to firm default risk and borrowing costs. In equilibrium, maturity walls account for 14% of defaults. However, since maturity walls are an endogenous choice, there is a selection issue: firms with maturity walls are not the same as those without. To address this, I model a counterfactual economy where all firms maintain their baseline borrowing levels but can only issue debt with a concentrated payment schedule. This allows me to generate exogenous variation in firms' debt composition and estimate, within the model, the causal impact of maturity walls on default risk and borrowing costs. I find that firm default rates increase by 25% (30 bps) and credit spreads rise by 21% (36 bps).

Given that maturity walls significantly increase default risk and borrowing costs, I explore whether firms would be less risky in an environment where it is cheaper to issue debt, which would allow firms to disperse their debt payments at a lower cost. Recent studies, such as Manconi, Neretina, and Renneboog (2018), estimate that 16–25% of underwriter fees are due to market power. I examine the effect of eliminating this market power on firm outcomes and value. Surprisingly, I find that firms are *more* risky when it is cheaper for firms to disperse their debt payments compared to the baseline economy. Reducing underwriter market power lowers the cost of debt issuance, prompting firms to spread out their debt maturity dates.

However, firms also respond by borrowing more since for a given level of debt, firms are less risky with dispersed debt payments. Therefore, it is ambiguous whether firms would be more or less risky when it is cheaper to issue debt. Quantitatively, I find that the substitution effect outweighs the direct effect, making firms riskier in an environment where it is cheaper to disperse their debt payments.

Finally, I explore how the presence of maturity walls may amplify aggregate shocks to the economy. Specifically, I consider an unexpected, one-time credit market freeze, during which debt markets shut down completely, preventing new borrowing or early pre-payment of debt. Additionally, the cost of injecting equity rises. Firms with maturity walls are particularly vulnerable during such events, as they face a higher risk of default if they need to roll over their debt while credit markets are frozen.

During a credit market freeze, I find that aggregate defaults increase by 1.68 percentage points from baseline. The presence of maturity walls amplifies this effect, with firms facing a 4 percentage point increase in default rates when they must repay a maturity wall, driving up overall defaults. Additionally, I show that omitting maturity walls, as is done in conventional models, leads to underestimating the impact of a credit market freeze on defaults. For example, a standard model of long-term debt, such as Leland and Toft (1996); Chatterjee and Eyigungor (2012), underestimates default rates by 60%, while a model of average maturity, such as Arellano and Ramanarayanan (2012); He and Milbradt (2016), underestimates the transmission of a credit market freeze to aggregate defaults by 16%.

Literature Review

There is a long tradition in corporate finance of modeling firms' maturity choice. In Leland and Toft (1996), Leland (1998), Diamond and He (2014), DeMarzo and He (2021), and Dangl and Zechner (2021), firms are not allowed to actively adjust the level of borrowing or maturity structure of their debt over time. In Brunnermeier and Oehmke (2013) and He and Milbradt (2016), firms are allowed to dynamically adjust maturity but the total value of debt is fixed. In my paper, firms dynamically choose their optimal maturity structure and level of debt each period.

My paper also relates to models of debt maturity and rollover frictions. He and Xiong (2012) show that short term debt can exacerbate rollover risk and that staggered debt is more susceptible to dynamic runs. Diamond and He (2014) show that maturing short-term debt can create less debt overhang than long-term debt. He and Milbradt (2016) endogenize the feedback between secondary market liquidity and rollover risk. Poor secondary market conditions exacerbate rollover risk in the primary market, making it more likely for firms to default. Chen, Xu, and Yang (2021) study the link between credit spreads, systematic risk, and lumpy maturity structure. Hu, Varas, and Ying (2022) analyze the dynamics of both leverage and average duration of corporate debt. They argue that long-term debt allows borrowers more efficiently to take advantage of the tax shield and offers better hedging against downside risk while short-term debt offers lenders of distressed borrowers protection from dilution and commitment to delever. A common theme in these papers is that long-term debt helps shield the firm from rollover risk. In contrast, my paper argues that long-term debt with concentrated maturity dates can still be potent sources of rollover risk.

Furthermore, my paper is closely associated with an early literature on the dispersion of debt maturity dates. Choi, Hackbarth, and Zechner (2018) document substantial time and cross-sectional variation in dispersion of maturity dates. They argue that staggering maturities allows firms to avoid costly asset sales. I also document cross-sectional variation in dispersion of maturity dates and use this as motivation for the development of a quantitative structural credit risk model. This allows me to quantify trade-offs involved when firms choose to concentrate or disperse their debt maturity dates. Huang, Oehmke, and Zhong (2019) develop a multi-period model of debt structure in which firms trade off incentives to repay debt and prevent costly early liquidation in the presence of privately observable cash flows. I develop a model where firm's cash flow is public information, but the presence of debt issuance costs and costly equity injection generate a trade-off to firm's maturity concentration choice.

Typically quantitative models of debt maturity assume either a dispersed maturity structure (i.e. Leland and Toft (1996); Jungherr and Schott (2021)for corporate bonds and Arellano and Ramanarayanan (2012); Hatchondo and Martinez (2009) for sovereign bonds) or a perfectly concentrated maturity structure (i.e. Geelen (2019); Chen, Xu, and Yang (2021)). While tractable from a modeling perspective, the schedule of debt payments made by firms is at odds with what firms do in the data. This paper endogenizes the choice of repayment schedules in a tractable way so as not to deal with a large state space. Chaderina (2023) explores the dispersion of debt in a model where firms have a one period bond and a two period bond. In contrast, my modeling approach allows for a better mapping of the model to the data, given that most firm debt is long term (greater than 2 period length).

Finally, my paper offers a methodological contribution to quantitative credit risk models. I adapt a similar approach to Dvorkin, Sánchez, Sapriza, and Yurdagul (2021), which solves a model with long-term debt and an endogenous maturity structure choice of sovereign debt. It is challenging to solve for the optimal default, debt, and maturity structure choices, and for the equilibrium prices of different bond types in a quantitative model. Exploiting methods from dynamic discrete choice models, I introduce idiosyncratic shocks affecting the borrower's debt portfolio decisions. Under standard assumptions on the distribution of these shocks, I characterize the choice probabilities and use them to deliver a smooth equilibrium bond-price equation.

Road map

The paper is organized as follows. In Section 2, I describe the data set, estimation strategy, and empirical findings. Section 3 develops the heterogeneous structural credit risk model with an endogenous choice of repayment schedule concentration. In Section 4, I characterize equilibrium firm behavior, emphasizing the role of rollover risk and fixed issuance costs in firms' decisions to adopt dispersed or concentrated repayment schedules. Section 5 explains how the model is mapped to the data, while Section 6 examines the properties of the estimated model. Section 7 presents the quantitative analysis, and Section 8 concludes.

2 Empirical Facts

In this section, I demonstrate that firms vary significantly in the number of bonds they have outstanding, which directly influences the concentration of their debt repayment schedules and the likelihood of facing a maturity wall. I introduce a measure of debt repayment schedule concentration, which captures the extent to which firms' debt payments are clustered in time. The analysis shows that smaller, younger, and lowly leveraged firms tend to adopt maturity walls. Additionally, I find that firms with maturity walls correlates with real firm outcomes, including their default risk and cost of borrowing.

2.1 Data Sources

I use data from Mergent Fixed Income Securities Database (FISD) to document the concentration of bond repayment schedules. Mergent FISD contains the universe of corporate bond issuances across all credit ratings and provides detailed information on issue date, amount, coupon, bond maturity, and underwriter fees. This enables me to construct a complete bond maturity profile at the firm-year level. Issue amounts, coupons, and maturities are aggregated annually, weighted by the bond issuance amount. Following Boyarchenko, Kovner, and Shachar (2022), I exclude bonds issued in foreign currency, as well as Yankee, Canadian, convertible, and asset-backed bonds[2].

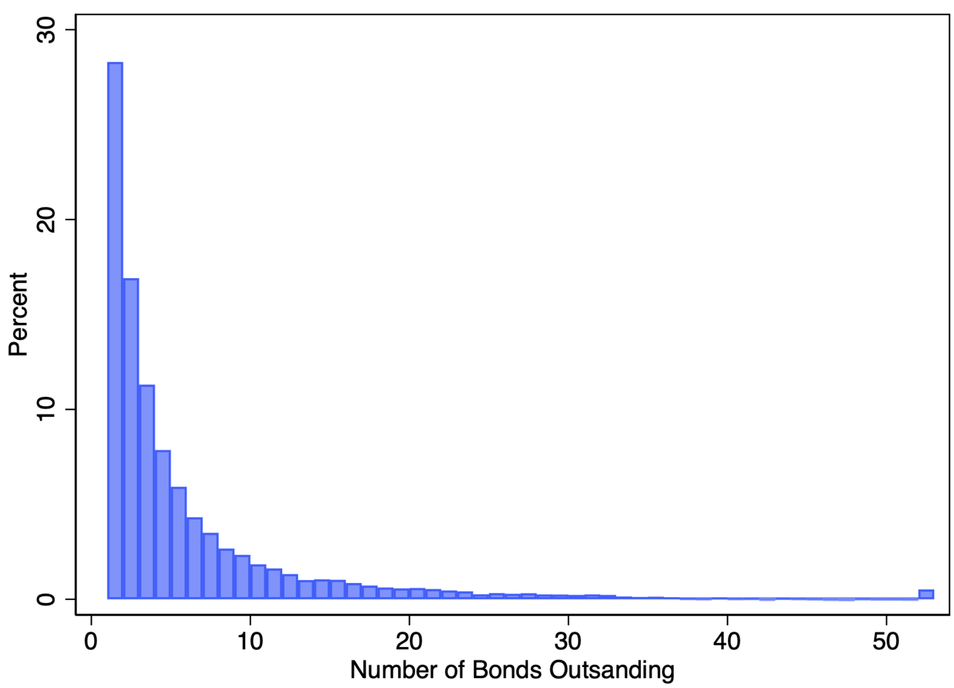
[2] 1,236 observations are dropped by excluding Yankee bonds; 721 observations are dropped by excluding Canadian bonds; 3,485 observations are dropped by excluding convertible bonds; 850 observations are dropped by excluding foreign currency bonds; 392 observations are dropped by excluding asset-backed bonds.

To analyze firm characteristics associated with dispersed or concentrated debt schedules, I merge the Mergent FISD data with balance sheet information from Compustat. In line with the literature, I exclude financial firms (SIC 6000–6999) and utilities (SIC 4900–4999). The sample consists of non-financial firm-year observations from 1995 to 2019 for firms issuing corporate bonds[3]. All variables are winsorized at the top and bottom 0.5% to mitigate the influence of outliers. My final sample includes 1,432 firms and 17,972 firm-year observations. Summary statistics are found in Table 8.

2.2 Measuring Maturity Walls

The concept of a maturity wall is often cited as a reason for firm downgrades by credit rating agencies, such as in the recent case of Antero Resources. Despite its frequent use, "maturity wall" remains a loosely defined term in the industry, generally referring to a period when a substantial portion of a firm's debt must be repaid within a short time frame. In this section, I provide a more formal definition of a maturity wall and assess its prevalence among firms.

Figure 1: Number of Bonds outstanding



Before formally defining a maturity wall, it is essential to establish a way to measure the concentration or dispersion of a firm's debt payments. This is particularly relevant given the

[3]While Mergent FISD contains earlier issuances, it only becomes comprehensive after 1995.

long-term nature of most corporate borrowing. For instance, in 2007, the median share of debt maturing in more than three years was 56.5% among publicly traded U.S. corporations Custódio, Ferreira, and Laureano (2013), with the average maturity of newly issued corporate bonds being around 11 years. As a result, firms are not necessarily making debt principal payments frequently, and there may be long periods with no payments at all. Additionally, firms vary significantly in the number of bonds they have outstanding, which affects their repayment schedules. Figure 1 shows that firms have an average of 5.4 bonds outstanding, with a median of 3, and the top 5% holding at least 19 bonds. This variation highlights the importance of capturing the concentration of debt payments, as firms with more bonds may have a more dispersed repayment schedule, while others may face significant rollover risk due to concentrated debt payments.

To formalize the dispersion of a firm's debt repayment schedule, I introduce a novel measure of maturity date dispersion that builds on existing approaches in the literature: the standard deviation of debt maturity dates. The standard deviation of debt maturity dates is defined as:

$$\sigma_{Mat,t} = \sqrt{\sum_{m=1}^{M} s_{m,t}(m - \mu_{Mat,t})^2} \tag{1}$$

where $s_{m,t} = b_{m,t} / \sum_{j=1}^{M} b_{j,t}$ represents the share of outstanding debt due in m years, $\mu_{Mat,t} = \sum_{m=1}^{M} s_{m,t} m$ is the average maturity of outstanding debts, and M is the longest bond maturity a firm can have[4]. The measure $\sigma_{Mat,t}$ is time-varying, adjusting as firms issue new bonds or repay existing ones.

The interpretation of σ_{Mat} is intuitive: a lower standard deviation indicates that debt payments are more concentrated around the average maturity. In the extreme case where $\sigma_{Mat,t} = 0$, all of a firm's debt payments come due in a single year, indicating maximum concentration.

$\sigma_{Mat,t}$ is a preferred measure of debt maturity concentration over those previously proposed in the literature due to its two key advantages. First, $\sigma_{Mat,t}$ is low when a large share of debt, $s_{m,t}$, is due within a single year, which aligns with the basic requirement for any concentration measure—this feature is shared by other measures, such as the Herfindahl Index. However, $\sigma_{Mat,t}$ also accounts for the dispersion of debt payments over time, capturing not just the concentration in a single period, but also the size of payments due around that period. This feature is essential for assessing how concentrated a firm's debt schedule truly is.

[4] I set M to 35 years, as bonds with maturities longer than 35 years account for only 0.5% of the sample.

For example, consider two firms that each have 50% of their outstanding debt due in $m = 1$. Firm A pays the remaining 50% in $m = 2$, while Firm B pays the remaining 50% in $m = 20$. The Herfindahl Index, $\sum_{m=1}^{M} s_{m,t}^2$, would treat both firms identically, giving each a score of 0.5. However, intuitively, we might expect Firm A to face greater rollover risk, since it must repay 100% of its debt within two years. My proposed measure, $\sigma_{Mat,t}$, distinguishes between these two firms: Firm A would have a $\sigma_{Mat,t}$ of 0.5, while Firm B would have a $\sigma_{Mat,t}$ of 9.5, reflecting the much wider dispersion of its debt payments. This is important because credit analysts typically consider debt payments over a window of a few years when assessing rollover risk[5].

2.3 Fact 1: 47% of firms choose maturity walls

Figure 2 shows the distribution of σ_{Mat}, binned by one-year increments. There is significant heterogeneity in the dispersion of debt maturity dates across firms. The average σ_{Mat} is 2.7 years, with a median of 1.4 years. Notably, a substantial number of firms have very concentrated debt payments, with $\sigma_{Mat} \leq 1$. I define a maturity wall as a firm with $\sigma_{Mat,t} \leq 1$, which is the dispersion of debt payments Antero Resources had at their downgrade by Fitch. This implies that the firm will pay off the majority of its debt within two years of starting debt repayments. I find that 47% of firms have a maturity wall. Therefore, the presence of a maturity wall, like that of Antero Resources, is not unusual but rather a common feature of corporate debt structures.

To explore which firm characteristics are associated with firms that concentrate their debt payments or not, I regress a set of firm characteristics on how dispersed their debt payments are. This allows me to examine the effects of various firm-level factors on the likelihood of having dispersing debt payments while controlling for unobservable characteristics through fixed effects and clustering standard errors at the firm level.

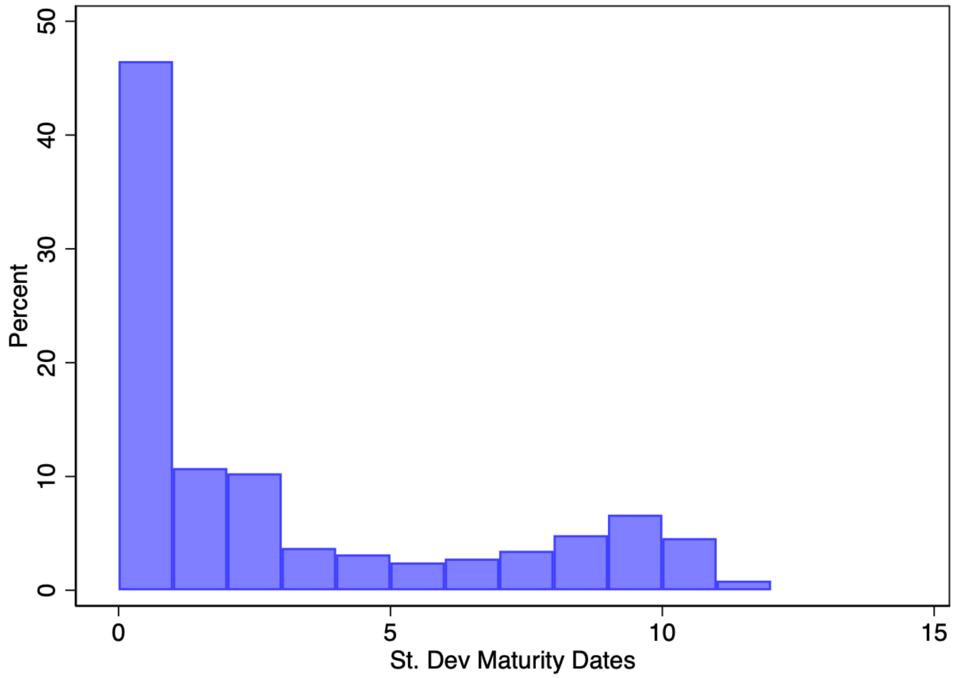
The model is specified as follows:

$$\sigma_{Mat,i,t} = X'_{i,t-1}\beta + \alpha_{FE} + \varepsilon_{i,t}, \tag{2}$$

where X is a vector of firm controls, and α_{FE} represents a set of fixed effects. The dependent variable is my measure of maturity date dispersion (σ_{Mat}). The independent variables are chosen based on factors likely to influence the choice of having a maturity wall. Specifically, I include market leverage, firm size, firm age, Q (Tobin's Q), firm profit, cash holdings, firm interest coverage ratio and the average maturity of outstanding debt. In addition, I also

[5]Fitch Ratings downgraded Antero Resources, citing a large maturity wall of $2.63 billion due between 2021 and 2023.

