Maturity Walls

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2026 North American Winter Meeting

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- Maturity walls: a majority of debt scheduled to mature within short period (< 2 yrs)
  - Large source of rollover risk
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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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  - Common feature (50%) of non-financial firms' debt structure
- Dimension of debt structure important to rating agencies
  - Existing frameworks not well suited to consider impact of maturity walls

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- Pose understudied risks to the aggregate economy

Opinion **Markets Insight**

The great wall of debt

Given the pile of maturing financing, 2025 and 2026 will prove challenging years for investors

If bull markets always climb a wall of worry, then financial crises often smash into a wall of debt. We are already walking into the foothills of another crisis. It is not just the growing size of the interest bill that matters, but more so the task of rolling over a pile of maturing debts. Next year and particularly 2026 will prove challenging years for investors.

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  - May amplify aggregate shocks if many firms refinance maturity walls during crisis

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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

Model

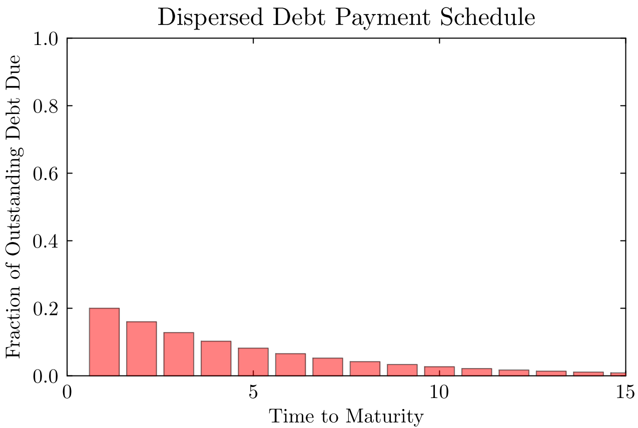
Model Environment

- Continuum of risk neutral firms that maximize dividend stream over infinite horizon
- Heterogeneous in states $\mathcal{S} \equiv (b_D, b_C, y, \eta)$
  - b_D: debt w/ dispersed payments
  - b_C: debt w/ concentrated payment
  - y: firm revenue $y \sim G(y|y_{-1})$
  - η: iid repayment shock $Pr(\eta = 1) = \lambda$
- Firm chooses:
  - $b'_D \in \mathcal{B}_\mathcal{D} \equiv \{b_{1,D}, b_{2,D}, \ldots, b_{n_D,D}\}$
  - $b'_C \in \mathcal{B}_\mathcal{C} \equiv \{b_{1,C}, b_{2,C}, \ldots, b_{n_C,C}\}$

Model Environment

- Debt Prices:
  - Priced by representative lender's zero profit condition
  - Firm specific prices $\{q_D(b'_D, b'_C, y), q_C(b'_D, b'_C, y)\}$ that depends on debt choices
- What breaks Modigliani-Miller?
  - Tax benefit of debt: $\tau(b_D + b_C)\tilde{c}$
  - Convex equity issuance cost: α
    - Reduced form approach to capture rollover risk to firm
    - Cannot rollover then may raise alternative costly funds to help repay
  - Fixed debt issuance cost: c_I
  - Limited liability: firms can default on debt obligations
  - Liquidation costs: lender recovers fraction of firm's assets (χ) if firm defaults

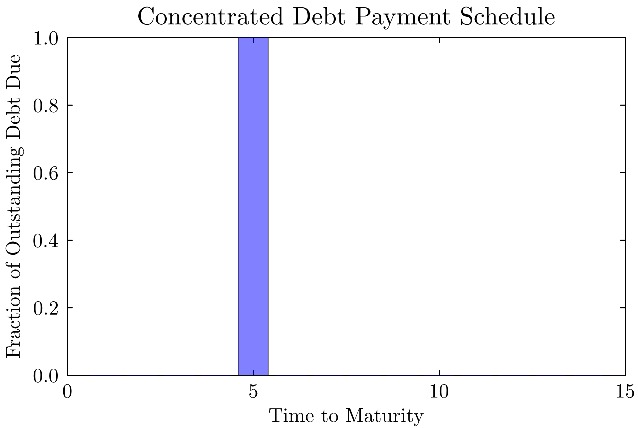
Modeling dispersed and concentrated debt payments



