

Maturity Walls

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Motivation

- **Maturity walls**: a **majority of debt** scheduled to mature within **short period** (< 2 yrs)
 - Large source of rollover risk
 - Failure to rollover $\rightarrow$ cut investment, fire workers, and default

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RATING ACTION COMMENTARY

Fitch Downgrades Antero Resources LT IDR to 'B'; Places Ratings on Rating Watch Negative

Thu 02 Apr, 2020 - 5:12 PM ET

Elevated Refinancing Risk: AR 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, even as select peers have tapped it during a brief January window opening. The collapse in prices since that time have made this situation more difficult.

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Research Questions

1. Why do firms hold maturity walls, and how do they impact borrowing and default risk?
2. How much do maturity walls amplify transmission of a credit market freeze?

What I do in this paper

- **Novel** measure of **debt maturity dispersion**: standard deviation of debt maturity dates
 - Mergent FISD (bond level data) + Compustat
 - 47% firms **choose** maturity walls (firms w/ 1 bond outstanding)
 - Maturity walls associated w/ higher credit risk (higher expected defaults and credit spread)
 - **Why?** Large **fixed costs** to issue bonds (economies of scale in bond issuance size)

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- Dynamic heterogeneous firm **credit risk model**:
 - Receive persistent income shocks
 - Pick **level** of long-term debt
 - Choose to **concentrate** or **disperse** debt payments
 - Trade-off: **Fixed debt** (**convex equity**) issuance costs $\longrightarrow$ **concentrate** (**disperse**) payments

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- Estimate model via SMM, externally validate, & quantify risks of maturity walls

Empirical facts guiding the model

Maturity date concentration: Low $\sigma_{Mat,t} \longrightarrow$ concentrated debt payments

$$\sigma_{Mat,t} = \sqrt{\sum_{m=1}^M \overbrace{s_{m,t}}^{\text{share due in } m} \left(m - \underbrace{\mu_{Mat,t}}_{\text{avg. mat.}} \right)^2}$$

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1. 47% of firms have maturity walls; primarily firms with one bond outstanding
2. Maturity walls are associated with $\uparrow$ default risk and $\uparrow$ credit spreads
3. Underwriter fees fall with issue size, consistent with fixed issuance costs

[More](#)
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Preview mechanism

- Fixed issuance costs reward fewer, larger bond issues and push firms to concentrate
- Rollover risk and costly equity injections push firms to disperse

Model

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- Continuum of risk neutral firms maximize equity value
 - Persistent revenue shocks: $y \sim G(y|y_{-1})$
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 - b_D : debt with **dispersed** principal payments
 - b_C : debt with **concentrated** principal payment

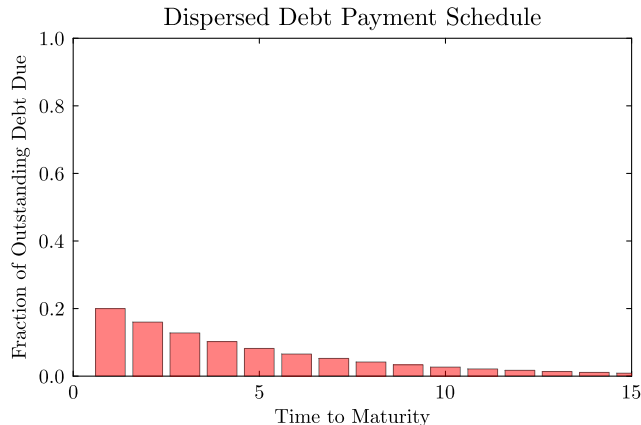
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 - b_D : debt with **dispersed** principal payments
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- Debt is priced by risk neutral lenders
 - Firm-specific prices $\{q_D(b'_D, b'_C, y), q_C(b'_D, b'_C, y)\}$
 - Zero-profit condition reflects default risk and recovery χ

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- What breaks Modigliani–Miller?
 - Tax benefit of debt
 - **Convex equity issuance** cost α captures rollover stress
 - **Fixed debt issuance** cost c_f
 - Limited liability and liquidation costs

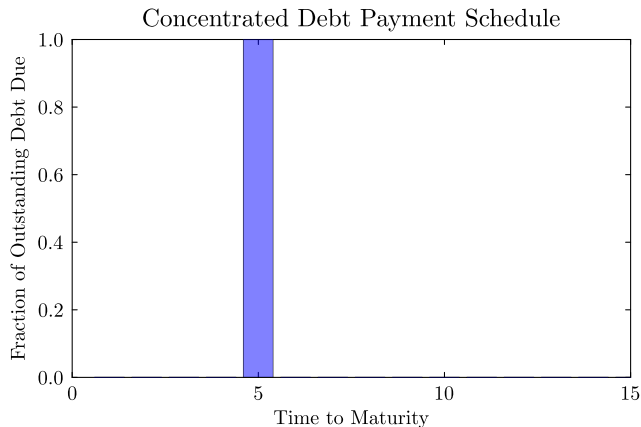
Modeling dispersed and concentrated debt payments



Dispersed Debt Payments (b_D):

- Exponentially maturing coupon bonds with constant amortization rate λ
- Each period: λb_D units of required principal repayments from maturing bonds