Figure 2: St. Dev of Bond debt payments
— Debt Repayment Schedule —



control for the number of bonds outstanding a firm has as well as the share of all debt held in bonds. All variables are standardized to facilitate interpretation and comparison.

The decision to disperse debt maturity dates may be influenced by unobservable firm- or industry-specific characteristics, as well as time-varying macroeconomic conditions. To account for this, I include either industry- or firm-level fixed effects to capture the impact of unobserved industry or firm characteristics on repayment schedule concentration. I also include time fixed effects to control for aggregate changes over time. Standard errors are clustered at the firm level.

Table 1 presents the estimation results. Across all specifications, leverage, size, age, and average maturity are statistically and economically significant predictors of a firm's dispersion of debt payments. The coefficient signs on leverage, size, age, and interest coverage ratio provide insight into the trade-off firms face when managing their debt repayment schedules.

Firm size emerges as the strongest predictor of having a maturity wall. The coefficient on firm size, measured by the log of total book assets, is positive and large. In specification 2, which includes firm fixed effects, a one standard deviation increase in log assets is associated with a 1.2 year increase in the dispersion of debt payments. Similarly, firm age is a significant predictor: a one standard deviation increase in age (23 years) increases the dispersion of debt payments by just over half a year. These findings suggest that larger and older firms are more

Table 1: σ_{Mat} and Firm Characteristics

	St. Dev of Maturity Dates		
	(1)	(2)	(3)
Leverage	0.513***	0.373***	0.384***
	(0.072)	(0.070)	(0.073)
Size	1.582***	1.247***	1.291***
	(0.115)	(0.233)	(0.227)
Age	0.199***	0.653**	0.693**
	(0.072)	(0.262)	(0.297)
Q	0.167**	-0.083	-0.168
	(0.083)	(0.091)	(0.106)
Profit	0.134**	0.036	0.077
	(0.056)	(0.048)	(0.061)
Cash	0.057	0.020	0.024
	(0.060)	(0.055)	(0.058)
Fraction of Bond Debt	0.344***	0.121**	0.165***
	(0.060)	(0.049)	(0.053)
No. Bonds Outstanding	0.591***	0.668***	0.724***
	(0.100)	(0.156)	(0.165)
Interest Coverage Ratio	-0.050	-0.342**	-0.298*
	(0.154)	(0.170)	(0.170)
Avg. Bond Maturity	1.753***	0.990***	0.888***
	(0.104)	(0.105)	(0.115)
Observations	6546	6762	6317
R^2	0.681	0.849	0.868
Fixed Effects	Ind & Year	Firm & Year	Firm & Ind × Year

likely to opt for dispersed repayment schedules, which aligns with the presence of large fixed costs in bond issuance. For instance, Altınkılıç and Hansen (2000) show that underwriter fees account for roughly 1% of corporate bond value, or approximately $2 million, a cost that larger firms can better absorb. Moreover, as firms age, there is more publicly available information about them, facilitating their access to credit markets and reducing the need to cluster debt payments.

Leverage is another strong predictor, with a significant positive coefficient. A one standard deviation increase in leverage (0.15%) is associated with a 0.37 year increase in the dispersion of debt payments. Similarly, firms with a low interest coverage ratio — the ratio of firm's profit to their interest payments – is associated with 0.34 year increase in the dispersion of debt payments. Firms with higher leverage and a low interest coverage ratio face increased rollover risk, which could lead to costly equity injections, early project terminations, or default. To mitigate these risks, firms may choose to disperse their debt payments, thereby minimizing per-period rollover risk. Lastly average maturity is positively correlated with the dispersion of debt maturity dates. This relationship is in part mechanical: firms with longer average maturities have the ability to disperse their debt payments by more compared to firms with shorter average maturity.

2.4 Fact 2: Firms with concentrated debt payments appear more risky

Do concentrated debt payments matter? Rating agencies' interest in the potential risk associated with concentrated debt payments, introduced in Section 1, hints at the fact that the concentration of debt repayment schedules has an influence on real firm outcomes. In this section, I focus on investigating how concentrated debt payments may correlate with firms' default decision, bond prices, coupon rate, and credit spread.

To explore how a firm's choice of repayment schedule affects its outcomes, I consider the following regression model:

$$Y_{i,t} = X'_{i,t-1}\beta + \alpha_{FE} + \varepsilon_{i,t}, \tag{3}$$

where Y represents firm outcomes, and X is a vector of firm-level and bond-level controls. The key variables of interest include the firm's debt structure characteristics: specifically, leverage, average maturity, and the dispersion of their debt payments not explained by average debt maturity[6]. I include industry and year fixed effects[7]. As before, all independent variables are standardized to facilitate interpretation and comparison of their effects on firm outcomes.

In Table 2, I focus on a number of firm outcomes: (i) the probability of default (measured by a firm's distance to default), (ii) the bond yield — or interest rate — on a newly issued bond, (iii) the annual coupon rate on a newly issued bond, and (iv) the credit spread of newly issued bonds. First, I examine the probability of default in specification (1). Leverage is a strong positive predictor, with a one standard deviation increase in leverage associated with a 5.8 percentage point increase in the probability of default. The dispersion of debt payments is also informative for the probability of default: a one standard deviation increase correlates with decreased default probability by 0.65 pps. This negative relationship is intuitive, as large and concentrated debt payments can increase a firm's risk, particularly if debt must be rolled over during adverse market conditions or poor firm performance. Similarly, average bond maturity is negatively correlated with default probability, and is associated with a marginal decrease in the probability of default of 0.04 pps. Notice that the dispersion of debt payments is still a significant predictor of firm default risk, even after controlling for leverage and average maturity.

The following specifications (2 - 4) all relate to terms outcomes firms face on newly issued corporate bonds. As a result, I control for variables related to the bond issuance, such as how large it is, the fraction of newly issued debt relative to the total amount of debt outstanding, and the maturity at issuance of the newly issued bond. For brevity, I will focus on debt structure characteristics relate to the credit spreads on newly issued bonds, shown in specification (4). The correlations between firm's debt structure characteristics and outcomes follows similar intuition. Leverage is again a significant predictor, with a one standard deviation increase in leverage being associated with a 52 basis point increase in credit spreads. Firms with more dispersed bond payments are associated with lower spreads — about 11 basis points — highlighting the perceived risk of concentrated debt payments. Average maturity of bonds is positively related to credit spreads, but the effect is not statistically significant. These results suggest that both leverage and debt dispersion are important factors in how lenders price corporate bonds and assess default risk.

[6] Given that there exists a correlation between the average maturity and dispersion of debt payments, I consider variation in σ_{Mat} that is uncorrelated with average maturity. This allows me to explore if variation in the dispersion of debt payments not associated with average maturity appears informative for predicting firm outcomes.

[7] I only consider industry fixed effects here because many firms are infrequent bond issuers. As a result, I lack sufficient observations to explore how debt structure characteristics impact for outcomes related to new bond issuances.

Table 2: σ_{Mat} and Firm Outcomes

	(1) Prob Default (pps)	(2) Yield (pps)	(3) Coupon Rate (bps)	(4) Credit Spread(bps)
Leverage	5.800***	0.592***	68.907***	52.534***
	(0.417)	(0.102)	(7.912)	(8.275)
Avg. Bond Maturity	-0.041	0.035	-1.517	2.872
	(0.254)	(0.051)	(4.886)	(4.500)
St. Dev of Maturity Dates$_{t-1}$	-0.645***	-0.123**	-8.594*	-11.372**
	(0.243)	(0.053)	(5.201)	(4.672)
Size	-0.235	-0.154**	-24.993***	-7.832
	(0.341)	(0.066)	(6.193)	(6.334)
Age	-0.301*	0.026	1.226	3.200
	(0.163)	(0.042)	(4.076)	(3.261)
Cash	0.820***	0.107**	5.337	12.388***
	(0.216)	(0.041)	(4.318)	(3.875)
Profit	-0.528*	-0.146***	-12.247***	-13.195***
	(0.300)	(0.047)	(4.248)	(4.026)
Tangibility	-0.045	0.017	-1.279	2.171
	(0.317)	(0.066)	(5.867)	(5.693)
Credit Rating	0.597*	-0.790***	-86.741***	-64.785***
	(0.352)	(0.081)	(7.144)	(6.861)
Fraction of Bond Debt	0.471**	0.011	-3.829	-1.730
	(0.222)	(0.060)	(4.248)	(5.464)
Amount New Issuance		0.184**	2.107	24.630***
		(0.072)	(6.837)	(7.015)
Frac New Issuance		0.091	20.765*	13.893
		(0.127)	(10.888)	(11.501)
Maturity at Issuance		0.305***	31.048***	-0.836
		(0.024)	(2.707)	(2.117)
Observations	6432	1369	1908	1213
R^2	0.242	0.768	0.762	0.692
Fixed Effects	Industry & Year	Industry & Year	Industry & Year	Industry & Year

2.5 Fact 3: Firms face economies of scale in bond issuance

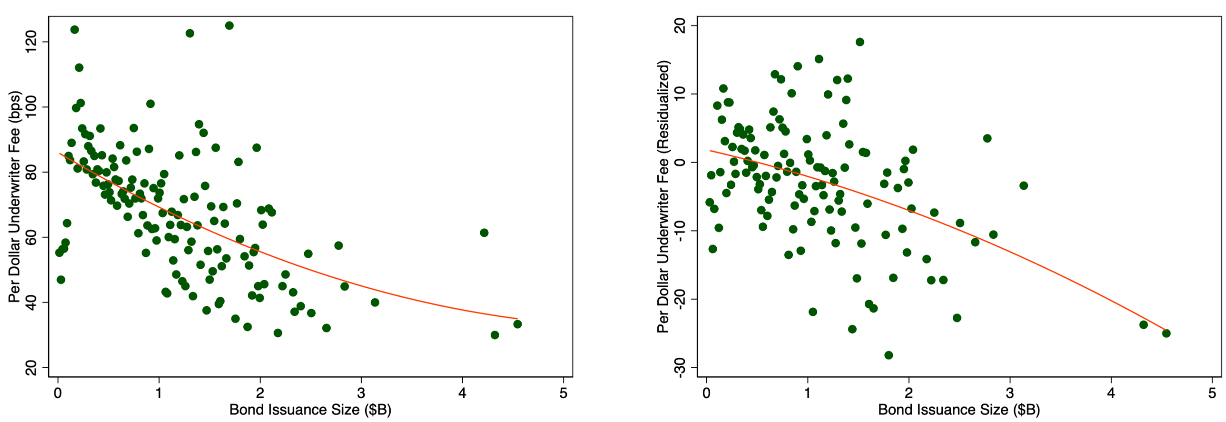
Given that many firms have very concentrated debt payments and this correlates significantly with negative outcomes for the firms, it is puzzling why so many firms *choose* to have concentrated debt payments in the first place. Next, I introduce a mechanism that explains why firms choose to concentrate their debt payments: there are large fixed costs associated with bond issuance. I provide evidence for the presence of economies of scale in underwriter fees observed in the data.

When a firm raises capital by issuing bonds, it selects an investment bank or a syndicate of banks (underwriters) to facilitate the process[8]. The underwriters assist the firm in structuring the bond deal, determining critical details such as the bond amount, maturity date, coupon rate, and pricing strategy. As part of this process, underwriters conduct due diligence on the firm's financial health and creditworthiness, which helps in setting the terms of the bond, including the interest rate and offer price. Underwriters charge fees for their services, typically as a percentage of the total bond issue. These fees cover underwriting, distribution, and marketing costs, and consist of both (i) fixed costs, which are independent of the bond issue size (e.g., legal and regulatory filings), and (ii) variable costs, which scale with the size of the issuance.

Figure 3: Economies of Scale in Bond Issuance: Underwriter Fees

(a) Raw Data

(b) Residualized Underwriter Spreads



Given the presence of fixed costs associated with underwriting corporate bonds, firms may reduce costs by issuing a larger bond to take advantage of economies of scale. This assertion is supported by Figure 3a, which looks at the relationship between the issuance size of the bond and the underwriter spread, or the underwriter fee relative to the size of the bond

[8]For more details on the corporate bond underwriting process, see Siani (2022).

issuance. There is a strong negative relationship between the size of the bond issuance and the underwriter spread paid by firms. Firms that issue bonds less than $1B face an average underwriter spread of 85 bps, while firms issuing bonds over $3B face an average underwriter spread of 40 bps or less. The negative relationship between bond issue size and underwriter spread even survives after controlling for a number of firm and bond characteristics that may influence the underwriter fee as seen in Figure 3b. I control for firm size, age, sales, and credit rating, which proxy for the amount of information available about the firm. I also control for variables that plausibly serve as a proxy for the relationship between a firm and various underwriters by controlling for the number of bonds a firm as issued. A firm that has issued a large number of bonds over their life is likely to have good relationships with various underwriters. Additionally, I control for characteristics of the bond issue, such as the maturity and coupon rate, as bonds with different characteristics may induce higher fees. There is still a strong negative relationship between the size of the bond issuance and the underwriter spread: bonds over $3B face roughly 25 bps lower underwriter spreads than bonds issued under $1B. This evidence is consistent with the presence of large fixed costs associated issuing corporate bonds; as firms issue bonds of larger size, they pay a lower underwriter fee per dollar issued.

Table 3: Bond Issuance Behavior

	Mean	Std. Dev	P25	Median	P75
Bond Issuance Frequency	0.146	0.353	0.000	0.000	0.000
Number of Bonds Issued	1.709	1.107	1.000	1.000	2.000
Time Since Last Issue (Years)	3.326	2.137	1.929	2.800	4.000
Number of Bonds Issued Last 5 Years	1.181	2.293	0.000	0.000	1.000
Number of Bonds Issued Last 10 Years	2.073	3.637	0.000	1.000	2.000
Number of Bonds Issued Last 20 Years	3.082	5.143	0.000	1.000	4.000
Bond Issuance Size ($M)	448.130	362.719	200.000	350.000	550.000
Asset Amount ($M)	8,842.525	19,061.048	1,129.499	2,859.618	7,912.119
Bond Issuance to Asset Amount	0.103	0.134	0.027	0.060	0.126
Bond Amount Outstanding ($M)	1,474.353	2,737.262	200.000	500.000	1,440.000
Bond Issuance to Amount Outstanding	0.432	0.334	0.147	0.318	0.682
Bond Issuance to Legacy Bond Debt	1.082	8.124	0.141	0.293	0.666

In addition to the economies of scale present in underwriter fees, firms are also infrequent bond issuers and when they issue in large amounts. Leary and Roberts (2005) explore bond and equity issuance behavior and show that infrequent issuance is most consistent with the presence of large fixed costs. In Table 3, I provide summary statistics on the frequency and size with which firms issue bonds. On average, firms only issue bonds for 15 percent of the periods and the total number of bonds issued by firms is 1.7. Consistent with this, the average time since their last bond issuance was 3.3 years. When firms issue bonds, they issue large amounts. The average issuance size is just under \$500M, though this is heavily skewed, with the 75th percentile of firms issuing bonds over \$4B. The average bond issuance size is 10% of their total assets or 40% of their total outstanding debt. Similarly, when firms issue bonds, the data suggests that they are largely rolling over their debt: relative to the amount of legacy debt — the remaining debt outstanding after firms have paid off their principal for the year — the amount issued is roughly 110%. Thus, the infrequent issuance behavior of bonds is consistent with the fact that firms face large fixed issuance costs.

2.6 Taking stock

I have documented a series of key characteristics of firms in the corporate bond market which concentrate their debt payments and how this decision affects their outcomes. Additionally, I have shown the presence of substantial fixed costs associated with issuing corporate bonds. In the next section, I develop a quantitative model based on these stylized facts, demonstrating that some firms optimally choose to hold maturity walls when facing fixed debt issuance costs and rollover risk coming from costly equity injection. I also show how the model can replicate the empirical findings presented in this section.

3 Environment

In this section, I build a model that can replicate features of my empirical exercise. To do so, I consider a discrete time structural credit risk model. There are two agents in my model: firms and lenders. I take the real interest rate to be a policy parameter as in a small open economy framework. This allows me to understand the mechanism delivered in my model that would carry through in a richer model where there are fluctuations in the aggregate state. All firms are ex-ante homogeneous and ex-post heterogeneous, due to idiosyncratic sequence of shocks they receive. In my model, firms borrow in debt that has dispersed debt payments or debt that has concentrated debt payments, pay a dividend out to equity holders, and make a default decision. There is a representative lender buys firms' debt. Given firms can renege on their promised debt payment, the lender forecasts if a firm is likely to default on their debt to set the price on debt borrowed by the firm.

3.1 Firms and Profits

Firms, indexed by j, are endowed with an asset that generates stochastic revenue. Firm j wishes to maximize the expected present discounted value of dividends. Formally:

$$\max_{\{b_{D,j,t+1},b_{C,j,t+1}\}} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \Big(\psi(d_{j,t}) + \varepsilon^{(b_{D,j,t+1},b_{C,j,t+1})} \Big), \tag{4}$$

where $b_{D,j,t+1}$ is the level of debt with dispersed repayment schedules of firm j, $b_{C,j,t+1}$ is the level of debt with concentrated repayment schedules of firm j, $d_{j,t}$ is the per-period dividend payout of firm j, $\psi(\cdot)$ is function governing the dividend payout, ε is a manager preference shock, and β is the firm's discount factor. In Subsection 3.3, I formally define $d_{j,t}$ and $\psi(\cdot)$. This environment can be thought of as a small open economy where the real interest rate is taken to be exogenously given.