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

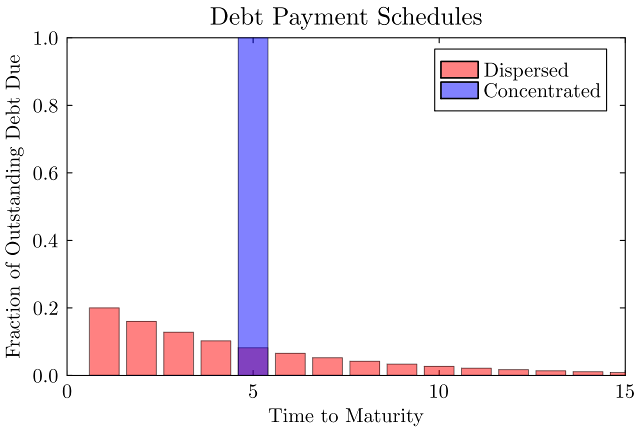
Modeling dispersed and concentrated debt payments



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

Modeling dispersed and concentrated debt payments



Remarks:

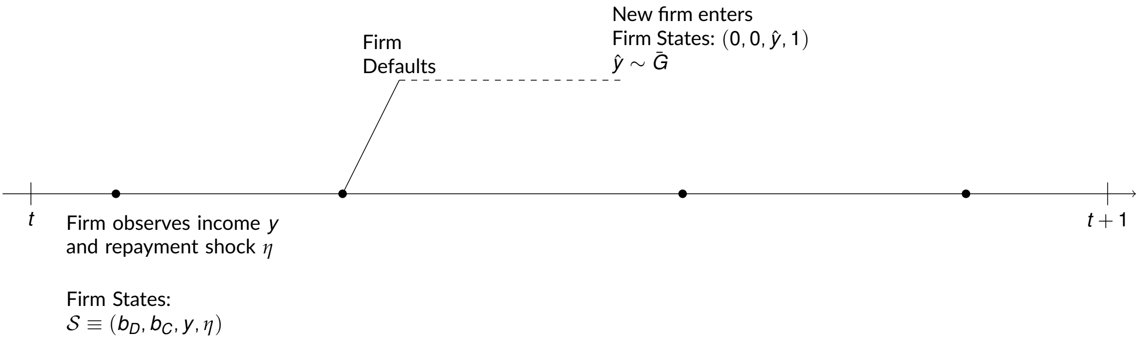
- Firm required to pay $\underbrace{\tilde{c}(b_D + b_C)}_{\text{Coupon}} + \underbrace{\lambda b_D + \eta b_C}_{\text{Principal}}$ to avoid default
- Bonds are identical in terms of (i) payment amount and (ii) average maturity $(1/\lambda)$
- Differ only in terms of schedule of payments

Timing

Firm observes income y
and repayment shock η

Firm States:
$\mathcal{S} \equiv (b_D, b_C, y, \eta)$

Timing


New firm enters
Firm States: $(0, 0, \hat{y}, 1)$
$\hat{y} \sim \bar{G}$
Firm
Defaults
t
Firm observes income y
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$t + 1$