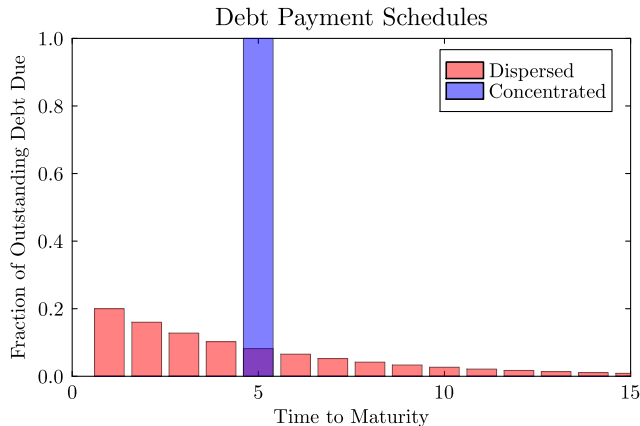
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Concentrated Debt Payment (b_C):

- Bond pays a coupon until **random** expiration ($\eta = 1$) which arrives w/ probability λ
- When bond expires ($\eta = 1$), firm must fully repay b_C

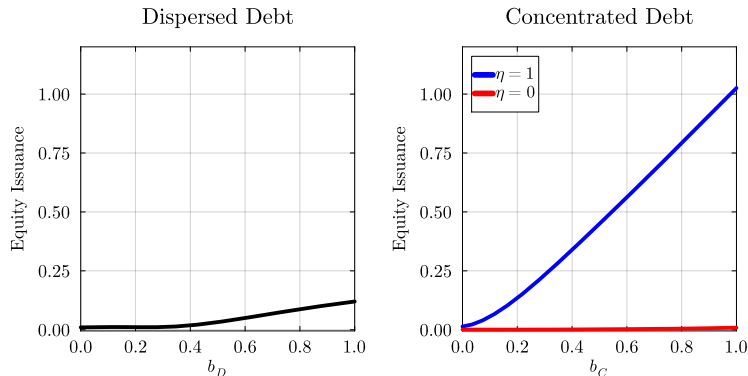
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Remarks:

- Firm required to pay $\underbrace{\tilde{c}(b_D + b_C)}_{\text{Coupon}} + \underbrace{\lambda b_D + \eta b_C}_{\text{Principal}}$ to avoid default
- Bonds are identical in terms of (i) payment amount and (ii) average maturity ($1/\lambda$)
- Differ only in terms of schedule of payments

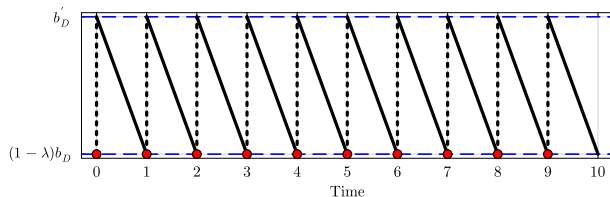
Dispersed debt smooths required repayments across states



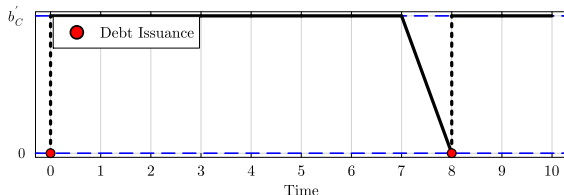
- Dispersed debt spreads principal repayments across states
- Smaller repayment needs reduce costly equity injections
- Benefit strongest when debt levels are high or firm income is low

Concentrated debt avoids repeated small issuances

Dispersed Debt Issuance

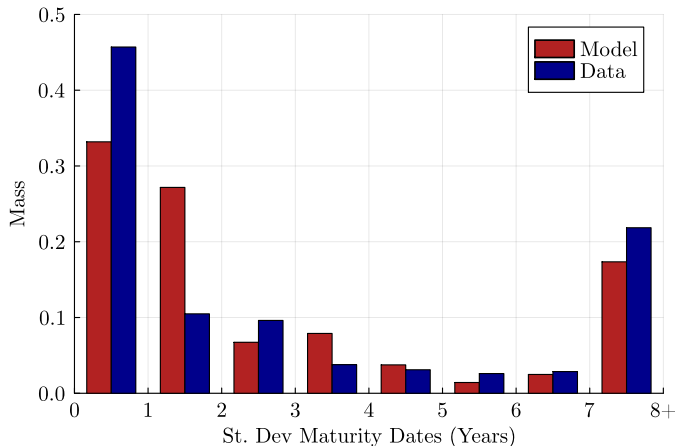


Concentrated Debt Issuance



- Dispersed debt requires frequent refinancing/top-ups
- Each issuance triggers a fixed cost
- Concentrated debt economizes on issuance costs
- Benefit strongest when rollover risk is low

Model matches maturity dispersion



Estimation Leverage fit Underwriter Fee fit

- Estimated via SMM using FISD and Compustat, 1995–2019
- Targets leverage, default risk, spreads, issuance costs, and maturity dispersion
- Matches the distribution of σ_{Mat} in the data

Quantitative Exercises

1. How much do maturity walls contribute to credit risk?
2. Do maturity walls amplify transmission of credit market freeze?
3. Are firms less risky if issuing debt is cheaper?