To make the problem tractable, I make a few assumptions about the support of the debt instruments and introduce additive manager preference shocks to choices. I assume that the debt instruments can only take values in a discrete support: $b_k \in \mathcal{B}_k \equiv \{b_{1,k}, b_{2,k}, \ldots, b_{n_{b_k},k}\}$ for $k \in \{D, C\}$. Second, I assume there is a random vector ε of size $n_{b_D} \times n_{b_C}$, which corresponds to the number of all possible combinations of debt instruments. As mentioned, the introduction of these shocks are useful to solve the model numerically using the tools of dynamic discrete choice. I assume ε is drawn from a multivariate distribution with joint cumulative density function $F(\varepsilon) = F(\varepsilon^{(b_{D,1},b_{C,1})}, \varepsilon^{(b_{D,2},b_{C,1})}, \ldots \varepsilon^{(b_{D,n_{b_D}},b_{C,n_{b_C}})})$ and joint density function $f(\varepsilon) = f(\varepsilon^{(b_{D,1},b_{C,1})}, \varepsilon^{(b_{D,2},b_{C,1})}, \ldots \varepsilon^{(b_{D,n_{b_D}},b_{C,n_{b_C}})})$.

Firm j has a unit of installed capital that generates a stochastic income $y_{j,t} \in Y \equiv \{y_1, y_2, \ldots, y_{n_y}\}$, which follows a first-order Markov process with transition matrix $G_y(y_{j,t+1}|y_{j,t})$. In order to produce each period, firms must pay a fixed production cost c_f. Their pre-tax profits are defined as their income less any costs of production:

$$\pi_{j,t} = y_{j,t} - c_f. \tag{5}$$

Firm j pays corporate taxes on operating profits. Consistent with the tax code, firms are able to subtract of interest payments on debt from their operating income:

$$\Upsilon_{j,t} = \pi_{j,t} - \varsigma b_{j,t} \tag{6}$$

where $b_{j,t} = b_{D,j,t} + b_{C,j,t}$ is the total amount of debt borrowed by firm j and ς is the coupon rate. The tax benefits to holding debt comes by way of firm j's ability to deduct interest rate expenses from their overall taxable income. Corporate taxes paid by the firm are then defined to be $T_t^c = \mathbb{1}_{\{\Upsilon_{j,t} \geq 0\}} \tau \Upsilon_{j,t}$, where $\mathbb{1}$ is an indicator function and τ is the corporate tax rate.

3.2 Debt Financing

The firm's operating cash flows can turn negative for low realisations of income (y_t). In order to finance its operations, the firm can rely either on internal funds accumulated from previous periods, on borrowing from the bond market, or on proceeds from seasoned equity offerings ($d_{j,t} < 0$). Issuing debt requires the payment of a fixed issuance cost c_I.

Firms can issue two different types of bonds: a bond that promises a dispersed set of principal payments ($b_{D,j,t}$) and a bond that offers a single concentrated payment ($b_{C,j,t}$). I assume that a bond with a dispersed set of principal payments is a bond that promises an infinite stream of principal payments which decreases at a constant rate λ. A bond of size $b_{D,j,t}$ issued in period t promises to pay $\lambda(1-\lambda)^{s-1} b_{D,j,t}$ in period $t+s$. Thus, to not default, a firm must make a payment of $b_{D,j,t}(\lambda + \varsigma)$. An alternative interpretation of this bond is one with a sinking fund provision and a constant amortization rate. This is a common and tractable approach to modeling long term bonds found in both the corporate finance and sovereign default literature[9], as it does not increase the state-space[10]: the entire schedule of payments is summarized by the level of outstanding debt ($b_{D,j,t}$) and the decay parameter (λ). While it is common to model a long-term bond as such, it implies a certain type of repayment schedule, which is often at odds with the empirical observation that firms hold maturity walls and make lumpy payments on their debt.

I allow firms to make concentrated payments by issuing a bond that has a single principal payment ($b_{C,j,t}$). I assume that a bond with a concentrated principal payment has a random maturity date. This is akin to a perpetuity bond with a put position, where the holder of the bond decides when the principal is due. When the outstanding bond is retired, firms must fully repay $b_{C,j,t}$ at which point they optimally reissue a new quantity of debt with a concentrated repayment schedule. The process for which debt matures is captured by the i.i.d. random variable η which takes a value of one with probability λ and zero otherwise. Thus, to not default, the firm must make a payment of $b_{C,j,t}(\varsigma + \eta)$.

While bonds do not mature randomly, I opt to model this bond as one with a random maturity date as opposed to one with a deterministic maturity date for two reasons. First,

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[9] See, among others, Hatchondo and Martinez (2009); Arellano and Ramanarayanan (2012); Leland and Toft (1996); He and Xiong (2012); Dangl and Zechner (2021); Jungherr and Schott (2021)

[10] Suppose, for instance, that the firm can issue any bond of maturity m less than some maximum maturity M. In order to solve the model, one would need to keep track of M state variables (one for each maturity). Thus, for large M,it would not be possible to summarize all future payment obligations with one state variable.

from the firms' perspective, the event that a bad fundamental shock arrives when firms need to make a large debt payment is random. Thus, a model with a deterministic maturity date and random fundamentals would look qualitatively the same. In Table 10, I verify empirically that the presence of large debt payments coming due does not induce the firm to hoard cash, decrease investment, or buy back their debt early in any economically significant way. Second, to model the bond maturing deterministically, it would add an additional state variable, which is computationally costly. Modeling bonds in this way is also strongly rooted in the corporate finance literature[11].

Figure 4: Model Implied Debt Repayment Schedules

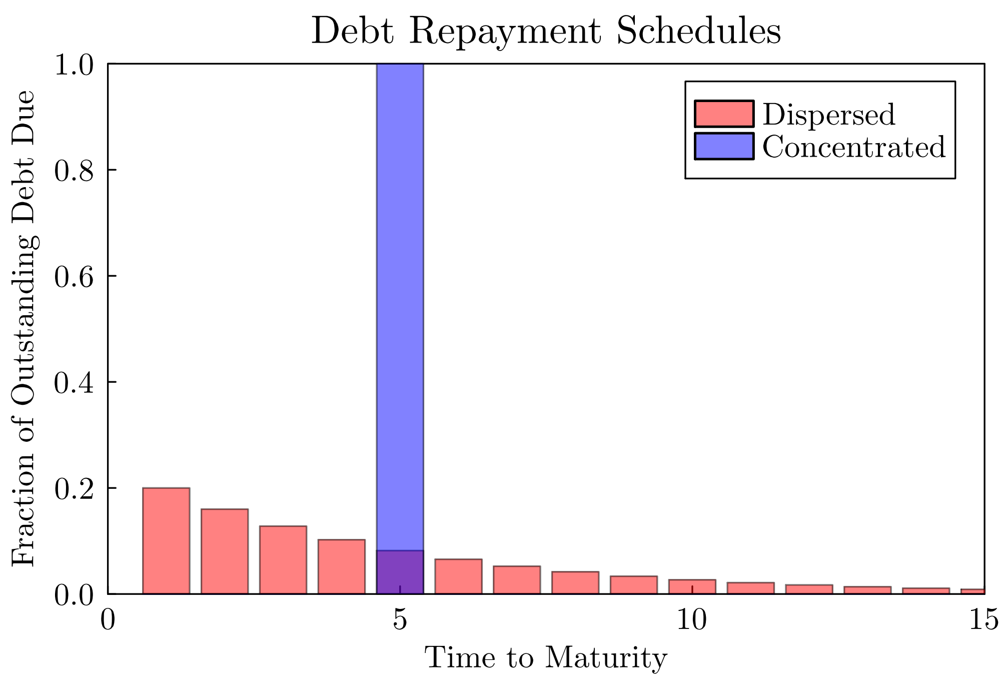


Figure 4 highlights what the model implied debt repayment schedules look like for a given realization of the repayment shock. We can see that the bond with a dispersed repayment schedule makes small frequent principal payments, while the bond with a concentrated repayment schedule makes one at period 5. The two types of bonds that firms can issue capture in a stylized way the different types of debt payment schedules we observe firms choosing in the data. In particular, the two bonds are identical along two dimensions: (i) conditional on not defaulting, both bonds will repay the same amount and (ii) both bonds have an average maturity of $1/\lambda$. The only difference, however, is that they differ in the schedule of payments.

[11]See, among others, Geelen (2019); Gomes and Schmid (2021); Chen, Xu, and Yang (2021)

3.3 Dividend and Equity Issuance

Cash-flows paid out to equity holders is given by:

$$\psi(d_{j,t}) = \begin{cases} d_{j,t} & \text{if } d_{j,t} \geq 0 \\ d_{j,t} - \alpha d_{j,t}^2 & \text{if } d_{j,t} < 0 \end{cases}$$

where

$$\begin{aligned} d_{j,t} = (y_{j,t} - c_f - \varsigma(b_{D,j,t} + b_{C,j,t}))(1-\tau) - (\lambda b_{D,j,t} + \eta b_{C,j,t}) + \\ q_{D,j,t}(b_{D,j,t+1}, b_{C,j,t+1}, y_{j,t}) I_{D,j,t} + q_{C,j,t}(b_{D,j,t+1}, b_{C,j,t+1}, y_{j,t}) I_{C,j,t} - \\ c_I(\mathbb{1}_{I_{D,j,t}>0} + \mathbb{1}_{I_{C,j,t}>0}) \end{aligned}$$

and

$$\begin{aligned} I_{D,j,t} &= b_{D,j,t+1} - (1-\lambda) b_{D,j,t} \\ I_{C,j,t} &= b_{C,j,t+1} - (1-\eta) b_{C,j,t}. \end{aligned}$$

The dividend the firm pays out to shareholders is $d_{j,t}$ and is composed of a number of terms. The first summand represents the firm's after-tax income. The firm receives a stochastic income $y_{j,t}$ and pays the fixed operating cost c_f. Additionally, it pays any coupon payments on outstanding debt. Notice that firms deduct coupon payments off their pretax income, highlighting the tax benefits of debt in this framework. The second summand captures principal payments the firm must make this period. With certainty, it must make a fractional payment on its outstanding dispersed debt ($\lambda b_{D,j,t}$). Additionally, it only makes a principal payment on the concentrated debt ($b_{C,j,t}$) when $\eta = 1$, which occurs with probability λ. The third and fourth summand captures the total revenue raised from the bond market. $q_{D,j,t}(b_{D,j,t+1}, b_{C,j,t+1}, y_{j,t}) I_{D,j,t}$ captures the revenue raised by issuing new bonds with dispersed debt payments and $q_{C,j,t}(b_{D,j,t+1}, b_{C,j,t+1}, y_{j,t}) I_{C,j,t}$ captures the revenue raised by issuing a new bond with a concentrated payment. $I_{k,j,t}$ is the law of motion for debt issuances of type k and $q_{k,j,t}(b_{D,j,t+1}, b_{C,j,t+1}, y_{j,t})$ is the price of newly issued debt for debt of type k, for $j \in \{D, C\}$. Finally, the the last term captures the cost of issuing new debt. Any time issuances are positive for dispersed or concentrated debt, the firm must pay the fixed debt issuance cost c_I.

3.4 Financial Markets

Lenders

There is a representative financial intermediary who has access to long-duration risk free bond at a price one and lends discount bonds to firms at a firm-specific loan price $q_{D,j,t}(b_{D,j,t+1}, b_{C,j,t+1}, y_{j,t})$ and $q_{C,j,t}(b_{D,j,t+1}, b_{C,j,t+1}, y_{j,t})$. Lenders have full information about firms' states. The price of bonds is a function of: (i) the amount of debt with dispersed payment schedules the firm plans to borrow (ii) the amount of debt with concentrated payment schedules the firm plans to borrow, and (iii) firm specific income level. To price debt for firms, lenders must forecast the likelihood of default given the firm j's current and future debt choices, and idiosyncratic income level. This will be formalized in Subsection 4.3.

Equity Issuance

Firm pays out their dividend according to the piece-wise function $\psi(d_{j,t})$. When $d_{j,t} \geq 0$, the firm linearly pays out excess cash-flows to shareholders. When $d_{j,t} < 0$, firms need to inject equity from shareholders. They are able to inject equity from shareholders subject to a convex cost $\alpha d_{j,t}^2$. In the model, costly equity injections serves as the cost to the firm from not being able to raise enough revenue from the bond market and roll over their debt.

3.5 Timing

At each period t:

1. Idiosyncratic productivity $y_{j,t}$ and repayment shock $\eta_{j,t}$ is realized by firms. The state space for an incumbent firm is $(b_{D,j,t}, b_{C,j,t}, y_{j,t}, \eta_{j,t})$.

2. Default decisions are made by firms. If a firm chooses to default on their debt, the firm is liquidated and the lender recovers a fraction χ of the firm's unlevered value. In addition, they avoid paying the fixed cost of production. After an incumbent firm has defaulted, a new firm enters.

3. If a firm does not choose to default, it pays the fixed cost of production and repays their debt in full. They then decide debt choices for next period.

4 Equilibrium

To save on notation, I drop the firm specific j subscript. Additionally, date t variables have dropped the time subscript and date $t+1$ variables are denoted by primes.

4.1 Recursive Representation of the Firm's Problem

I begin with the problem faced by an incumbent firm. An incumbent firm enters the period with debt with dispersed repayment schedules b_D, debt with a concentrated repayment schedule b_C, and idiosyncratic income y. The firm chooses between two discrete actions: (i) to stay in the economy and produce or (ii) to default on its debt payment and exit the economy. In other words, the firm maximizes its value over these two distinct choices:

$$V(b_D, b_C, y, \eta) = \max_{\delta \in \{0,1\}} \Big\{ (1-\delta) V^{stay}(b_D, b_C, y, \eta) + \delta V^{default}(b_D, b_C, y, \eta) \Big\}, \tag{7}$$

where $\{V^{stay}, V^{default}\}$ denote the value of the firm if it chooses to stay in the economy and if it chooses to default on its debt. In the event that its debt obligation is larger than the funds they are able raise from debt markets or the amount of equity they can inject, the firm chooses to default and obtains a value $V^{default}(b_D, b_C, y, \eta) = 0$. I define $\delta(b_D, b_C, y, \eta)$ to be default decision rules made by the firm. In the event of default, $\delta(b_D, b_C, y, \eta) = 1$. If the firm does not choose to default on their debt obligation, we can express the firm's problem of staying in the following recursive form, where $\varepsilon^{(b'_D, b'_C)}$ denotes the manager preference shock:

$$V^{stay}(b_D, b_C, y, \eta) = \int_{\varepsilon} W(b_D, b_C, y, \eta, \varepsilon) dF(\varepsilon) \tag{8}$$

$$W(b_D, b_C, y, \eta, \varepsilon) = \max_{b'_D, b'_C} \Big\{ \psi(d) + \varepsilon^{(b'_D, b'_C)} + \beta \mathbb{E}_{\{y', \eta'\}} V(b'_D, b'_C, y', \eta') \Big\} \tag{9}$$

subject to

$$\psi(d) = \begin{cases} d & \text{if } d \geq 0 \\ d - \alpha d^2 & \text{if } d < 0 \end{cases}$$

where

$$\begin{aligned} d = {} & (y - c_f - \varsigma(b_D + b_C))(1-\tau) - (\lambda b_D + \eta b_C) + \\ & q_D(b'_D, b'_C, y) I_D + q_C(b'_C, b'_C, y) I_C - c_I(\mathbb{1}_{I_D > 0} + \mathbb{1}_{I_C > 0}) \end{aligned}$$

and

$$I_D = b'_D - (1-\lambda)b_D$$
$$I_C = b'_C - (1-\eta)b_C.$$

4.2 Entrants Problem

A new firm enters the economy when an incumbent firm defaults. I assume here that the entering firms come in with zero debt and draws its idiosyncratic income from the stationary Markov distribution of $\bar{G}_y$.

4.3 Lender's Problem

To price debt for firms, the representative lender must forecast the likelihood of default given the firm's debt choices and current idiosyncratic income level. On a given loan to a firm with idiosyncratic income y who chooses debt with dispersed repayment schedules b'_D and debt level with a concentrated repayment schedule b'_C, the lender expects to make zero profits on all loans. Thus, we can express the price of a unit of dispersed debt in the following recursive form:

$$\begin{aligned} q_D(b'_D, b'_C, y) = \beta \mathbb{E}_{\{y',\eta'\}} \Big\{ & (1-\delta(b'_D, b'_C, y', \eta'))(\varsigma + \lambda + (1-\lambda) q_D(b''_D, b''_C, y')) \\ & + \delta(b'_D, b'_C, y', \eta') \min \left[1, \chi \frac{\tilde{V}(y')}{b'_D + b'_C} \right] \Big\} \end{aligned} \tag{10}$$

where $\tilde{V}(y) = \psi(y) + \beta \mathbb{E}_{\{y'\}} \max\{\tilde{V}(y'), 0\}$ is un-levered firm value. Similarly the price of a unit of concentrated debt in the following recursive form:

$$\begin{aligned} q_C(b'_D, b'_C, y) = \beta \mathbb{E}_{\{y',\eta'\}} \Big\{ & (1-\delta(b'_D, b'_C, y', \eta'))(\varsigma + \eta + (1-\eta) q_C(b''_D, b''_C, y')) \\ & + \delta(b'_D, b'_C, y', \eta') \min \left[1, \chi \frac{\tilde{V}(y')}{b'_D + b'_C} \right] \Big\} \end{aligned} \tag{11}$$

Lender's profits for a given loan can be decomposed into the cost to the lender today (left hand side of equation 22 and 11) and the expected revenue the lender gets over the duration that the bond is outstanding (right hand side of equation 22 and 11). Notice that the bond price depends both on the one period ahead default decision of the firm $\delta(b'_D, b'_C, y', \eta')$, which is a function of firm debt choices today. Thus, if the firm is more likely to default in the future when issuing debt that has a concentrated repayment schedule, the lender will purchase the debt at a lower price (higher interest rate). In addition, the price of debt depends on future firm borrowing choices b''_D and b''_C, since this impacts the creditworthiness of the firm in the future. Because these are long-term contracts, the lender cares about the future creditworthiness of the firm and prices it in.