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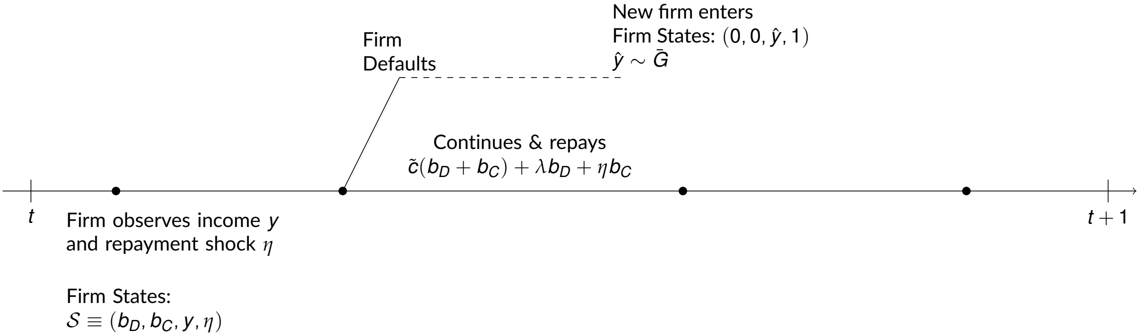
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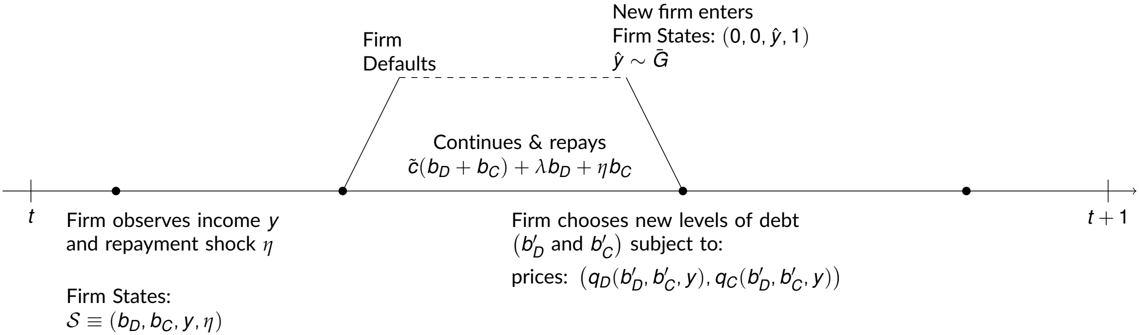
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Firm observes income y
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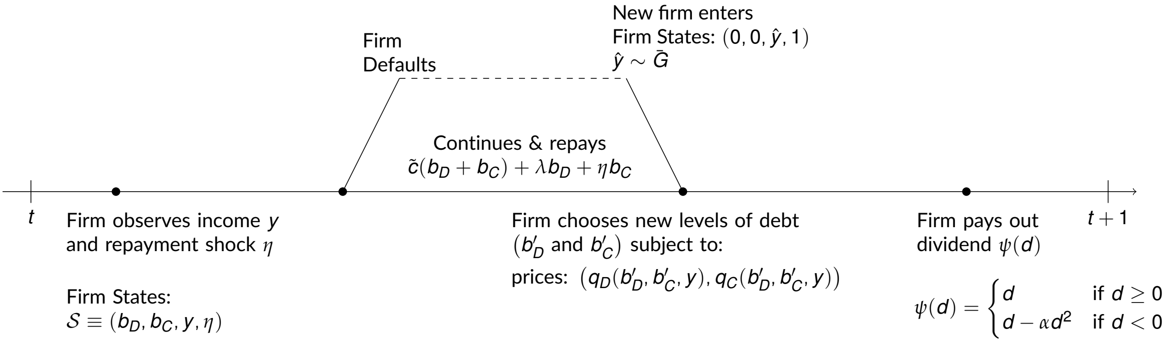
Firm States:
$\mathcal{S} \equiv (b_D, b_C, y, \eta)$
Firm chooses new levels of debt
$(b'_D$ and $b'_C)$ subject to:
prices: $(q_D(b'_D, b'_C, y), q_C(b'_D, b'_C, y))$
$t + 1$

Timing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Firm pays out
dividend $\psi(d)$
$t+1$
$\psi(d) = \begin{cases} d & \text{if } d \geq 0 \\ d - \alpha d^2 & \text{if } d < 0 \end{cases}$

Quantitative Exercises

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

How much do maturity walls contribute to credit risk?

In equilibrium:

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Causal effect of maturity walls on credit risk:

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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
iii firm's optimally choose to default
iv lender's optimally price debt to make zero profits

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	bps	%	Baseline Value
Δ Default Rate	35.9	25.0	1.2%
Δ Credit Spread	30.0	21.1	1.7%

Mechanism

Are firms less risky if issuing debt is cheaper?