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In equilibrium:

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Counterfactual economy:

- i firm's total leverage decision is **held constant** at baseline values
- ii firm's borrow all in b_C
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	bps	%	Baseline Value
Δ Default Rate	30.0	25.0	1.2%
Δ Credit Spread	35.9	21.1	1.7%

Macro implications of maturity walls on credit market freeze

Credit market freeze

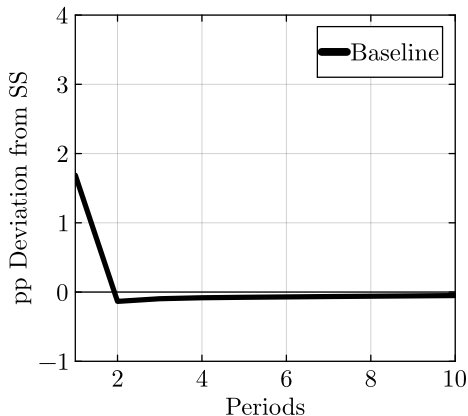
- Large decline in volume of transactions in primary market
- Unanticipated one period shock where
 - i. debt market shuts down
 - ii. equity issuance cost rises
- Firms may be “unlucky” at having to repay maturity wall at time of market freeze
 - Unable to rollover
 - Amplifies default

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Default Rate

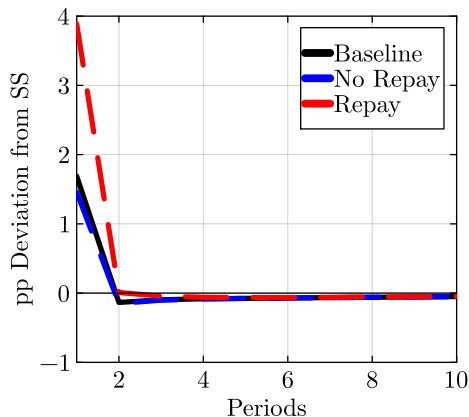


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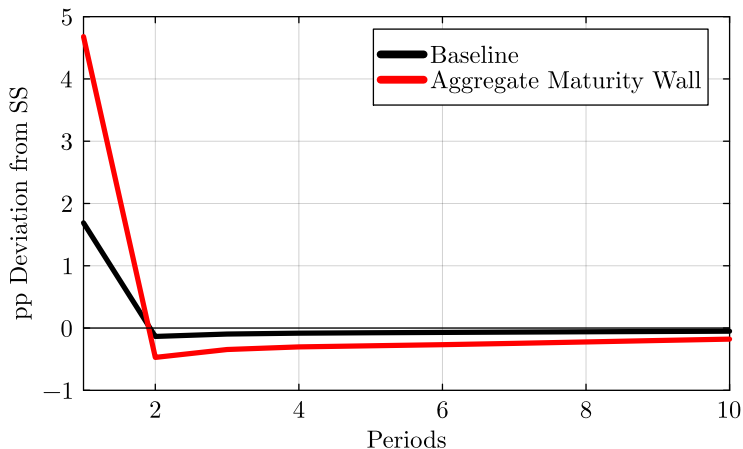
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Firms w maturity walls due at freeze account for majority of $\uparrow$ defaults

Aggregate maturity wall during credit market freeze

Default Rate



Aggregate maturity wall (η common across firms) $\rightarrow$ 299bps (178%) higher default rate

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Ex-ante **unclear** how decreasing issuance cost will impact default & spreads:

- **Composition** of debt changes:
borrow **more b_D** and less b_C : $\downarrow$ default risk & credit spreads
- Total debt **level** increases:
maintain **higher total debt** with b_D : $\uparrow$ default risk & credit spreads

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In economy with competitive underwriter market

- $\uparrow$ risk from borrowing more $>$ $\downarrow$ reduced risk from debt composition changes
- Credit spreads $\uparrow$ **1.2 pp** & default rates $\uparrow$ **1 pp**

Conclusion

Maturity walls matter for borrowing level, default, and borrowing costs

- Structural model of firm debt and maturity date concentration
- Key trade-off: issuance cost v. rollover risk

1. How much do maturity walls matter for firm credit risk?

- $\uparrow$ default rates by 30 bps (25%) & borrowing costs by 36 bps (21%)

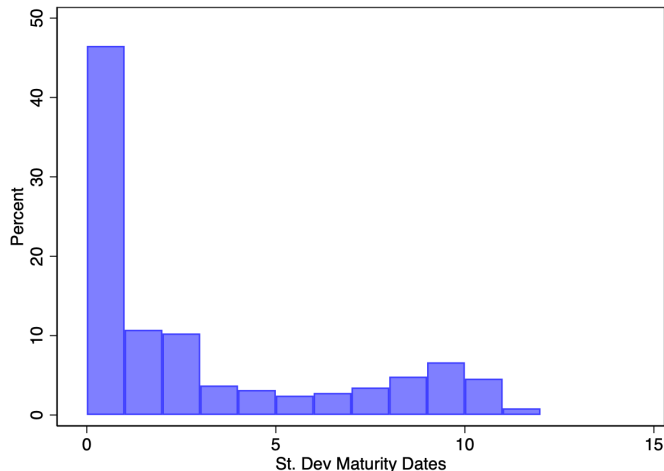
2. Do maturity walls amplify an aggregate credit shock to firm defaults?

- Firms w/ maturity walls due at shock account for 100% more defaults

3. Are firms less risky if it is cheaper to issue debt?

- Higher eqm default (1 pp) & credit spreads (1.2 pp) (firms $\uparrow$ borrowing wrt to baseline)

Fact 1: 47% of firms have maturity walls



- Avg σ_{Mat} : 2.6 years
Median σ_{Mat} : 1.5 years
- Maturity Wall: $\sigma_{Mat} \leq 1$
(Antero's σ_{Mat} at rating downgrade)
- Firms w/ maturity walls typically issue few bonds
 - Avg. # of bonds: 1.8
 - Median # of bonds: 1
 - P75 # of bonds: 2

Which firms are holding maturity walls?