4.4 Definition of Equilibrium

A recursive Markov equilibrium is a set of value and policy functions $\{V^*, b^*_D, b^*_C, \delta^*\}$ and debt prices $\{q^*_D, q^*_C\}$ such that:

1. Given prices q^*_D and q^*_C firms optimize yielding V^*, b^*_D, and b^*_C.

2. The default decision δ^* is consistent with firm decision rules.

3. Debt prices q^*_D and q^*_C are such that the representative lender expects to earn zero profits.

4. Stationary distribution of firms is determined by firm decision rules and law of motion for y and η

   - Mass of defaulting firms is replaced with an equal mass of firms with $b_D = 0$, $b_C = 0$, $\eta = 1$ and $y \sim \bar{G}_y$.

5 Mapping the Model to the Data

The data used for the model estimation is the same as in Section 2. In this section, I describe how I match the quantitative model to the key moments on firm heterogeneity related to maturity walls, the total level of borrowing, the cost of borrowing firms face on bonds, and their default rates. I discuss how these moments help recover the model primitives in Subsection 5.1. The estimated model will be used to quantify the importance of maturity walls on firms' credit risks, examine the implications of large debt issuance cost, and study the importance of maturity walls in analyzing the impact of credit market freezes on aggregate economy.

5.1 Estimation Strategy

The model has 11 parameters. 6 of them are chosen outside the model. The remaining 5 parameters are chosen to match a set of moments in the data via simulated method of moments (SMM). Table 4 summarizes the baseline parameters of the model.

Externally Calibrated Parameters

Similar to my data, the model period is one year. The discount factor, β, is common to all agents in the economy. I set the discount factor to be 0.96, which implies an annualized risk free rate of 4.0%. The coupon rate is set to be the risk free rate, implying that risk free bonds are issued at par, or price of 1. Following Hennessy and Whited (2007), I set the tax rate, τ to be 0.30.

Firms' income process is calibrated outside of the model. I make a parametric assumption on the shock process. I assume that idiosyncratic productivity follows an AR(1) process:

$$log(y_{t+1}) = \rho_y log(y_t) + \epsilon_{y,t+1}, \quad \epsilon_y \sim \mathcal{N}(0, \sigma_y),$$

where $\rho_y < 1$ is the persistence parameter on the shock. To break up the shock into a discrete grid of points, I follow the method proposed in Tauchen (1986). To estimate the parameters in the process for y, I estimate the following regression:

$$log(Sales_{i,t-1}) = \rho_y log(Sales_{i,t-1}) + \alpha_i + \alpha_t + \epsilon_{i,t},$$

where α_i and α_t are firm and year fixed effects. The results provide us with an estimate of ρ_y and σ_y. I calibrate $\rho_y = 0.66$ and $\sigma_y = 0.31$. Additionally, I calibrate $1/\lambda = 8.3$ to be the average time to maturity of bonds held on firms' balance sheet observed in the data.

Internally Estimated Parameters

The remaining five parameters are estimated via SMM by minimizing the distance between six model moments and data moments. The model is over-identified and the moments are selected to provide identification for the parameters. Specifically, the parameters are chosen to minimize the following objective function:

$$J(\Theta) = \min_{\Theta}(m^D - m^M(\Theta))'W^*(m^D - m^M(\Theta)), \tag{12}$$

where, m^D is a vector of data moments, $m^M(\Theta)$ is a vector of moments calculated within the model, conditional on vector of parameters Θ. For the weighting matrix, W^* , I use the covariance of the empirical moments, constructed using the influence function approach of Erickson and Whited (2002). Standard errors are given by:

$$\left(1 + \frac{1}{K}\right) \left[\left(\frac{\partial m^M(\Theta)}{\partial \Theta} \right)' W^* \left(\frac{\partial m^M(\Theta)}{\partial \Theta} \right) \right]^{-1}, \tag{13}$$

where the term $\left(1+\frac{1}{K}\right)$ is the adjustment for simulation error.

The success of SMM relies on effective model identification, which requires selecting moments that are sensitive to variations in the structural parameters. Next, I describe and rationalize the 6 moments that I match in the estimation. Since every moment that results from the model is a function of all parameters, there is no one-to-one link between parameters and moments. However, we can point to moments that are more informative to pin down a given parameter or set of parameters than others.

Table 4: Estimated Parameters

Parameter	Description	Value	SE	Target/Reference	Data	Model
Externally Calibrated						
β	Discount factor	0.960	—	4% Annual Risk Free Rate	—	—
ς	Per-period coupon payment	$1/\beta-1$	—	Risk free debt issued at par	—	—
τ	Corporate tax rate	0.300	—	Hennessy & Whited (2007)	—	–
ρ_y	Persistence: income shock	0.660	—	Auto-correlation of log sales	0.66	0.66
σ_y	St. dev: income shock	0.310	—	Log sales volatility	0.31	0.31
$1/\lambda$	Average Maturity of debt	8.300	—	Avg. debt maturity	8.30	8.30
Internally Estimated						
c_f	Fixed cost of production	0.967	0.244	Default rate (%)	1.13	1.20
α	Convex equity issuance cost	0.011	0.002	Avg. debt to income	2.22	2.22
σ_ε	St. dev: pref. shock	0.001	0.000	St. dev debt to income	5.36	5.34
χ	Lender recovery fraction	0.093	0.040	Avg. credit spread	1.87	1.70
c_I	Fixed debt issuance cost	0.003	0.001	Avg. dispersion maturity dates	2.61	2.62
				Avg. underwriter fee (%)	0.79	0.75

The default rate is informative for pinning down the fixed cost of production, c_f. As the cost of production increases, firms have lower pre-tax profits, increasing the likelihood that the firm will choose to default. I estimate the fixed cost of production to be 0.967. This implies a free-cash flow to sales ratio of roughly 3%. Note that c_f is capturing both fixed and variable costs of production (such as labor inputs) typically found in the data. The convex equity issuance cost, α, is estimated to be 0.01 and is identified off of the average debt to income level. Given an income level, firms decide the level of debt based on the tax benefit of debt and the potential (relative) cost of having to inject equity. Since I fix the tax rate, the key trade-off governing how beneficial debt is to the firm is the relative cost of equity injections. As α increases, the marginal cost of injecting equity rises, increasing the benefits of debt. The lender recovery rate χ is estimated to be 9.3% and is identified by the average credit spread observed. Recall that χ shows up directly in the structural equation for the bond price firms borrow at, which maps directly to credit spreads. As lenders are able to recover a higher fraction of the firm's unlevered value in default, credit spreads will be lower. Finally, I estimate the fixed debt issuance cost off of two moments. First, I target the average dispersion of maturity dates (σ_{Mat}) observed in the data. I exploit the fact that there exists a one-to-one mapping between the share of dispersed debt firms hold in the model and σ_{Mat}. The fixed debt issuance cost is informative for pinning down the average dispersion of maturity dates since it is one of the fundamental trade-offs firms present that encourages firms to chose between dispersed and concentrated debt payments. Additionally, I target the average underwriter fee observed in my data for the fixed debt issuance cost. This is to ensure that fixed costs in the model are empirically reasonable. If, for example, my model implied underwriter fee was greatly at odds with what is observed in the data, this would imply that the presence of fixed debt issuance costs may not be the correct trade-off firms face when choosing to hold maturity walls or not. I estimate the fixed debt issuance cost to be 0.003, which is about 10% of the free-cash-flow to the firm. This is an economically large value and consistent with the empirical observation that firms face large fixed costs when choosing to issue corporate bonds through underwriters. In the next section, I compare the economic magnitudes of the debt and equity issuance costs.

To estimate the variance of the manager preference shocks, I target the variance of the debt to income ratio. Since the manager preference shocks are simply injecting some noise into the debt choices of the firm, they should not impact the average choice of the firm, just the spread in choices firms make. The value of σ_ε must be strictly positive for the computational benefits of the extreme value shocks to apply. The benefit of these shocks comes because they assign similar probabilities of selecting choices that yield similar levels of utility to the firm; in models of long-term debt, it is often observed that different levels of debt can yield similar levels of utility for firms, increasing computational challenges (Chatterjee and Eyigungor, 2012). The manager preference shocks help differentiate the value of selecting various levels of debt for the firms. Therefore, it helps explain the firms' choices, as well as help the model fit the data better. Economically, these preference shocks are capturing unobserved costs and benefits to managers of selecting a given level of debt and composition of debt maturity dates.

One measure of the size of the extreme value shocks is how noisy the debt decisions are; at an individual level, the variance of debt decisions, conditional on the firm's current states, is zero without the extreme value shocks. In my model, the average coefficient of variation of debt to income across all firms is only moderately high at 11.67%[12]. While moderately large, this is not too surprising and can be explained by the fact that the preference shock is capturing other unobservable factors behind the debt choice decision not included in the model, such as investment decisions taken by firms.

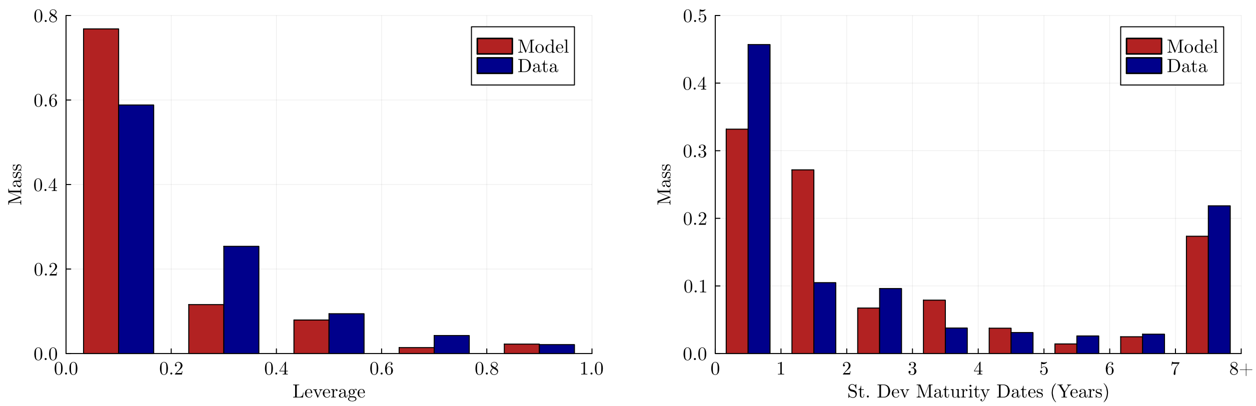
[12] At each point in the state space, I compute the standard deviation and mean of debt-to-income implied by the decision rules. I then take the ratio of these numbers at each point and average over the stationary distribution.

5.2 Model fit: Unconditional distributions

I next assess how the model performs relative to certain non-targeted properties in the data. In particular, I ask how the model matches the general distribution of the market leverage rates and the dispersion of debt maturity dates (σ_{Mat}), presented in Figures 5a and 5b.

Figure 5: Distributions in Model and Data

(a) Market Leverage (b) St. Dev Maturity Dates



First, consider the distribution of market leverage rates in the model (in red) and in the data (in blue), which is completely untargeted. As in the data, the model correctly generates a long-left tail for market leverage. While the model does a good job matching the qualitative properties of the market leverage distribution — particularly the long right tail — it slightly overstates the fraction of firms with a market leverage ratio below 0.2.

Second, I consider the fit on the standard deviation of maturity dates. The model does a good job of matching the distribution of debt payment dispersion: in particular, it implies a large fraction of firms with relatively concentrated debt payments: In the model and data, around 50% percent of firms have a standard-deviation of maturity dates less than 2 years. In addition, the model matches the fraction of firms with very dispersed debt payments. Since the maturity of the long-term bonds in the model is fixed at $1/\lambda$, the maximum dispersion the model can generate is truncated at just below 8 years. As a result, to consider the relative fit of the model generated distribution of σ_{Mat} to the data, I also truncate the data at 8 years[13].

[13]It is likely that a more flexible model with a choice on the average maturity parameter $1/\lambda$, similar to Bocola and Dovis (2019); Dvorkin, Sánchez, Sapriza, and Yurdagul (2021); Poeschl (2023) would allow for a better fit of firms with very dispersed debt payment dates.

6 Model Properties

I begin by describing the trade-offs faced by the firm when selecting between debt with dispersed payments and debt with a concentrated payment. I then go on to highlight how the relative cost between issuing debt and equity issuance affect capital structure choices. Finally, to validate the estimated model, I show how it matches untargeted moments on (i) how the income process (i.e. sales) and leverage affect firms' debt concentration choice and the persistency of the choice, and (ii) the relationship between the dispersion of debt payments and credit spreads.

There are three factors the firm considers when deciding on the composition of its debt: (i) the equity smoothing benefits of dispersed debt, (ii) the issuance cost savings of concentrated debt, and (iii) lower interest rates on concentrated debt driven by firms defaulting with lower levels of debt when they hold more concentrated debt.

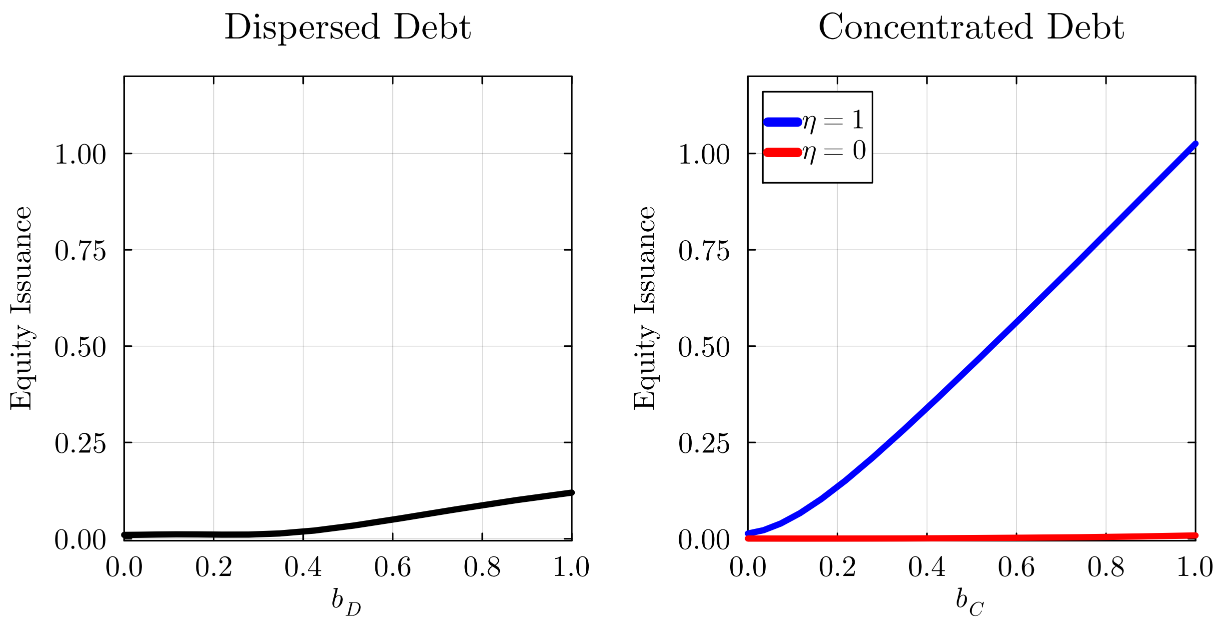
6.1 Equity smoothing benefits of dispersed debt

Consider, first, the equity smoothing benefits of dispersed debt. Dispersed debt can act as a hedge against rollover risk for firms. Recall that firms may need to inject equity from shareholders if they are not able to raise enough revenue on the bond market to roll over their debt. Given that equity injection costs are convex, the firm has an incentive to smooth equity injections from shareholders over time. This arises from the fact that the firm acts as if it were a risk averse agent, due to the curvature of the dividend payout function $\psi(d)$ governed by the parameter α.

Why does dispersed debt smooth equity injections for the firm? It is due to the dispersed repayment schedule b_D comes with. Consider a firm with a low realization of y, such that it has a high likelihood of injecting equity. The dispersed bond offers small and deterministic principal payments to lenders (λb_D), which translates to small and deterministic equity injections, since the amount of equity needed to inject is independent of η. In contrast, the concentrated bond *is* dependent on η: it offers infrequent but potentially large equity injections, if it is required to repay all of b_C.

This can be most clearly observed in Figure 6. The left panel shows the amount of equity needed to inject when its entire debt holdings are in b_D. As the firm holds higher levels of debt, it requires larger equity injections which grow convexly. Further, note that the amount of equity needed to be injected is independent of η, since the firm makes deterministic principal payments. The right panel shows the amount of equity needed to inject when its entire debt holdings are in b_C. Again, the amount of equity needed to be injected grows as

Figure 6: Equity Smoothing Benefits of Dispersed Debt



b_C grows. However, the amount of equity needed to be injected is dependent on η: When $\eta = 1$, and the firm needs to roll over b_C, the firm needs to inject a higher amount of equity, while when $\eta = 0$, the firm doesn't need to inject anything. Given that the firm's preference is to smooth equity injections over future states, the dispersed bond is preferred, all else equal. In effect, dispersed debt acts as an insurance product for the firm to protect against rollover risk, or large equity injections.