Underwriter fees (c_I) are important input in firm's choice to have maturity wall or not

- Manconi, Neretina, Renneboog (2019) find corporate bond underwriters have market power
- Economically significant: upwards of 19.4 bps (25%) of underwriter fee

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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

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
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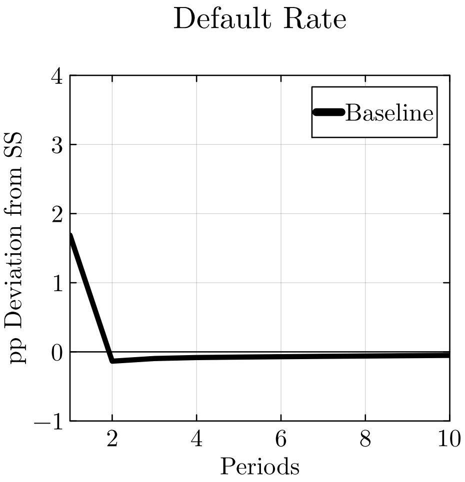

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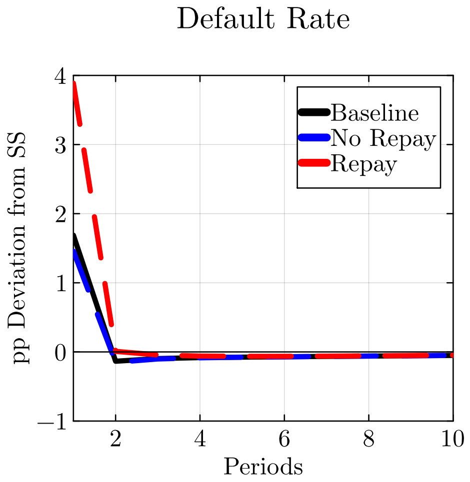
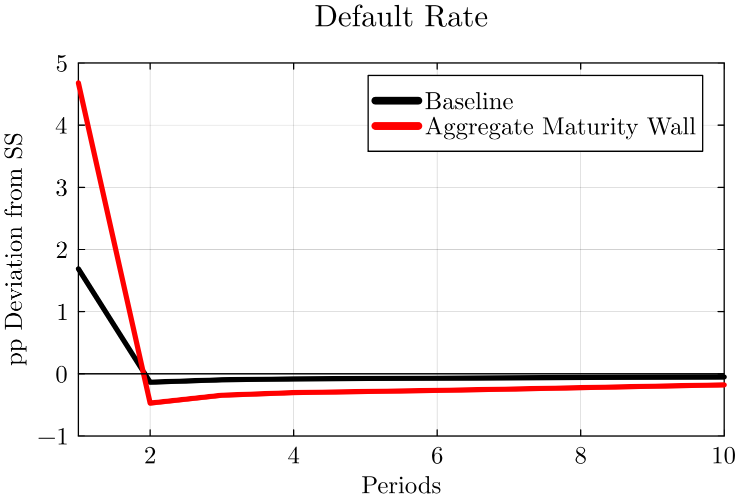


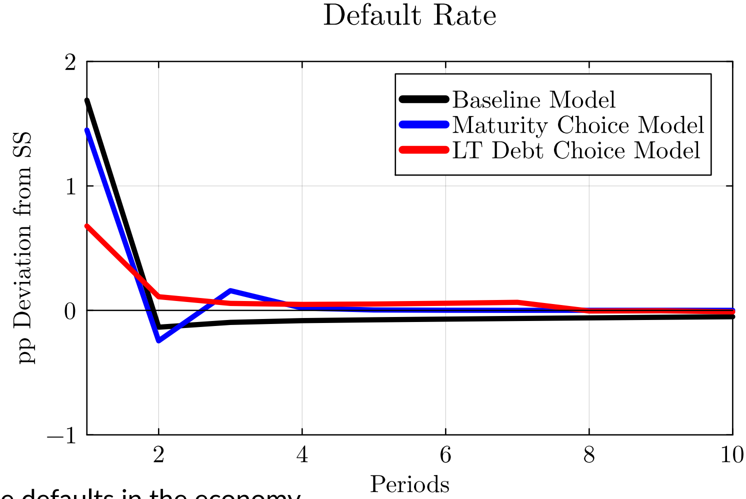
Firms w maturity walls due at freeze account for majority of ↑ defaults

Aggregate maturity wall during credit market freeze



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

What do we miss without concentrated debt payments?



We underestimate defaults in the economy

- 60% (100 bps) compared to LT debt choice model (DeMarzo & He, 2021)
- 14% (25 bps) compared to maturity choice model (He & Milbradt, 2016)

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 36 bps (25%) & borrowing costs by 30 bps (21%)
2. 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)
3. Do maturity walls amplify an aggregate credit shock to firm defaults?
   - Firms w/ maturity walls due at shock account for 100% more defaults
4. What do we get wrong by omitting maturity walls?
   - Underestimate transmission of credit shock to default rates by up to 60%

Appendix

What about bank debt?