	(1) St. Dev Maturity Dates	(2) Maturity Wall
Leverage	0.827*** (0.062)	-0.154*** (0.011)
Size	1.521*** (0.085)	-0.257*** (0.014)
Age	0.258*** (0.060)	-0.050*** (0.009)
Q	0.285*** (0.085)	-0.069*** (0.012)
Revenue	-0.064 (0.066)	0.018* (0.010)
Cash	-0.007 (0.056)	-0.003 (0.009)
Avg. Bond Maturity	1.618*** (0.079)	-0.043*** (0.009)
Observations	8986	8986
R^2	0.649	0.442
FEs	Yes	Yes

Firms w/ maturity walls associated w/:

- ↑ leverage, concerned about rollover risk
→ disperse payments
- ↑ revenue, less concern about rollover risk
→ concentrate payments
- ↑ Q, more concern about rollover risk
(investment opportunities valuable to firm)
→ disperse payments

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Fact 2: Firms with maturity walls appear more risky

	(1) Prob Default (pps)	(2) Prob Default (pps)	(3) Credit Spread(bps)	(4) Credit Spread(bps)
Leverage	5.010*** (0.415)	3.617*** (0.497)	48.041*** (9.972)	41.883*** (9.607)
Avg. Bond Maturity	-0.281 (0.203)	-0.389* (0.201)	-3.444 (3.413)	-3.291 (3.297)
Maturity Wall	2.805*** (0.474)	2.649*** (0.449)	25.979*** (8.561)	64.405*** (12.077)
Leverage $\times$ Maturity Wall		2.401*** (0.612)		69.966*** (14.357)
Observations	6410	6410	1213	1213
R^2	0.234	0.242	0.685	0.694
Controls	Firm	Firm	Firm & Bond	Firm & Bond
Fixed Effects	Industry & Year	Industry & Year	Industry & Year	Industry & Year

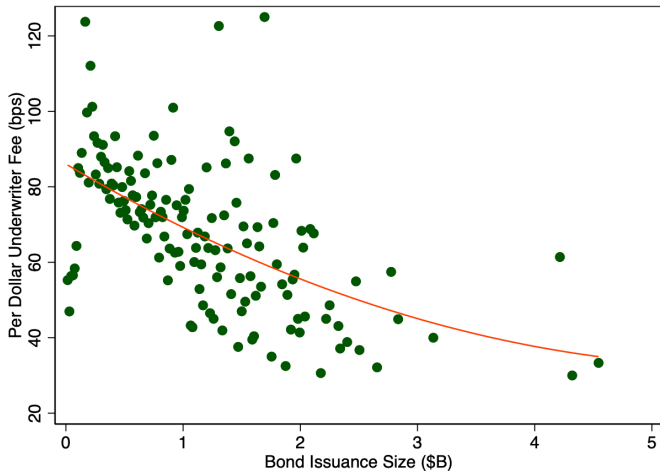
Takeaway:

- Firms w/ maturity walls associated w/ $\uparrow$ prob. default & credit spreads
- Large maturity walls associated w/ $\uparrow$ credit risk

Fact 3: Firms face economies of scale issue bonds

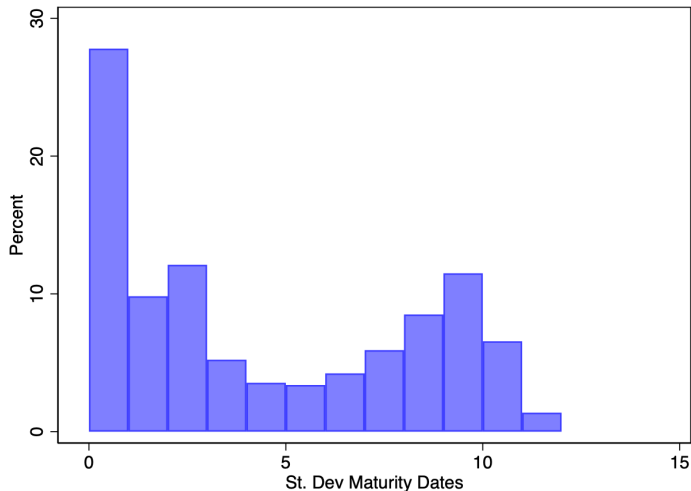
Underwriter fees:

- Cost to *issue* corporate bond (fixed + variable cost)
- Spread out fixed cost by issuing larger amounts
- What are these fixed costs?
 - Pricing bond
 - Rating & regulatory filings
 - Determining who wants to buy bond on secondary market
- Underwriter spread (Fee / Iss. Size)
 - < \$1B issue: 80 bps
 - > \$3B issue: 40 bps