6.2 Issuance cost savings of concentrated debt

Next consider how concentrated debt can save the firm on issuance cost payments. A common feature of this class of models is the presence of a target leverage ratio. Conditional on an income level, the target leverage ratio balances the costs of holding debt (default costs) and benefits of holding debt (tax benefits). Suppose that a firm is at it's target leverage ratio and it understands that it's income is to remain relatively stable over the future periods. How would a firm choose the composition of its debt?

Given the presence of fixed issuance costs, the firm is going to prefer to issue the concentrated debt, due to its infrequent principal payments, and thus, infrequent issuance cost payments. In contrast, the dispersed debt requires frequent principal payments, and as a result, frequent issuance cost payments by the firm. The frequent issuance costs are a result of the firm wanting to maintain it's target leverage ratio over time. Thus, the firm tops-up its total level of debt each period to return to its target leverage ratio. But in doing so, it pays the issuance cost.

Figure 7: Issuance Cost Savings of Concentrated Debt

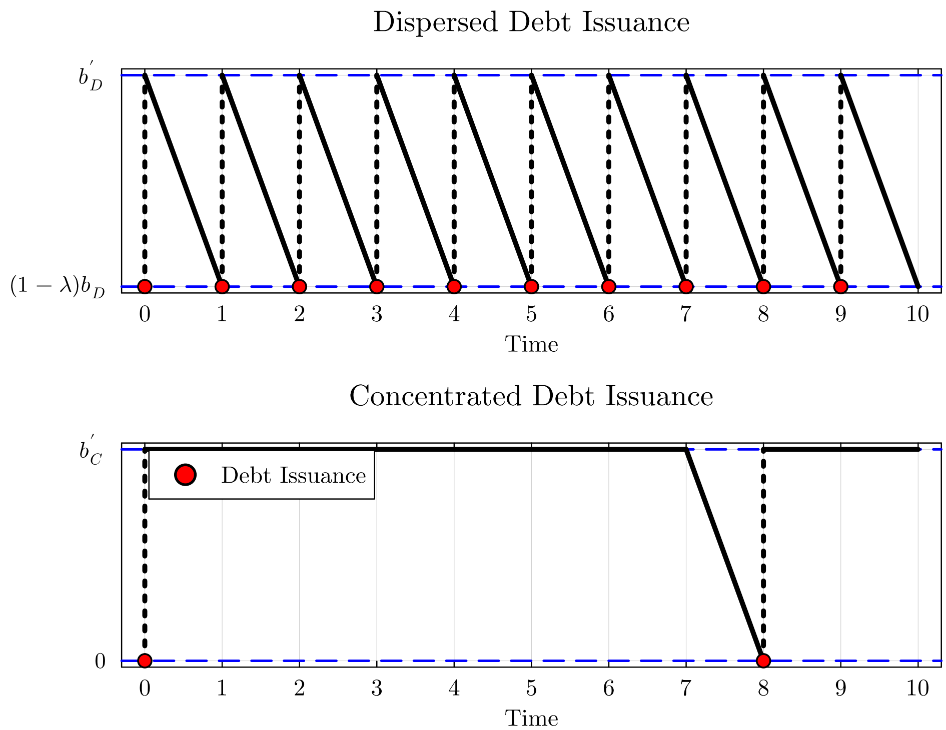


Figure 7 highlights this scenario for a firm. In this example, a firm has deterministic income $y_t = \bar{y}$ for all t and wants to remain at its target leverage ratio. The top panel considers the issuance behavior of a firm at its target leverage ratio holding b_D. Each period it repays principal λb_D, but since it would like to remain at a leverage ratio of b_D, it chooses to re-issue the amount of λb_D, thus incurring the debt issuance cost. The bottom panel considers the issuance behavior for a firm at its target leverage ratio holding b_C. In this setting, the firm does not have to make any principal payments until $t = 8$. Since it is already at its target leverage ratio, it also does not make any new issuances, thus avoiding paying the issuance cost until $t = 8$.

6.3 Relative costs of debt issuance and equity issuance

As noted in above, b_D and b_C each afford some cost savings to the firm: b_D can save the firm from issuing costly equity to help repay their debt. However, because the firm regularly issues to maintain a target debt level, b_D incurs more frequent debt issuance cost. Thus, as the firm chooses which type of debt to issue, it focuses on the cost of injecting equity relative to the cost of issuing debt. Understanding the relative cost of issuing debt and equity gives insights into why, and which type of firms pick debt with a concentrated payment vs debt with dispersed payments. Additionally, it sheds light on how to recover the structural parameters related to the debt issuance cost and rollover risk, that are unobserved to the researcher, based on firm choices that are observed in the data.

Figure 8: Relative Cost of Issuing Debt and Equity

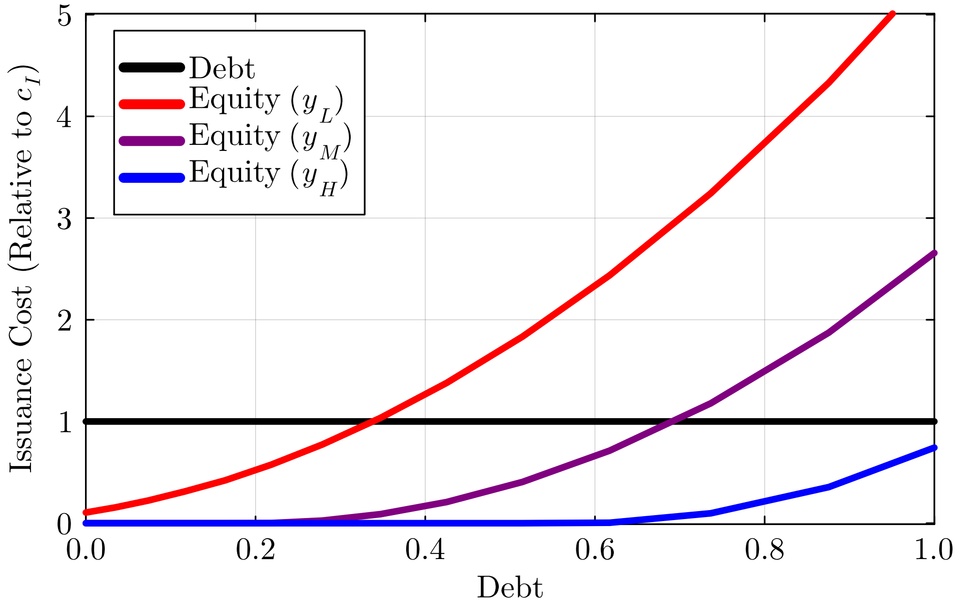


Figure 8 details how the relative cost of debt and equity vary based on how much the firm borrows and their income. All costs are normalized by the cost of issuing debt (c_I). The black horizontal line plots the cost of issuing debt. Note that the black line is horizontal because the cost of issuing debt is a fixed cost; regardless of how much debt is issued, the cost is the same. The cost of equity[14] varies based on (i) how much debt the firm has and (ii) their level of income. Note that conditional on a firm's income, the cost of equity injection increases convexly as the firm has a higher total level of debt. This is due to two forces: (i) the principal payment increases as the total level of borrowing increases and (ii) the coupon payment also increases as the total level of borrowing increases.

Based on the relative costs, firms with low levels of leverage have low rollover risk and choose more concentrated debt payments. Opting for concentrated debt payments, firms are likely to be able to rollover the principal upon a realization of $\eta = 1$. Even if they

[14]The cost of issuing equity is $\alpha d(b, y; s_D, b', s'_D)^2 \mathbb{1}_{d<0}$, where s_D is the share of dispersed debt held by the firm, b' is the level of borrowing done by the firm, and s'_D is the new share of dispersed debt borrowed by the firm. I fix s_D, b', s'_D at the level for the average firm in the economy. I have integrated out the repayment shock η.

cannot fully rollover their debt, the amount of equity they would need to inject from equity holders to make up the difference would be small, too. These firms do not find it beneficial to repeatedly pay the fixed debt issuance cost, since they do not capture any of the benefits from debt with dispersed payments.

As firms lever up, however, this changes. At some point, the cost of injecting equity exceeds the cost of issuing debt. When firms have higher levels of leverage, they face higher rollover risk, especially when their debt composition is tilted more toward concentrated debt. Failing to rollover large amounts of debt translate to large equity injection for firms, which is exceedingly costly. As a result, firms now find it optimal to repeatedly pay the debt issuance cost, which allows them to tilt their debt composition toward debt with dispersed payments, since debt with dispersed payments aims to minimize rollover risk by smoothing equity injections.

The choice of dispersed or concentrated debt also depends on the firms' income level. Note that as firms have lower income, the cost of equity injections quickly dominates the cost of debt issuance for lower levels of debt. Firms with lower income already have less internal cash to work with and face higher interest rates from the bond market. Thus, the likelihood of them failing to raise enough revenue from bond market is non-trivial and thus they rely more heavily on equity injections. As a result, firms with low income prefer to disperse their debt payments, precisely because the benefits of dispersing their debt payments, which allows for smooth equity issuance, dominates the repeated cost of issuing bonds.

In equilibrium, I find that the cost of issuing debt is on average 3.3 times greater than the cost to issuing equity. The relative cost comparison of debt and rollover risk — or equity in the model — underscores the large mass of firms holding maturity walls observed empirically. Firms hold maturity walls not because they are exceptionally risky, but because the costs associated with failing to roll over maturity walls is small relative to the cost of issuing bonds.

Table 5: External Validation
Debt Payment Dispersion Predictors

	St. Dev Maturity Dates	
	Data	Model
St. Dev Maturity Dates$_{t-1}$	0.749	0.890
Leverage	0.182	0.189
Revenue	-0.071	-0.033
Additional Firm Controls	Yes	—

The predictions from the model are consistent with the data. Table 5 runs the same regression in my model as in the data. In it, I regress a dispersion of debt payments (σ_{Mat}) on a lagged version of itself, their book leverage choice, and their sales revenue[15]. As is evident from the table, firms' debt maturity dispersion choice is persistent over time and matches the magnitudes observed in the data. Additionally, a one standard deviation in firms' book leverage increases the dispersion of debt payments by 0.55 years (0.18 standard deviations). Finally, the data lends support to the prediction about the relationship between revenue and a firm's choice to *not* disperse their debt payments: in the model and data, a one standard deviation increase in sales revenue decreases the dispersion of debt payments by about 0.1 years (0.07 standard deviations).

6.4 Firms default more with higher levels of concentrated debt

Finally, observe that the price of dispersed debt $q_D(b'_D, b'_C, y)$ and concentrated debt $q_C(b'_D, b'_C, y)$ need not be the same in equilibrium. The difference comes from the fact that the default choices may depend on the composition of debt, as can be seen in Figure 9. As a result, the prices of debt will not be the same since the lender does not expect to be repaid the same amount. In the estimated model, I find that the the price of debt, which is inversely related to the interest rates on debt, $q_D(b'_D, b'_C, y) > q_C(b'_D, b'_C, y)$ in equilibrium, as seen in Figure 10.

To understand the intuition for why it is more costly to borrow b_C than b_D, consider a stylized three-period environment where a firm borrows a $b_D = b_C = B$ in period 1.The firm receives deterministic income y_2 in period 2 and $y_3 = -\infty$ in period 3. As a result, the firm will default with certainty in period 3[16]. Additionally, the lender cannot recover any of the firm's assets ($\chi = 0$). What would the prices of debt $q_D(B, B, y_2)$ and $q_C(B, B, y_2)$ be?

To see that $q_D(B, B, y_2) > q_C(B, B, y_2)$, suppose that y_2 is such that $\delta(B, B, y_2, \eta_2 = 0) = 0$ and $\delta(B, B, y_2, \eta_2 = 1) = 1$. In other words, the firm defaults with probability λ in period 2. In period 1, each bond is priced as the expected repayment the lender expects to get:

$$q_D(B, B, y_2) = \beta(1 - \lambda)(\varsigma + \lambda)$$
$$q_C(B, B, y_2) = \beta(1 - \lambda)\varsigma$$

[15]In the data, I additionally control for other factors that are likely to impact a firm's choice to have a maturity wall that are absent from my model. The controls include, size, age, average maturity, cash holdings, the fraction of bond debt, and firm's credit rating.

[16]This assumption is in place to keep the setup simple and allows me to ignore future borrowing decision by the firm. The firm will not borrow anything since prices are 0, or interest rates are infinite; lenders will not receive any cash-flow from the new borrowing since the firm is guaranteed to default.

Figure 9: Default Choice: Dispersed vs Concentrated Debt

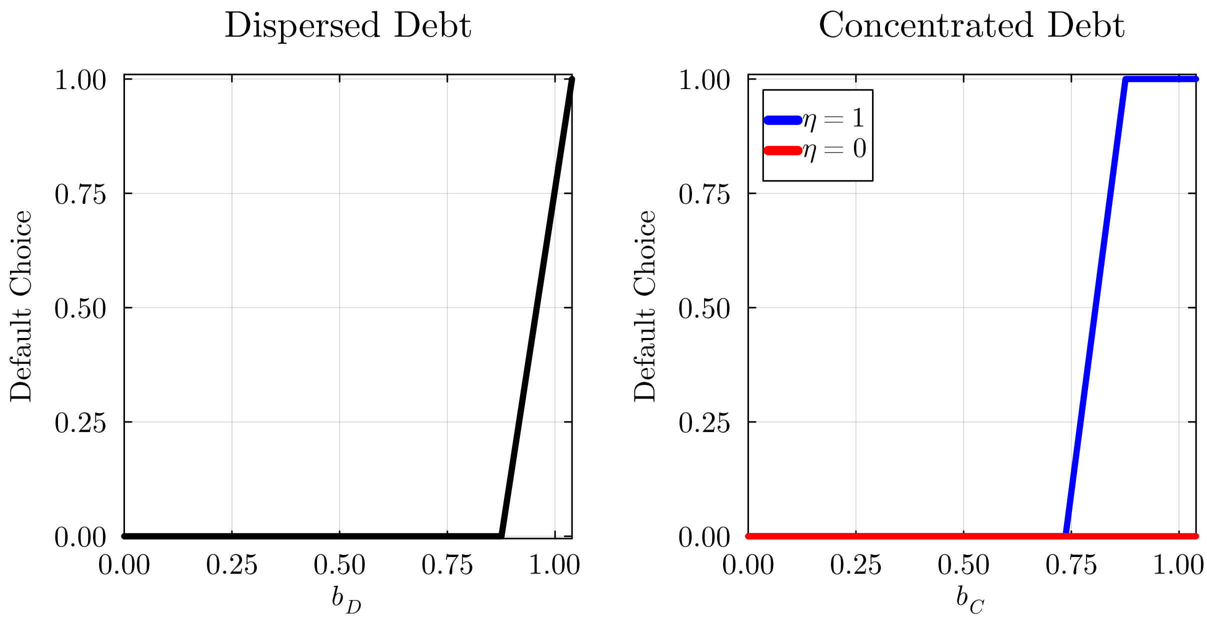
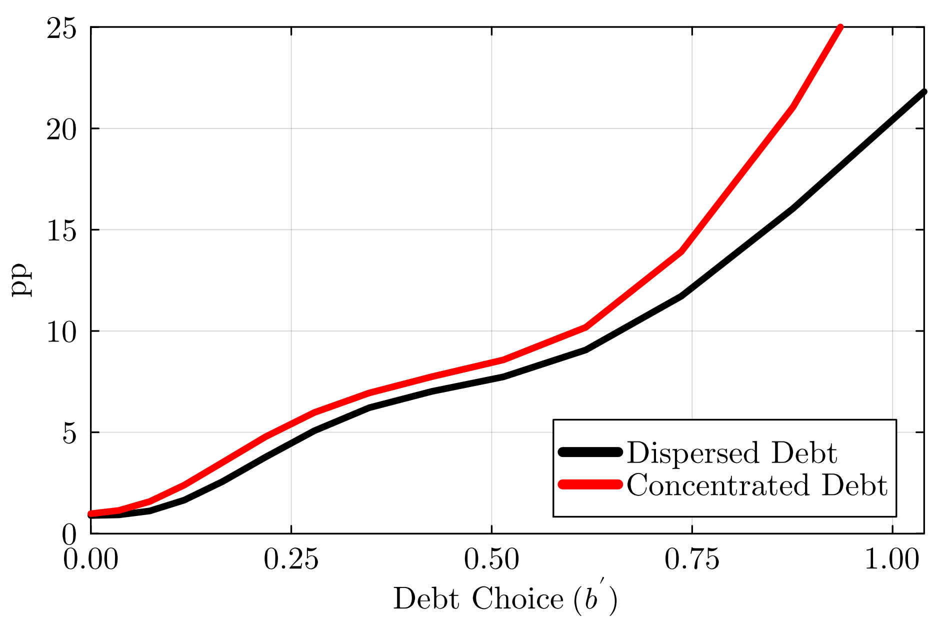


Figure 10: Credit Spreads: Dispersed vs Concentrated Debt



It is easy to see that that $q_D(B, B, y_2) > q_C(B, B, y_2)$, or the cost of borrowing b_C is higher than b_D since the lender expects higher total payments when the firm borrows the dispersed bond.

Given that the default decision is dependent on the composition of debt, and, as a result, bond prices differ by each type of debt, the cost of borrowing each bond is not going to be the same. In particular, because lenders are less likely to be fully repaid when a firm borrows debt with concentrated payments, they demand higher interest rates.