Takeaway: Economies of scale consistent with large fixed issuance costs

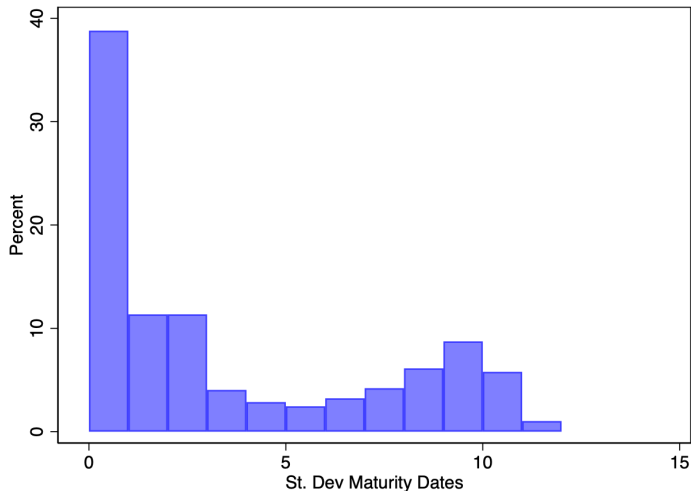
Firms concentrate debt maturity dates (weighted by firm age)



Average: 3.1 years

Median: 4.5 years

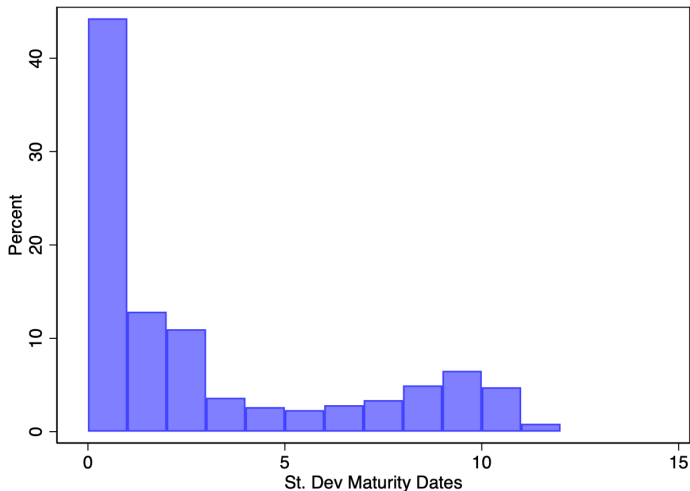
Firms concentrate debt maturity dates (weighted by firm size)



Average: 3.8 years

Median: 2.7 years

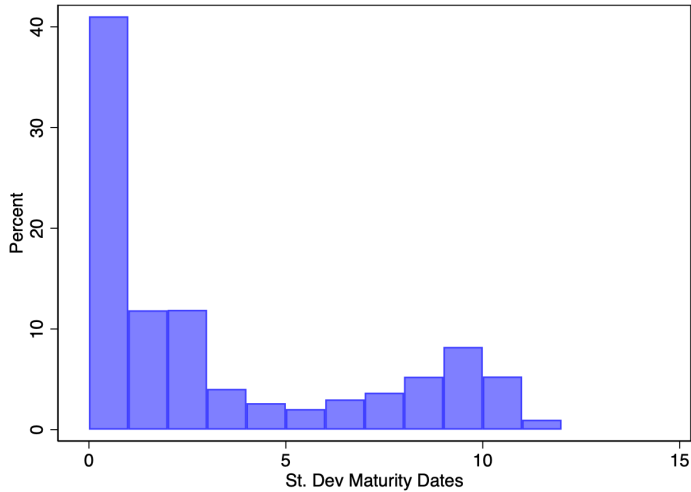
Firms concentrate debt maturity dates (weighted by firm leverage)



Average: 3.3 years

Median: 1.8 years

Firms concentrate debt maturity dates (weighted by bond debt pct)



Average: 3.4 years

Median: 1.9 years

Firms infrequently issue corporate bonds

	Mean	Std. Dev
Bond Issuance Frequency	0.114	0.318
Number of Bonds Issued	1.874	1.360
Time Since Last Issue (Years)	3.359	2.263
Bond Issuance Size (\$M)	435.980	421.972
Bond Amount Outstanding (\$M)	1,681.264	3,658.709
Bond Issuance to Amount Outstanding	0.407	0.334
Number of Bonds Issued Last 5 Years	1.037	2.590
Number of Bonds Issued Last 10 Years	1.902	4.358
Number of Bonds Issued Last 20 Years	3.098	6.663

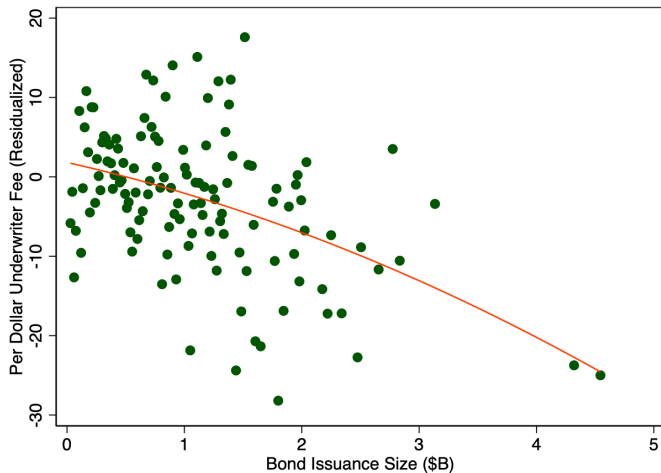
Firms issue bonds infrequently:

- 11.4% obs feature bond issuance
- Avg bonds issued in last 10 years is 1.9

Firms issue large amounts

- New bond issuance accounts for 40% of total amount outstanding

Economies of scale robust to firm and bond controls



Do firms behave differently before large repayment dates?

	Cash	Investment	1_{Buyback}
s_1	-0.002 (0.007)	0.007 (0.008)	-0.241*** (0.052)
s_2	-0.003 (0.008)	0.002 (0.008)	-0.228*** (0.051)
s_3	-0.002 (0.007)	0.003 (0.008)	-0.217*** (0.049)
s_4	-0.006 (0.007)	0.002 (0.008)	-0.253*** (0.048)
s_5	-0.007 (0.006)	0.002 (0.007)	-0.222*** (0.048)
Fixed Effects	Firm & Year	Firm & Year	Firm & Year
Additional Controls	Yes	Yes	Yes

Note: s_m is share of long-term debt due in m years

How has the literature modeled long-term debt?

Modeling long-term debt with exponentially declining maturity structure:

- Hatchondo and Martinez (JIR, 2009); Arellano and Ramanarayanan (JPE, 2012); Aguiar et. al (ECMA, 2019)
- He and Xiong (JF, 2012); Dangl & Zechner (RFS, 2021); DeMarzo & He (JF, 2021); Jungherr and Schott (RED, 2021); Jungherr et. al (R&R ReSTUD, 2023)

Modeling long-term debt randomly maturing “lumpy” bond:

- Geelen (R&R JF, 2019); Gomes and Schmid (JF, 2021); Chen et al (JFE, 2021)

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(Continuing) Firm's Problem

$$V(\mathcal{S}) = \max_{\{b'_D, b'_C\}} \left\{ \psi(d) + \overbrace{\varepsilon(b'_D, b'_C)}^{\text{Manager Pref. Shock}} + \beta \mathbb{E}_{\{y', \eta'\}} \max \{ V(\mathcal{S}'), 0 \} \right\}$$

Subject to:

$$d = \underbrace{(y - \underbrace{c_F}_{\text{Production Cost}} - \tilde{c}(b_D + b_C))}_{\text{After tax income}} (1 - \tau) - \underbrace{(\lambda b_D + \eta b_C)}_{\text{Debt repaid}}$$

$$+ \underbrace{q_D(b'_D, b'_C, y) l_D}_{\text{Dispersed debt issuance revenue}} + \underbrace{q_C(b'_D, b'_C, y) l_C}_{\text{Concentrated debt issuance revenue}} - \underbrace{c_I(\mathbb{1}_{l_D > 0} + \mathbb{1}_{l_C > 0})}_{\text{Debt issuance cost}}$$

$$l_D = b'_D - (1 - \lambda)b_D$$

$$l_C = b'_C - (1 - \eta)b_C$$

$$\psi(d) = \begin{cases} d & \text{if } d \geq 0 \\ d - \underbrace{\alpha d^2}_{\text{Eq. issuance Cost}} & \text{if } d < 0 \end{cases}$$

Lender's Problem

Debt is priced by rep lender making zero-profits in expectation

- $\delta(S')$: default decision in state $S' \equiv (b'_D, b'_C, y', \eta')$
- $\mathcal{R}(b_D, b_C, y) = \min [1, \chi \tilde{V}(y) / b_D + b_C]$: lender's recovery value in default

Price of unit of dispersed debt

$$q_D(b'_D, b'_C, y) = \beta \mathbb{E}_{\{y', \eta'\}} \left\{ (1 - \delta(S')) \left(\underbrace{\tilde{c} + \lambda}_{\text{Payment tomorrow}} + \underbrace{(1 - \lambda) q_D(b''_D, b''_C, y')}_{\text{Expected future revenue to lender}} \right) + \delta(S') \mathcal{R}(b'_D, b'_C, y') \right\}$$

Price of unit of concentrated debt

$$q_C(b'_D, b'_C, y) = \beta \mathbb{E}_{\{y', \eta'\}} \left\{ (1 - \delta(S')) \left(\underbrace{\tilde{c} + \eta}_{\text{Payment tomorrow}} + \underbrace{(1 - \eta) q_C(b''_D, b''_C, y')}_{\text{Expected future revenue to lender}} \right) + \delta(S') \mathcal{R}(b'_D, b'_C, y') \right\}$$

where $Pr(\eta = 1) = \lambda$

Equilibrium Definition

A recursive Markov equilibrium is a set of value and policy functions $\{V^*, b_D^*, b_C^*\}$ 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 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 determined by firm decision rules and law of motion for y and η
 - Mass of defaulting firms are replaced with an equal mass of firms with $b_D = 0$, $b_C = 0$, $\eta = 1$ and $y \sim \bar{G}$

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Mapping the model to the data

Model is estimated on annual FISD & Compustat data from 1995 - 2019

- Parameters divided into **externally calibrated** and **internally estimated**
- **Externally calibrated** parameters are chosen outside model
 - Estimate income process to capture underlying asset value fluctuations
 - Income is mapped to annual sales data
 - $\log(y') = \rho_y \log(y) + \sigma_y \varepsilon_y, \quad \varepsilon_y \sim \mathcal{N}(0, 1)$
 - Average maturity $1/\lambda$ is matched to average maturity of corp. bonds
- **Internally estimated** parameters are jointly estimated via SMM
 - Match empirical moments important for debt issuance, rollover, and concentration
 - Construct model equivalent St. Dev of Debt Maturity Dates