Table 6: External Validation
Credit Spreads & Debt Payment Dispersion

	Credit Spread (bps)	
	Data	Model
Leverage	29.688	72.798
Revenue	-36.929	-46.551
σ_{Mat}	-12.351	-19.794
Additional Firm Controls	Yes	—

Again, the qualitative predictions and the magnitudes predicated in the model are consistent with the data. Table 6 runs the same regression in my model as in the data. In it, I regress a firm's credit spread on a newly issued bond, the firm's choice of book leverage, an indicator if the firm chooses a maturity wall, and their sales revenue[17]. The following observations can be made from the table. First, firms with higher levels of leverage face higher credit spreads: a one standard deviation in firms' book leverage is associated with increased credit spreads by 29 bps in the data and 72 bps in the model. Second, firms with high revenue face lower credit spreads: a one standard deviation increase in revenue is associated with a decreases in spreads by between 36 bps and 46 bps. Finally, firms with more dispersed debt payments face lower credit spreads: a one standard deviation increase in the dispersion of debt payments is associated with a decreases in spreads by between 12 bps and 19 bps.

7 Quantitative Results

The previous section showed that the model successfully replicates key cross-sectional facts about the financing choices of U.S. public firms. The model thus provides an appropriate quantitative framework for quantifying the role of maturity walls in the presence of idiosyncratic and aggregate shocks.

[17] I additionally control for the same variables as in Footnote 15.

7.1 How much do maturity walls contribute to firm default & credit spreads?

In equilibrium, firms may default for a variety of reasons, one of them being the inability to roll over a maturity wall. How much of the equilibrium default rate can be attributed to maturity walls? To address this question, I can decompose total defaults observed in equilibrium into those that coincide with firms needing to roll over a maturity wall ($\eta = 1$) and those that are unrelated to firms needing to roll over a maturity wall ($\eta = 0$). Then, it is straightforward to quantify the fraction of defaults coming from firms failing to roll over maturity walls. I find that maturity walls account for 14% (0.17 pp) of all defaults observed in equilibrium.

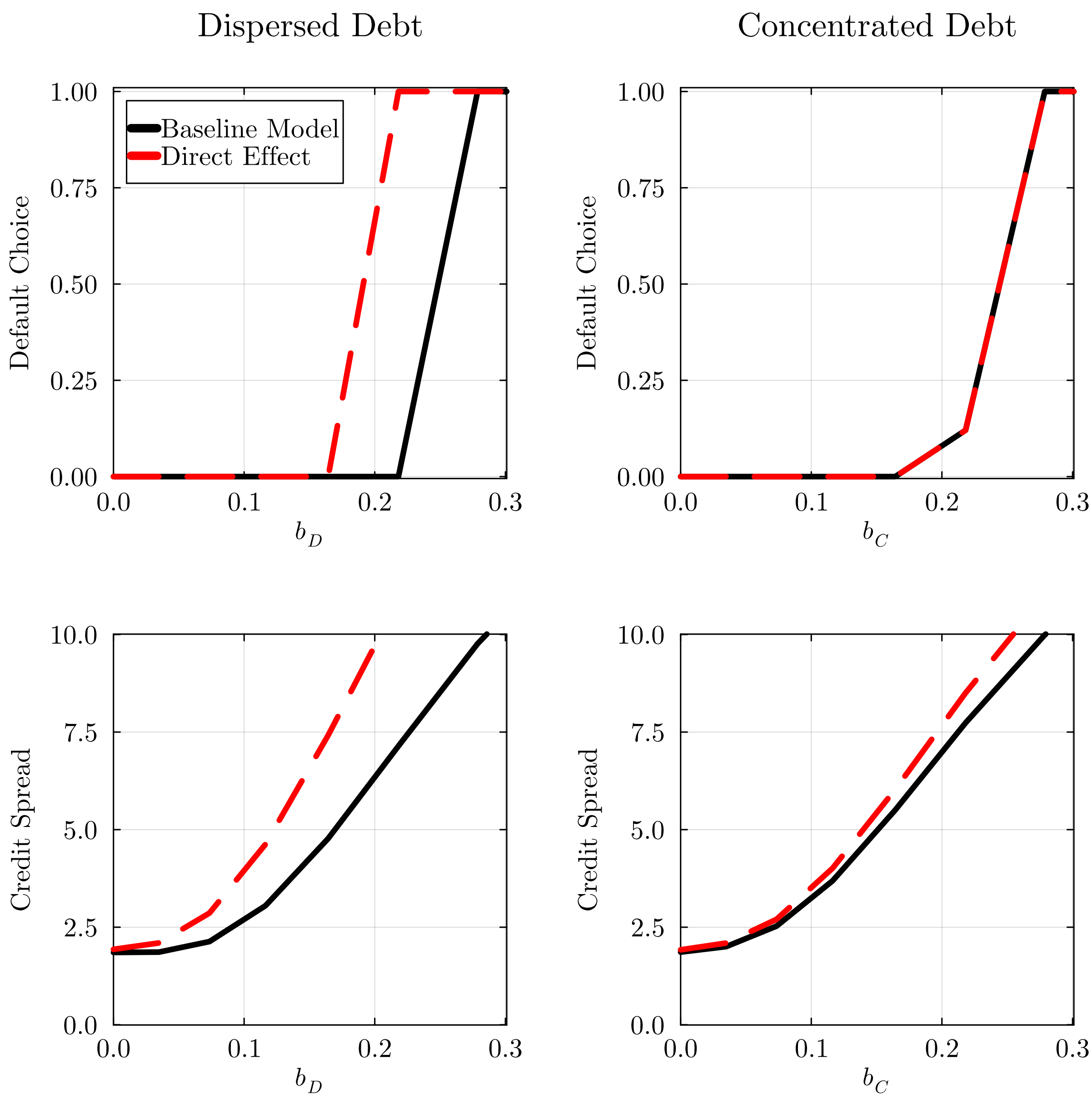
The above decomposition is based on the steady state values that arise in equilibrium. In the next exercise, I quantify the causal effect of having maturity walls on individual firms' default rates and credit spreads. It is not sufficient to simply compare how credit spreads or defaults differ for firms with maturity walls and those without in equilibrium, since it is not an apples-to-apples comparison. Firms with maturity walls are qualitatively different, in terms of their states and choices, from firms without maturity walls. Thus, an exercise of simply looking at how credit spreads or defaults differ for firms with and without maturity walls would not be isolating the *causal impact* of maturity walls on these outcomes as it would be confounded with firms' states and choices in the model.

To isolate the effect that maturity walls have on firms' default rates and credit spreads, I use the structural model to generate exogenous variation in firms' debt structure, while holding all other choices and states fixed. In particular, I solve for a counterfactual economy where firms make the same total leverage choice as they do in equilibrium, but firms are restricted to borrow in b_C, the debt with a concentrated payment. In addition, firms optimally choose to default or not, and lenders price all new loans consistent with them making zero profits in expectation. Finally, new moments are calculated under the baseline stationary distribution. This way, I can exogenously vary firms' debt structure choice by restricting them to borrow in b_C, and isolate the causal direct effect of having maturity walls on individual firms' default choice and their credit spreads[18].

The quantification exercise finds that maturity walls increases firm default risk on average by 25% (30 bps). In addition, firms with maturity walls see an increase in their credit spread on average by 21% (36 bps). As is detailed in Figure 11, firms see an increase in their default

[18] I refer to this as a "direct" effect of maturity walls as firms keep their leverage the same as when there is no restriction on b_C and only adjust their repayment schedule under the new restriction. When firms are also allowed to optimize over their leverage under the new restriction, the "indirect" effect can arise through firms jointly optimizing leverage *and* debt repayment schedule.

Figure 11: Direct Effect of Maturity Walls



risk and their credit spreads because they are losing out on the equity smoothing benefits of b_D. The top two panels explores how firms with all dispersed debt and all concentrated debt change their default behavior in the baseline model (solid black line) and the counterfactual economy (dashed red line). It is evident from the figure that firms who held dispersed debt in the baseline economy cannot sustain as high of a level of debt in the counterfactual economy, due to the fact that they have random large principal payments they need to make. As a result, these firms now find it optimal to default, rather than inject costly equity to cover their rollover losses. Not surprisingly, the default behavior of firms with concentrated debt does not change. The bottom two panels look at how lenders react by changing their credit spread. Lenders, recognizing this shift in firm's behavior, demand higher interest rates on new loans to compensate for the risk. The loan changes are largest for firms who held dispersed debt in the baseline economy as these are the firms that see the highest rise in default risk. However, spreads for firms with concentrated debt also slightly rise, as these firms also have elevated long-run default risk.

7.2 Are firms less risky if it is cheaper to disperse debt payments?

A key trade-off in the model that governs the firm's choice of a maturity wall is the debt issuance cost, or the empirical equivalent underwriter fee. As discussed above, the underwriter fee is in part serving as a transaction cost, where the underwriter conducts due diligence on the firm and brings the bond to market. However, a non-trivial component of the underwriter fee has also been attributed to rents underwriters extract due to their market power. Manconi, Neretina, and Renneboog (2018) document that the underwriter market has different levels of competition, with underwriters often exploiting their market power when bringing corporate bonds to market. They find that the most powerful underwriters use their market power to extract rents at the expense of issuing firms, typically by demanding higher fees. These higher underwriter fees, driven by market power, have often driven firms to alter their issuance strategies, as they try to avoid paying these rents.

By choosing to have maturity walls, firms are taking on some rollover and default risk. The above exercise highlighted that maturity walls can be risky for firms and quantifies that the presence of maturity walls increases default risk by 25% and credit spreads by 21%. A natural question arises: would firms be less risky if it were cheaper to disperse their debt payments?

My model provides an interesting framework to assess the effects of underwriter market power on firms choice of maturity walls, their total borrowing choice, and their default risk and credit spreads. In addition, I can also quantify the economic inefficiency that arises due to the presence of underwriter market power. Manconi, Neretina, and Renneboog (2018) estimate the fraction of underwriter fees that is directly attributed to underwriter market power, finding that the on average, market power accounts for 16% (12.2 bps) of underwriter fees; the maximum rents account for 25% (19.4 bps) of the underwriter fee[19].

To answer this question, however, an equilibrium analysis must be undertaken. Holding current firm choices fixed, reducing the debt issuance would make firms safer since it will be cheaper for them to disperse their debt payments. However, recall that firm's choice of their payment schedule is jointly chosen with their total level of debt. Thus, by reducing the underwriter fee, firms will adjust and make new debt level choices. Indeed, since in the baseline framework firms that do not have maturity walls have higher total levels of debt, it is likely that firms will opt to borrow even *more* debt, potentially undoing the risk minimization benefits of dispersed debt. As a result, it is quantitatively ambiguous how reducing the markup in underwriter fees would impact firm creditworthiness. I solve for a counterfactual equilibrium where my debt issuance cost is reduced by the mean and maximum estimated rents to approximate the underwriter fees that would arise in a competitive equilibrium. Table 7 reports the moments from the baseline economy compared to the counterfactual economies with reduced underwriter fees.

Table 7: Counterfactual equilibrium: No maturity walls

	Baseline	$0.84c_I$	$0.75c_I$
Share of debt held in b_D	18.25%	42.46%	50.00%
Debt Maturity Dispersion σ_{Mat}	2.62 years	4.85 years	5.62 years
Book leverage	20.72%	38.03%	42.48%
Market leverage	14.67%	24.26%	26.59%
Credit spread on b_D	1.44%	2.54%	2.84%
Credit spread on b_C	1.70%	2.65%	2.89%
Average credit spread	1.69%	2.64%	2.88%
Firm default rate	1.19%	1.96%	2.15%
Δ Market value	—	0.85%	1.01%

Decreasing the underwriter fee has predictable implications for firms' choice of debt payment dispersion. Eliminating underwriter market power, and thereby decreasing underwriter fees firms increase the average dispersion of debt payments by up to 5.6 years. Recall that the relative trade-off between debt and equity governs firms' choice of debt payment disper-

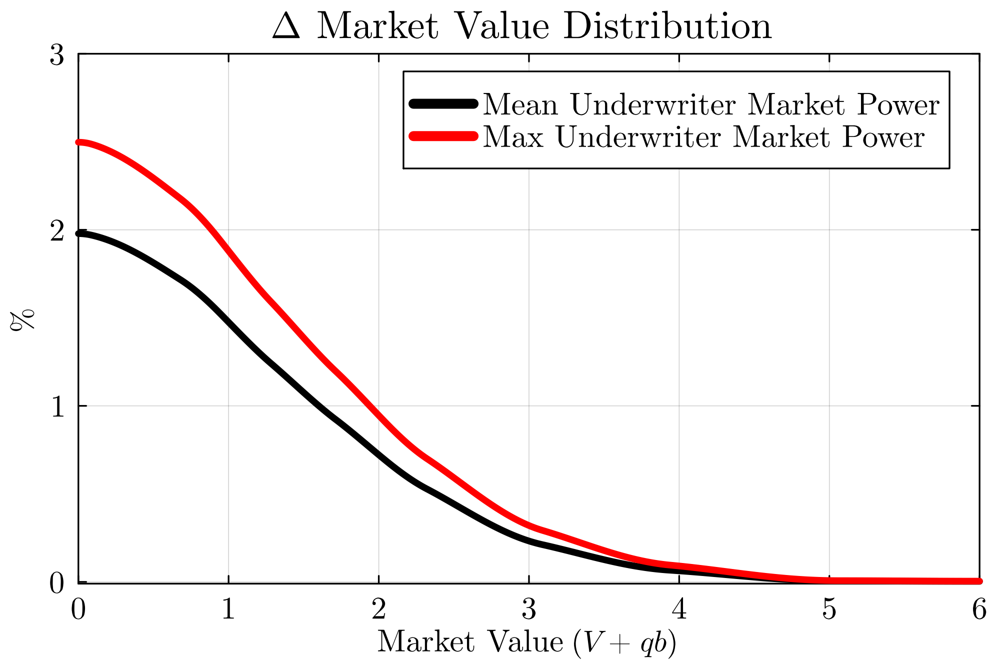
[19]To arrive at this number, I use their estimate on the relationship between *Power* and the underwrite fee issuers face in Table 2.A.1, combined with the fact that the mean (max, in absolute value terms) power is -2.23 (-3.53).

sion. As the underwriter fee falls, the cost of issuing debt versus equity changes: injecting equity is now *relatively* more expensive and as a result, firms substitute to debt with more dispersed payments. Additionally, firms will also increase their total of level of borrowing and their market leverage. I find that firms increase their book leverage, or total amount of borrowing, from 20.7% to up to 42.5% and increase their market leverage, which captures their total level of borrowing relative to shareholder value, from 14.7% up to 26.6%. This increase in borrowing arises from the fact that as it becomes cheaper for firms to issue debt, firms opt to disperse their debt payments to reduce the amount of rollover risk they are subject to. As a result, they opt to hold higher levels of debt because they reassess the benefits of holding debt with the costs of holding debt. Relative to their original debt choices, firms are safer and thus they opt to take on more default risk through higher borrowing because of the higher tax benefits of debt they can claim.

Given that decreasing underwriter fees induces firms to disperse their debt payments more *and* borrow a higher level of debt, it is, ex ante, unclear how eliminating market power in the economy will impact firm's default rate and their credit spreads. Clearly, a shift to more dispersed debt will attenuate default risk, holding the level of borrowing fixed. However, since firms are likely to increase their level of borrowing, this increases their default risk, holding all else fixed. The effect of eliminating underwriter power on default risk and credit spreads again will depend on the relative size of each channel. Strikingly, I find that firms increase their borrowing so much that they see up to a 80% increase in their default rates and up to a 70% increase in the cost of borrowing (interest rates). Increases in defaults and spreads are driven in part by the fact that firms are choosing higher levels of debt, but it is also driven by the fact that all firms now are paying the fixed debt issuance cost more frequently: the present discounted value (PDV) of all future debt issuance costs made by firms increases by 10%.

How does the reduction in underwriter market power impact total firm value? I find that the reduction in market power leads to substantial growth in the market value of firms, defined as $V(\mathcal{S}) + q_D(b'_D, b'_C, y)b'_D + q_C(b'_D, b'_C, y)b'_C$. Figure 12 plots the change in market value for the distribution of firms. The x-axis considers the market value of the firm in the baseline economy and the y-axis displays the percent growth in that firm's market value. The black line considers the case when the mean underwriter rents are removed and the red line considers the case when the maximum underwriter rents are removed. In both cases, all firms are weakly seeing growth in their market value, while firms with the lowest market value in the baseline economy sees the largest growth. On average, I find that market value increases by 0.85% to 1.01%.

Figure 12: Firm Value Growth in Perfectly Competitive Underwriter Market



7.3 Maturity walls and credit market freezes

The model assumes firm default failure is driven by idiosyncratic shocks to the asset value of individual firms. In reality, many firm failures occur due to aggregate shocks. Aggregate shocks may further interact with the presence of maturity walls in non-trivial ways. For example, numerous papers (Almeida, Campello, Laranjeira, and Weisbenner, 2009; DeFusco, Nathanson, and Reher, 2023; Meeuwis, Papanikolaou, Rothbaum, and Schmidt, 2023), note that firms that need to roll over their debt during a credit market freeze often struggle to do so, and as a result they see real cuts to their investment rate and labor hires. Credit market freezes, such as the 2008 Global Financial Crisis (GFC), can be particularly high periods of rollover crises because credit market freezes are typically characterized by a large reduction in the volume of transactions in the bond market and other forms of external financing becomes more costly. Thus, firms that get unlucky and need to roll over a maturity wall during a credit market freeze may not be able to cover the principal payment out of their cash flows, and injecting equity may be too expensive. As a result, they may opt to default. However firms that only need to roll over a small portion of their debt may be more likely to cover it out of their cash-flows.