Mapping b_D & b_C to σ_{Mat}

Model Estimation

Parameter	Description	Value	SE	Target/Reference	Data	Model
Externally Calibrated						
β	Discount factor	0.960	-	4% Annual Risk Free Rate	-	-
$\tilde{c}$	Per-period coupon payment	$1/\beta - 1$	-	Eqm price of riskless debt is 1	-	-
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	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_l	Fixed debt issuance cost	0.003	0.001	Avg. dispersion maturity dates	2.61	2.62
				Avg. underwriter fee (%)	0.79	0.75

Model fit: Leverage Distribution

Model fit: σ_{Mat} Distribution

Model fit: Underwriter Fee Distribution

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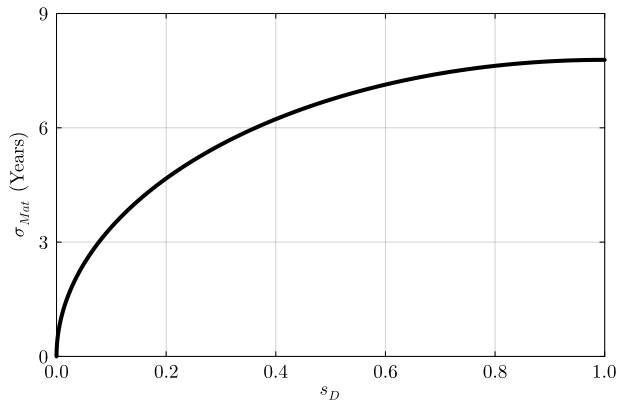
Constructing σ_{Mat} in the model

Let

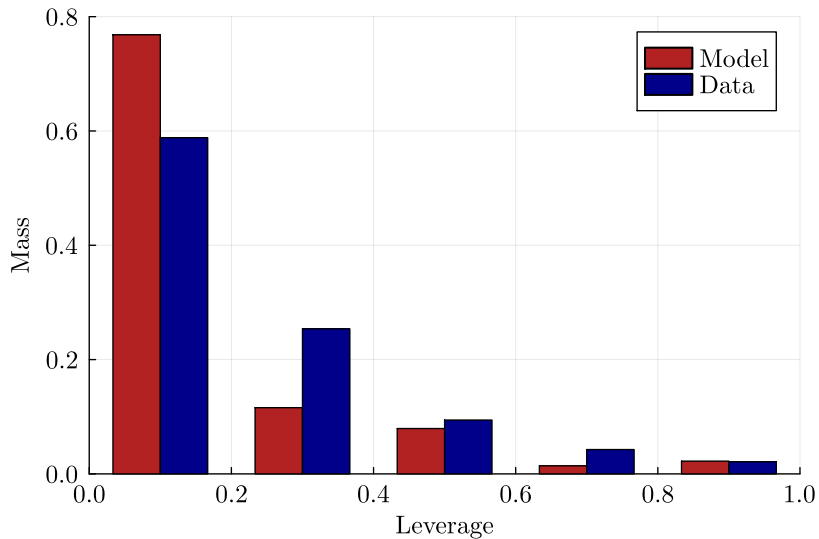
$$s_D = \frac{b_D}{b_D + b_C}$$

The mapping from s_D to σ_{Mat} is

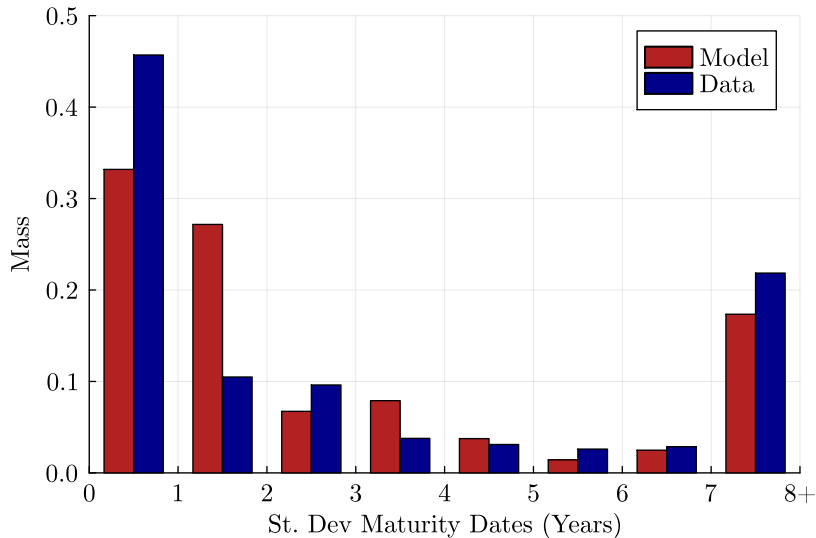
$$\sigma_{Mat} = \frac{\sqrt{(1 - \lambda)(2s_D - s_D^2)}}{\lambda}$$



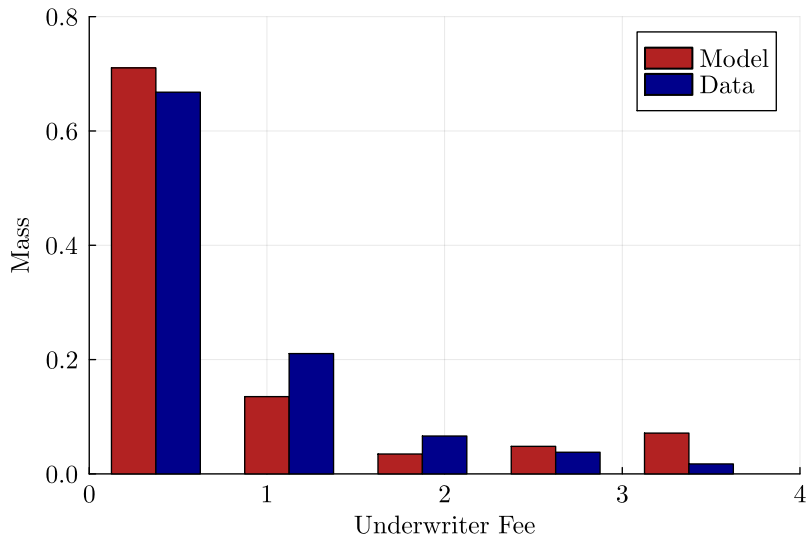
Model Fit: Market Leverage Distribution



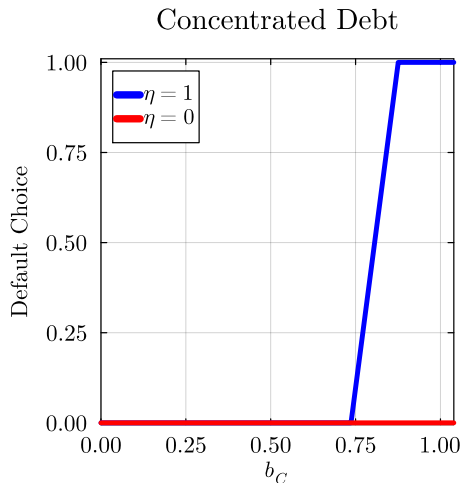
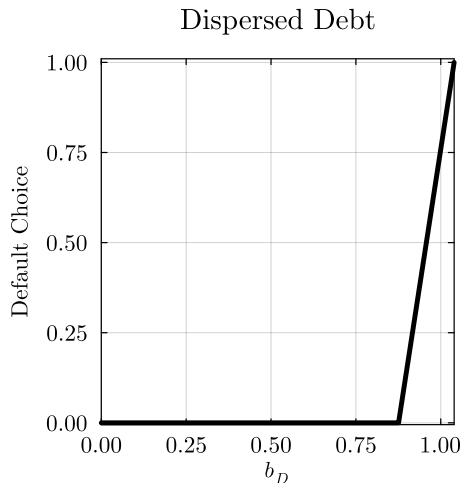
Model Fit: St. Dev of Maturity Dates Distribution



Model Fit: Underwriter Fee Distribution

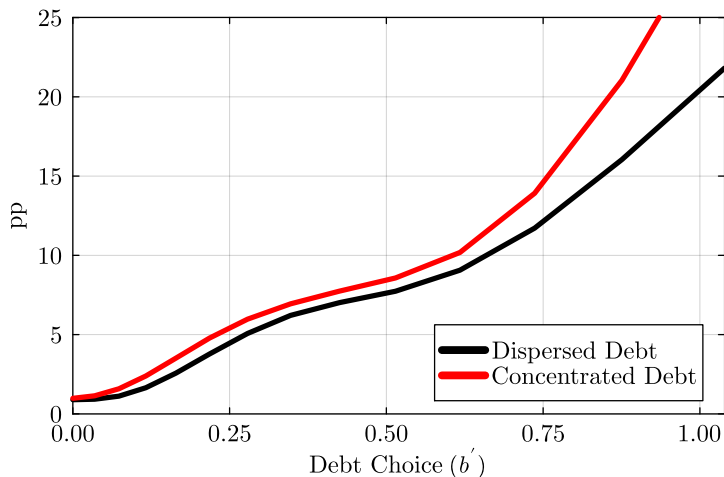


Default behavior depends on debt payment concentration choice



Firm w/ b_C cannot sustain as high a level of debt as b_D

Dispersed debt payments $\rightarrow$ lower interest rates



Takeaway: Interest rates price in firm def. risk $\rightarrow$ borrowing cost $b_C >$ borrowing cost b_D

Lender's Problem

Debt is priced by rep lender making zero-profits in expectation

- $\delta(S')$: default decision in state $S' \equiv (b'_D, b'_C, y', \eta')$
- $\mathcal{R}(b_D, b_C, y)$: lender's recovery value in default

Price of unit of dispersed debt

$$q_D(b'_D, b'_C, y) = \beta \mathbb{E}_{\{y', \eta'\}} \left\{ (1 - \delta(S')) \left(\underbrace{\tilde{c} + \lambda}_{\text{Payment tomorrow}} + \underbrace{(1 - \lambda) q_D(b''_D, b''_C, y')}_{\text{Expected future revenue to lender}} \right) + \delta(S') \mathcal{R}(b'_D, b'_C, y') \right\}$$

Price of unit of concentrated debt

$$q_C(b'_D, b'_C, y) = \beta \mathbb{E}_{\{y', \eta'\}} \left\{ (1 - \delta(S')) \left(\underbrace{\tilde{c} + \eta}_{\text{Payment tomorrow}} + \underbrace{(1 - \eta) q_C(b''_D, b''_C, y')}_{\text{Expected future revenue to lender}} \right) + \delta(S') \mathcal{R}(b'_D, b'_C, y') \right\}$$

where $Pr(\eta = 1) = \lambda$