In this section I explore if the presence of maturity walls can amplify the transmission of an aggregate credit shock to the aggregate default rate. As a simple framework to study the transmission of a credit shock and its interaction with maturity walls, I introduce a one-period, unanticipated shock to the credit market in the benchmark economy. A credit market freeze will be characterized by two things. First debt markets completely shut down and firms cannot issue new debt or buy back debt early. This is equivalent to an infinite interest rate on new debt issuances or prices $q_D = q_C = 0$. Second, equity injections become more expensive. I calibrate the increase in the equity injection cost (α) to target the increase in firm defaults observed in the 2008 GFC.

Effects of a credit market freeze

Figure 13: Heterogeneous Effects of Credit Market Freezes

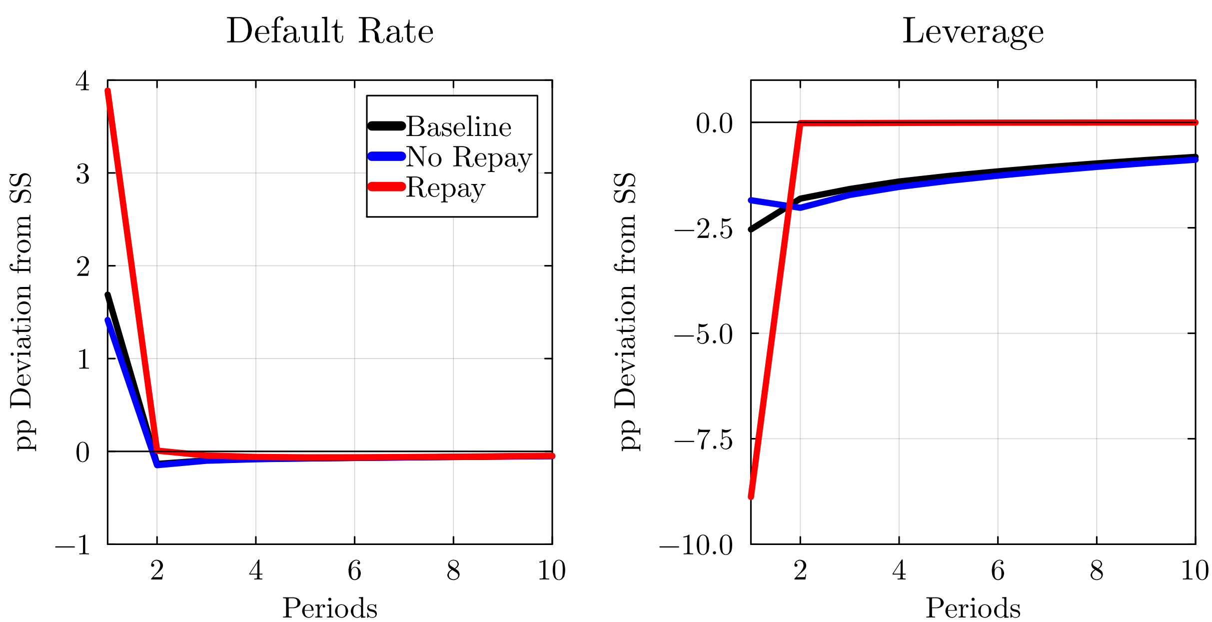
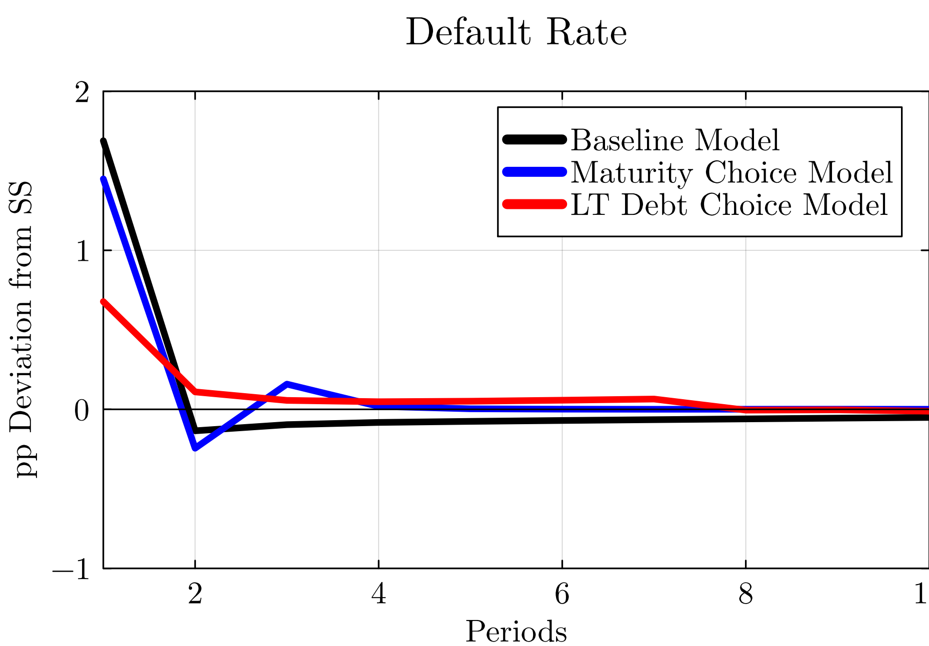


Figure 13 plots the deviation of aggregate default rates and aggregate book leverage from steady state in response to the unanticipated market freeze in black. I find that the aggregate default rate increases and by 168 bps (140%) at the impact of the credit market freeze and aggregate leverage declines by 2.5 pp. Defaults increase, because many firms cannot roll over their debt, and thus they opt to default rather than inject costly equity. Additionally, leverage falls in the first period since non-defaulting firms can only repay principal, but not borrow new debt. The impact of the shock is short lived, given that it is only a one-period shock. After the shock dissipates, the default rate falls below its steady state level — because firms are under-levered — and slowly returns back to steady state. Further, firms slowly build back up their leverage after the shock dissipates.

How do firms that need to rollover their maturity walls fair compared to those that don't? I explore the heterogeneous responses to a credit market freeze in Figure 13. The red line plots the response of firms that must repay maturity walls at the time of the market freeze and the blue line plots the response to firms that do not need to repay a maturity wall. I find that firms that need to rollover their maturity walls at the onset of the credit market freeze are most likely to default, defaulting at a rate of nearly 4pp more than they do in steady state. This has the effect of pulling up the aggregate default rate in the economy in response to a credit market freeze. However, the effect is small since roughly λ percent of firms need to roll over a maturity wall in any given period. Firms that successfully repay their maturity walls at the onset of a credit market freeze exit the period with zero debt, which explains the large drop in their leverage choice.

Credit market freezes under model mis-specification

Figure 14: Credit Market Freeze under Model Misspecification



To highlight the role of maturity walls for the aggregate transmission of a credit market freeze, I compare my benchmark model to two alternative economies: (i) one in which firms can only issue long-term debt modeled as debt with disperse payments (b_D) a la Chatterjee and Eyigungor (2012) and (ii) one in which firms make a maturity choice over their debt holdings a la Arellano and Ramanarayanan (2012). Each model is then re-estimated to match the same data moments as our benchmark model. Then, using the newly estimated parameters, I shock the economy with the same credit market freeze — (i) debt markets completely freeze and (ii) the cost of equity rises to the same level as before — and study how aggregate default rates differ. The model environment and parameter estimates are described in the appendix. Figure 14 plots the default rate response in the baseline model (black line), model with a maturity choice (blue line), and model with long-term debt choice (red line). I find that in a model with only long-term debt modeled as a dispersed bond, the default rate response to the credit shock is sufficiently muted: defaults are 60% (100 bps) lower compared to the baseline model. Similarly, a model with a maturity choice underestimates the default rate response but by a smaller margin; default rates are 14% (25 bps) lower compared to the baseline model. What is the reason for why each model is underestimating the transmission of a credit shock to firm default rates?

First, consider a model with just a long-term debt choice. As discussed throughout the paper, the classical way to model a long-term bond is debt with dispersed payments. The framework essentially makes firms as insulated from rollover risk as they can possibly be *by assumption*. Thus, it is not surprising that a credit market freeze has an attenuated effect on firm default risk since firms do not need to roll over a large amount of principal at the time of the credit market freeze.

Second, consider a model with a maturity choice, where the long-term debt asset is modeled as debt with dispersed payments. This environment produces significantly higher default rates compared to the model with only the long-term bond because firms with sufficiently short average maturity have to roll over a large portion of their debt stock at the time of the market freeze. However, this framework still underestimates the transmission of the credit shock to defaults because firms that are borrowing heavily in short term debt are endogenously borrowing a smaller amount of it compared to firms with maturity walls, since maturity walls are concentrated, yet distant, payment events. Thus, even though these firms need to roll over a sizeable portion of their debt during a market freeze, because it is small, they are more likely to be able to do so.

8 Conclusion

Maturity walls are events where a majority of debt comes due within a short period of time. This paper investigates the role of maturity walls in shaping firms capital structure choices, cost of borrowing, and default risk. I document empirically that maturity walls are a common feature of non-financial firms' capital structure and I build a quantitative model explicitly modeling the choice to have a maturity wall. I find that maturity walls increase credit spreads by 21% (36 bps) and default rates by 30% (25 bps). Decreasing the cost of issuing debt encourages firms to disperse their debt payments more, but it increases their credit risk because firms increase their total level of borrowing. Additionally, maturity walls amplify the transmission of an aggregate credit market freeze to aggregate defaults. The model also underscores the importance of accounting for maturity walls when assessing the transmission of aggregate shocks: omitting maturity walls would underestimate the transmission of a credit market freeze by 14%-60%.

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Appendix

The appendix is organized as follows:

- Section A describes the details of the data construction in Section 2.
- Section B describes additional empirical results noted at the end of Section ??.
- Section C describes the computational algorithm used to solve the model in Section 4.
- Section D describes the environment and estimated parameters for the alternative models considered in 7.

A Data Construction

Bond level data is obtained from Mergent FISD and firm balance sheet data is obtained from Compustat North American Fundamentals Annual running from 1995 - 2019. All data is accessed using WRDS. The choice of firm identifier is `GVKEY`. In section A.3, I describe how I match `GVKEY`s to firm issuers in Mergent FISD, since `GVKEY` is not present there.

A.1 Mergent FISD

I start with all bonds in the Mergent database and proceed with the following cleaning process.

1. I exclude the following types of bonds: Yankee, Canadian, Convertible, Foreign Currency, Asset Backed, Foreign Issue, Perpetual, Rule 144A, Private Placement.
2. I restrict the sample to corporate bonds, including: Corporate Debentures ("CDEB"), Corporate Medium Term Notes ("CMTN"), Corporate Medium-Term Zero-Coupon Note ("CMTZ"), Corporate Zero-Coupon Bond ("CZ"), and US Bonds ("USBN").
3. I require that I can match the bond issuer to S&P's Compustat North America database.
4. I exclude bonds issued by financial and utilities firms (SIC codes 4900 - 4999 and 6000 - 6999).

I utilize the following variables as I construct the amount of debt outstanding in each year.

1. `offering_amt`: Bond issue size (rescaled to be in $M)
2. `offering_date`: The date on which the bond was issued.
3. `underwriter_spread`: `gross_spread/principal_amt`*100 is the per-dollar underwriter fee firms pay to issue a corporate bond.

4. `coupon`: Coupon rate on newly issued bond
5. `treasury_spread`: Credit spread, or difference between yield on bond issued and treasury of comparable maturity.
6. `maturity`: The date which the bond must be paid back.
7. `general_type`: Defined to be one of four possible actions the firm can take on the bond and is constructed from `action_type`. `D` represents a default on the bond issue by the firm; `A` represents scheduled principal payments; `I` represents new bond issuances by the firm; and `P` represents unscheduled payments by the firm. This requires use of the AMOUNT_OUTSTANDING and AMT_OUT_HIST tables from Mergent. See Ma, Streitz, and Tourre (2023) Appendix A.2.2 for more details.
8. `offering_date`: The date on which the change to the issue's amount outstanding became effective.

For each bond, at each year, I construct construct the amount of principal outstanding, taking note to make sure that I capture any early pre-payments on their debt, as noted in `general_type`. To construct the amount of bond debt outstanding in each year, I aggregate up to the firm level. From there, it is straightforward to construct the share of debt due for each maturity-year, average maturity of all bonds outstanding, and $\sigma_{Mat,t}$.

A.2 Compustat

Compustat variables follow the standard definitions used in the literature.

1. Leverage: (`DLTT` + `DLC`)/(`AT` + `PRCC` × `CSHO` - `CEQ` - `TXDB`)
2. Size: log of total assets (`AT`)
3. Age: Number of years between fiscal year and CRSP listing year (`LISTYEAR`).
4. Market-to-Book (Q): (`AT` + `PRCC` × `CSHO` - `CEQ` - `TXDB`)/`AT`
5. Cash: `CH/AT`
6. Profit: earnings before interest, taxes, depreciation, and amortization scaled by total assets, `EBITDA/AT`.
7. Interest Coverage Ratio: EBITDA to interest expense, `EBITDA/XINT`
8. Tangibility: plant, property, and equipment scaled by total assets, `PPENT/AT`.
9. Credit Rating: S&P Credit Rating File
10. Bond Fraction: ratio of total book value of bonds available to total book debt for each firm.

A.3 Merging Mergent FISD with Compustat

To match bonds to the firm in every period over the bond's lifetime. To do so, I construct a mapping from `GVKEY`, the Compustat firm identifier, to the bond-level `CUSIP` in two steps. Each bond is given a unique `CUSIP` that is recorded in Mergent. First, I construct a mapping between `GVKEY` and `COMPANYID` in CapitalIQ. Second, I construct a mapping between `COMPANYID` and security-level `CUSIP` also using CapitalIQ. Each mapping is time-varying and takes notes of when the linking period is valid. From here, I am able to construct a mapping from `GVKEY` to bond level `CUSIP` using this mapping. This accounts for the majority of links between `GVKEY` and bond level `CUSIP`. As a second pass, I utilize Mergent FISD's `issuer_id` to extrapolatively fill `GVKEY`s. For example, if Bond A is linked to a `GVKEY` and Bond B is not, but both bonds are issued by the same firm, I assign the same `GVKEY` to Bond B.

A.4 Summary Statistics

Table 8: Summary Statistics: Full Sample

	Mean	Std. Dev	P25	Median	P75
Mkt Value ($M)	15,802.657	4,946.319	1,759.315	4,946.319	14,523.744
Size ($M)	11,984.706	4,486.572	1,816.425	4,486.572	11,716.066
Age	28.657	23.000	9.000	23.000	42.000
Q	1.670	1.407	1.109	1.407	1.903
Market Leverage	0.338	0.288	0.164	0.288	0.477
Profit	0.135	0.131	0.094	0.131	0.175
Tangibility	0.348	0.287	0.141	0.287	0.525
Profit Volatility	0.036	0.024	0.014	0.024	0.041
Interest Coverage Ratio	7.391	4.105	1.785	4.105	8.492
Debt and Interest Coverage Ratio	4.888	2.435	1.089	2.435	5.195
Cash	0.068	0.044	0.016	0.044	0.094
Pays Dividend	0.709	1.000	0.000	1.000	1.000
Equity Issuance	0.015	0.003	0.000	0.003	0.009
Prob. Default	0.043	0.000	0.000	0.000	0.000
Number of Bonds Outstanding	5.409	3.000	1.000	3.000	6.000
Bond Debt to Bank + Bond Debt Fraction	0.876	1.000	0.857	1.000	1.000
Bond Debt to Total Debt Fraction	0.593	0.612	0.372	0.612	0.841
Bond Debt Issued ($M)	940.532	462.622	250.000	462.622	1,000.000
Bond Debt Outstanding ($M)	1,581.626	555.389	238.268	555.389	1,559.876
Bond Buyback	0.153	0.000	0.000	0.000	0.000
Avg. Bond Maturity	8.309	7.000	5.000	7.000	10.000
Coupon Rate	6.427	6.477	4.559	6.477	7.973
Credit Spread (bps)	188.017	145.000	95.000	145.000	237.500
Underwriter Fee	0.786	0.650	0.566	0.650	0.781
St. Dev Maturity Dates	2.940	1.414	0.000	1.414	5.200
Maturity Wall	0.470	0.000	0.000	0.000	1.000

Table 8 presents summary statistics for my sample. The average firm size is $11.98 billion, which is larger than the average Compustat firm because my sample focuses on bond issuers, who tend to be larger than non-bond issuers. The average market leverage ratio is 0.34, and firms hold around 7% of their assets in cash. Bonds account for the majority of firms' total debt — 59% on average — with the remainder consisting of bank loans, credit lines, commercial paper, and capital leases. Bank debt, which is the main substitute for bond debt, only accounts for 12% of firm's debt.

On average, firms have 5.4 bonds outstanding at any given year, although the distribution is skewed, with a median of 3 bonds. The average bond issuance size in a year is $941 million, while the average total bond debt outstanding is $1.58 billion. The distribution of bond issuance size is skewed toward larger issuances, with the 25th percentile at over $460 million, suggesting the presence of fixed costs associated with corporate bond issuance. Additionally, firms generally hold their bonds to maturity, with only 15% of firms partially or fully repurchasing their debt[20]. This pattern aligns with the high costs associated with recalling bonds.

Regarding bond characteristics, the average bond maturity is 8.3 years. Firms pay an average coupon of 6.43%, an average credit spread of 188 bps on newly issued bonds, and an underwriter fee of 0.79% of the bond issuance.

Table 9 presents summary statistics for firms with and without maturity walls, revealing substantial heterogeneity in firm and bond characteristics based on the dispersion of their repayment schedules. Notably, firms that disperse their debt payments tend to be larger ($18B vs. $4B), older (36 vs. 18 years), and have better investment opportunities ($Q = 1.76$ vs. $Q = 1.55$) compared to those with more concentrated schedules. The fact that larger firms opt for more dispersed repayment schedules suggests the presence of large fixed costs associated with issuing debt, which these firms can better economize on. Indeed, firms with dispersed repayment schedules incur lower bond issuance costs. Measured by the underwriter spread, or the per-dollar cost to issue a bond, firms with dispersed debt payments face an underwriter spread of 72 bps compared to 121 bps for firms with concentrated debt payments.

To shed light on the economic mechanisms behind the above observation, the trend that older firms prefer dispersed repayment schedules indicates that adverse selection may play a role in bond issuance; lenders likely have better information about older, more mature firms. As for firms with better investment opportunities, Choi, Hackbarth, and Zechner (2018) explain that these firms may spread out their debt maturities to protect against rollover risk. In the event of a rollover crisis, a firm may be forced to forgo profitable growth opportunities to meet its debt obligations.

The table also highlights differing financing strategies between firms that disperse and concentrate their debt repayments. Firms with dispersed schedules are more likely to pay dividends and less likely to issue equity, suggesting that spreading out debt payments helps mitigate the need for costly equity injections during rollover crises, as explored by He and Xiong (2012).

The decision to disperse or concentrate debt repayment schedules also correlates with bond characteristics. Firms with more dispersed schedules tend to issue a higher number of bonds and at larger amounts. On average, firms with dispersed repayment schedules have 8.6 bonds outstanding, compared to 1.8 for firms with concentrated schedules. The average bond issuance size for firms with dispersed repayments exceeds $1.2 billion, while firms with concentrated schedules issue bonds averaging $361 million. This suggests that firms needing

[20] A more detailed breakdown shows that 8% of bonds are fully called, 1% are partially called, and 7% are repurchased via tender offers.

Table 9: Summary Statistics: By Maturity Wall

	Maturity Wall		No Maturity Wall	
	Mean	Median	Mean	Median
Mkt Value ($M)	4,816.259	1,915.511	24,118.004	10,154.285
Size ($M)	3,785.147	1,864.891	18,202.942	8,656.835
Age	18.530	13.000	36.312	32.000
Q	1.553	1.324	1.759	1.480
Market Leverage	0.392	0.357	0.299	0.247
Profit	0.126	0.122	0.141	0.137
Tangibility	0.359	0.296	0.339	0.281
Profit Volatility	0.042	0.028	0.031	0.022
Interest Coverage Ratio	5.954	2.728	8.467	5.345
Debt and Interest Coverage Ratio	4.317	1.926	5.313	2.814
Cash	0.068	0.043	0.067	0.045
Pays Dividend	0.596	1.000	0.809	1.000
Equity Issuance	0.021	0.002	0.011	0.003
Prob. Default	0.070	0.000	0.023	0.000
Number of Bonds Outstanding	1.828	1.000	8.618	6.000
Bond Debt to Bank + Bond Debt Fraction	0.811	1.000	0.927	1.000
Bond Debt to Total Debt Fraction	0.518	0.494	0.649	0.681
Bond Debt Issued ($M)	361.311	250.000	1,206.201	600.000
Bond Debt Outstanding ($M)	362.220	244.111	2,663.186	1,384.966
Bond Buyback	0.126	0.000	0.177	0.000
Avg. Bond Maturity	6.439	6.000	9.390	8.387
Coupon Rate	8.158	8.000	5.688	5.750
Credit Spread (bps)	273.126	245.000	175.137	138.760
Underwriter Fee	1.212	0.750	0.720	0.650
St. Dev Maturity Dates	0.127	0.000	5.436	4.805

larger amounts of financing opt to disperse their debt payments to mitigate rollover risk.

Additionally, firms with dispersed repayment schedules secure more favorable borrowing terms. They pay lower coupon rates, face narrower credit spreads, and have a lower probability of default compared to firms with concentrated debt payments. Notably, firms with concentrated debt structures do not appear to be substituting bond debt for bank debt, as they still hold a significant proportion of bond debt relative to bank debt.

B Additional empirical results

Table 10 explores how firm choices depend on large debt payments coming due. I regress firm's cash holdings, investment choice, and a binary variable capturing if a firm repurchased their debt early or not on the fraction of debt coming due in the next 1-10 years and other firm controls. The results suggest that firms are not adjusting their choices in response to large debt payments coming due. Firms do not hoard cash, cut investment, or buyback debt early, in anticipation of large debt payments coming due.

C Computational Algorithm

The model is solved using Julia. The solution algorithm is a value function iteration algorithm similar to Chatterjee and Eyigungor (2012). It proceeds as follows:

1. Define the state-space: Set grids for $b_D \in \mathcal{B}_\mathcal{D}$ and $b_C \in \mathcal{B}_\mathcal{C}$ such that firm choices fall within the interior set. Discritize firm income (y) following Tauchen (1986).

2. Initalize Value Functions and Bond Prices: Start with a guess for the value function and bond prices. The equilibrium for the infinite horizon model might not be unique. I therefore follow Hatchondo and Martinez (2009) and approximate the infinite horizon value functions by finite horizon value functions for the first period. Therefore, the initial guesses are the terminal value function and the terminal bond prices.

3. Update Value Functions: For each state, (b_D, b_C, y, η) solve for the optimal default choice $\delta(b_D, b_C, y, \eta)$ and debt choices $b'_D(b_D, b_C, y, \eta)$ and $b'_C(b_D, b_C, y, \eta)$ taking as given the bond prices $q_D(b'_D, b'_C, y)$ and $q_C(b'_D, b'_C, y)$, and $\mathbb{E}V(b'_D, b'_C, y', \eta')$.

4. Bond Prices: For each choice the firm can make, (b'_D, b'_C, y) evaluate the right hand side of Equations 22 and 11, taking as given the default choice $\delta(b_D, b_C, y, \eta)$ and debt choices $b'_D(b_D, b_C, y, \eta)$ and $b'_C(b_D, b_C, y, \eta)$ of the firm and $q_D(b''_D, b''_C, y')$ and $q_C(b''_D, b''_C, y')$.

5. Iterate jointly on Value Functions and Bond Prices until convergence.

Table 10: Repayment Schedule Concentration and Firm Actions

	(1) Cash	(2) Investment	(3) Buyback Debt
% Debt Due in 1 Year	-0.002	0.007	-0.241***
	(0.007)	(0.008)	(0.052)
% Debt Due in 2 Years	-0.003	0.002	-0.228***
	(0.008)	(0.008)	(0.051)
% Debt Due in 3 Years	-0.002	0.003	-0.217***
	(0.007)	(0.008)	(0.049)
% Debt Due in 4 Years	-0.006	0.002	-0.253***
	(0.007)	(0.008)	(0.048)
% Debt Due in 5 Years	-0.007	0.002	-0.222***
	(0.006)	(0.007)	(0.048)
% Debt Due in 6 Years	-0.006	0.010	-0.245***
	(0.006)	(0.007)	(0.047)
% Debt Due in 7 Years	-0.010	0.015**	-0.210***
	(0.006)	(0.007)	(0.048)
% Debt Due in 8 Years	-0.009	0.018**	-0.103**
	(0.007)	(0.007)	(0.049)
% Debt Due in 9 Years	-0.011*	0.024***	-0.229***
	(0.006)	(0.008)	(0.048)
% Debt Due in 10 Years	-0.012**	0.020***	0.251***
	(0.006)	(0.007)	(0.055)
Leverage	-0.001	-0.006***	0.119***
	(0.001)	(0.002)	(0.010)
Size	-0.032***	0.015***	0.064***
	(0.004)	(0.004)	(0.024)
Q	0.010***	0.018***	-0.020
	(0.002)	(0.002)	(0.013)
Profit	-0.006***	0.008***	-0.025***
	(0.002)	(0.002)	(0.009)
Fraction of Bond Debt	0.020***	0.009*	-0.142***
	(0.005)	(0.005)	(0.039)
Observations	6657	6676	6793
R^2	0.664	0.640	0.280
Fixed Effects	Firm & Year	Firm & Year	Firm & Year

D Alternative Model Environments

D.1 Long-term debt only model

Firms Problem

An incumbent firm enters the period with long-term debt b and idiosyncratic income y. The firm chooses between two discrete actions: (i) to stay in the economy and produce or (ii) to default on its debt payment and exit the economy. In other words, the firm maximizes its value over these two distinct choices:

$$V(b, y) = \max_{\delta \in \{0,1\}} \Big\{ (1-\delta) V^{stay}(b, y) + \delta V^{default}(b, y) \Big\}, \tag{14}$$

where $\{V^{stay}, V^{default}\}$ denote the value of the firm if it chooses to stay in the economy and if it chooses to default on its debt.

In the event that its debt obligation is larger than the funds they are able raise from debt markets or the amount of equity they can inject, the firm chooses to default and obtains a value $V^{default}(b, y) = 0$. I define $\delta(b, y)$ to be default decision rules made by the firm. In the event of default, $\delta(b, y) = 1$. If the firm does not choose to default on their debt obligation, we can express the firm's problem of staying in the following recursive form, where $\varepsilon^{(b')}$ denotes the manager preference shock:

$$V^{stay}(b, y) = \int_{\varepsilon} W(b, y, \varepsilon) dF(\varepsilon) \tag{15}$$

$$W(b, y, \varepsilon) = \max_{b'} \Big\{ \psi(d) + \varepsilon^{(b')} + \beta \mathbb{E}_{\{y'\}} V(b', y') \Big\} \tag{16}$$

subject to

$$\psi(d) = \begin{cases} d & \text{if } d \geq 0 \\ d - \alpha d^2 & \text{if } d < 0 \end{cases}$$

where

$$d = (y - c_f - \varsigma b)(1-\tau) - \lambda b + q(b', y) I - c_I (\mathbb{1}_{I>0})$$

and

$$I = b' - (1-\lambda) b$$

Entrants Problem

A new firm enters the economy when an incumbent firm defaults. I assume here that the entering firms come in with zero debt and draws its idiosyncratic income from the stationary Markov distribution of $\bar{G}_y$.

Lender's Problem

To price debt for firms, the representative lender must forecast the likelihood of default given the firm's debt choices and current idiosyncratic income level. On a given loan to a firm with idiosyncratic income y who chooses debt with dispersed repayment schedules b'_D and debt level with a concentrated repayment schedule b'_C, the lender expects to make zero profits on all loans. Thus, we can express the price of a unit of dispersed debt in the following recursive form:

$$q(b', y) = \beta \mathbb{E}_{\{y'\}} \Big\{ (1 - \delta(b', y'))(\varsigma + \lambda + (1 - \lambda) q(b'', y')) \\ + \delta(b', y') \min \left[1, \chi \frac{\tilde{V}(y')}{b'} \right] \Big\} \tag{17}$$

Definition of Equilibrium

A recursive Markov equilibrium is a set of value and policy functions $\{V^*, b^*, \delta^*\}$ and debt prices $\{q^*\}$ such that:

1. Given prices q^* firms optimize yielding V^* and b^*.
2. The default decision δ^* is consistent with firm decision rules.
3. Debt prices q^* are such that the representative lender expects to earn zero profits.
4. Stationary distribution of firms is determined by firm decision rules and law of motion for y
    - Mass of defaulting firms are replaced with an equal mass of firms with $b = 0$ and $y \sim \bar{G}_y$.

Estimated Parameters

Estimated parameters are in Table 11

D.2 Maturity choice model

Firms Problem

I begin with the problem faced by an incumbent firm. An incumbent firm enters the period with debt with long-term debt b_L, debt with short-term debt b_S, and idiosyncratic income y. The firm chooses between two discrete actions: (i) to stay in the economy and produce or (ii) to default on its debt payment and exit the economy. In other words, the firm maximizes its value over these two distinct choices:

$$V(b_L, b_S, y) = \max_{\delta \in \{0,1\}} \Big\{ (1 - \delta) V^{stay}(b_L, b_S, y) + \delta V^{default}(b_L, b_S, y) \Big\}, \tag{18}$$

Table 11: Estimated Parameters
— Long-term debt only model —

Parameter	Description	Value	Target/Reference	Data	Model
Externally Calibrated					
β	Discount factor	0.960	4% Annual Risk Free Rate	—	—
ς	Per-period coupon payment	$1/\beta - 1$	Risk free debt issued at par	—	—
τ	Corporate tax rate	0.300	Hennessy & Whited (2007)	—	–
ρ_y	Persistence: income shock	0.660	Auto-correlation of log sales	0.66	0.66
σ_y	St. dev: income shock	0.310	Log sales volatility	0.31	0.31
$1/\lambda$	Average Maturity of debt	8.300	Avg. debt maturity	8.30	8.30
Internally Estimated					
c_f	Fixed cost of production	0.950	Default rate (%)	1.13	1.42
α	Convex equity issuance cost	0.002	Avg. debt to income	2.30	2.28
σ_ε	St. dev: pref. shock	0.000	St. dev debt to income	5.37	4.36
χ	Lender recovery fraction	0.320	Avg. credit spread	1.90	1.20
c_I	Fixed debt issuance cost	0.069	Avg. underwriter fee (%)	0.79	0.81

where $\{V^{stay}, V^{default}\}$ denote the value of the firm if it chooses to stay in the economy and if it chooses to default on its debt.

In the event that its debt obligation is larger than the funds they are able raise from debt markets or the amount of equity they can inject, the firm chooses to default and obtains a value $V^{default}(b_L, b_S, y) = 0$. I define $\delta(b_L, b_S, y)$ to be default decision rules made by the firm. In the event of default, $\delta(b_L, b_S, y) = 1$. If the firm does not choose to default on their debt obligation, we can express the firm's problem of staying in the following recursive form, where $\varepsilon^{(b'_L, b'_S)}$ denotes the manager preference shock:

$$V^{stay}(b_L, b_S, y) = \int_\varepsilon W(b_L, b_S, y, \varepsilon) dF(\varepsilon) \tag{19}$$

$$W(b_L, b_S, y, \varepsilon) = \max_{b'_L, b'_S} \left\{ \psi(d) + \varepsilon^{(b'_L, b'_S)} + \beta \mathbb{E}_{\{y'\}} V(b'_L, b'_S, y') \right\} \tag{20}$$

subject to

$$\psi(d) = \begin{cases} d & \text{if } d \geq 0 \\ d - \alpha d^2 & \text{if } d < 0 \end{cases}$$

where

$$d = (y - c_f - \varsigma(b_L + b_S))(1 - \tau) - (\lambda b_L + b_S) + \\ q_L(b'_L, b'_S, y) I_L + q_S(b'_S, b'_S, y) I_S - c_I(\mathbb{1}_{I_L > 0} + \mathbb{1}_{I_S > 0})$$

and

$$I_L = b'_L - (1-\lambda)b_L$$
$$I_S = b'_S.$$

Entrants Problem

A new firm enters the economy when an incumbent firm defaults. I assume here that the entering firms come in with zero debt and draws its idiosyncratic income from the stationary Markov distribution of $\bar{G}_y$.

Lender's Problem

To price debt for firms, the representative lender must forecast the likelihood of default given the firm's debt choices and current idiosyncratic income level. On a given loan to a firm with idiosyncratic income y who chooses long-term debt b'_L and short-term debt b'_S, the lender expects to make zero profits on all loans. Thus, we can express the price of a unit of dispersed debt in the following recursive form:

$$q_S(b'_L, b'_S, y) = \beta \mathbb{E}_{\{y'\}} \Big\{ (1 - \delta(b'_L, b'_S, y'))(\varsigma + 1) + \delta(b'_L, b'_S, y') \min \left[1, \chi \frac{\tilde{V}(y')}{b'_L + b'_S} \right] \Big\} \tag{21}$$

$$q_L(b'_L, b'_S, y) = \beta \mathbb{E}_{\{y'\}} \Big\{ (1 - \delta(b'_L, b'_S, y'))(\varsigma + \lambda + (1-\lambda) q_L(b''_L, b''_S, y')) + \delta(b'_L, b'_S, y') \min \left[1, \chi \frac{\tilde{V}(y')}{b'_L + b'_S} \right] \Big\} \tag{22}$$

Definition of Equilibrium

A recursive Markov equilibrium is a set of value and policy functions $\{V^*, b^*_L, b^*_S, \delta^*\}$ and debt prices $\{q^*_L, q^*_S\}$ such that:

1. Given prices q^*_L and q^*_S firms optimize yielding V^*, b^*_L, and b^*_S.
2. The default decision δ^* is consistent with firm decision rules.
3. Debt prices q^*_L and q^*_S are such that the representative lender expects to earn zero profits.
4. Stationary distribution of firms is determined by firm decision rules and law of motion for y
    - Mass of defaulting firms are replaced with an equal mass of firms with $b_L = 0$, $b_S = 0$, and $y \sim \bar{G}_y$.

Estimated Parameters

Estimated parameters are in Table 12

Table 12: Estimated Parameters
— Maturity choice model —

Parameter	Description	Value	Target/Reference	Data	Model
Externally Calibrated					
β	Discount factor	0.960	4% Annual Risk Free Rate	—	—
ς	Per-period coupon payment	$1/\beta - 1$	Risk free debt issued at par	—	—
τ	Corporate tax rate	0.300	Hennessy & Whited (2007)	—	–
ρ_y	Persistence: income shock	0.660	Auto-correlation of log sales	0.66	0.66
σ_y	St. dev: income shock	0.310	Log sales volatility	0.31	0.31
$1/\lambda$	Average Maturity of debt	8.300	Avg. debt maturity	8.30	8.30
Internally Estimated					
c_f	Fixed cost of production	0.961	Default rate (%)	1.13	1.26
α	Convex equity issuance cost	0.017	Avg. debt to income	2.30	1.42
σ_ε	St. dev: pref. shock	0.000	St. dev debt to income	5.36	3.62
χ	Lender recovery fraction	0.721	Avg. credit spread	1.87	1.22
c_I	Fixed debt issuance cost	0.007	Avg. share short-term debt	0.04	0.05
			Avg. underwriter fee (%)	0.79	0.93