Conditional on being bond issuer:

- Bond debt accounts for 87% of bank + bond debt
- Bank debt accounts for 60% of total debt (bank, bond, mortgages, credit lines, CP, etc.)

At aggregate level (Flow of Funds):

- Bond debt accounts for 55% of aggregate corporate borrowing
- Bank debt accounts for 10% of aggregate corporate borrowing

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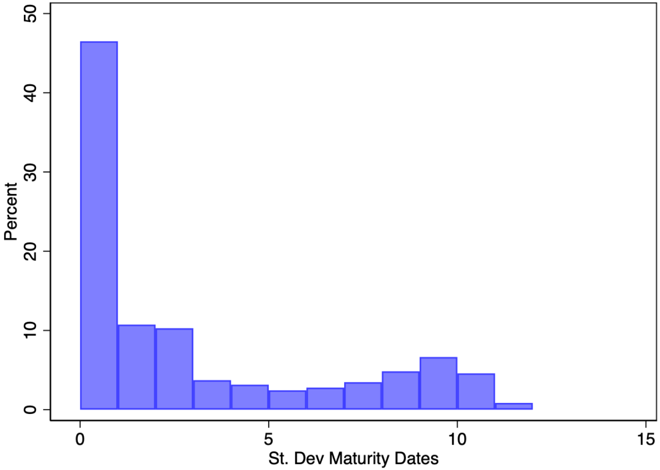
Fact 1: 47% of firms have maturity walls



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  Median σ_{Mat}: 1.5 years

Weighted by age Weighted by size Weighted by leverage Weighted by bond fraction

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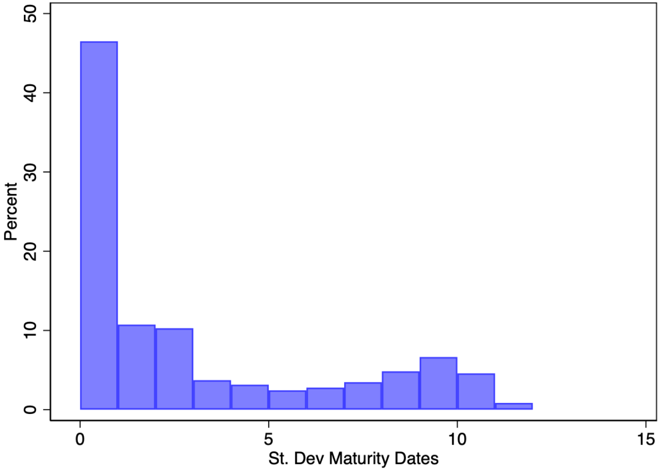

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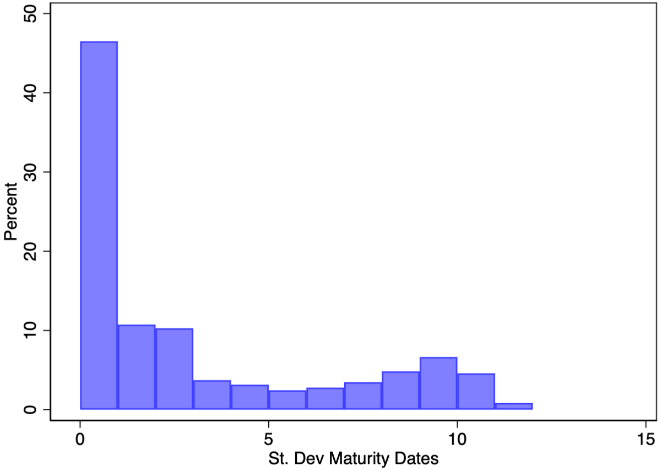

- Avg σ_{Mat}: 2.6 years
  Median σ_{Mat}: 1.5 years
- Maturity Wall: $\sigma_{Mat} \leq 1$
  (Antero's σ_{Mat} at rating downgrade)
- Firms w/ maturity walls typically issue few bonds
  - Avg. # of bonds: 1.8
  - Median # of bonds: 1
  - P75 # of bonds: 2

Weighted by age Weighted by size Weighted by leverage Weighted by bond fraction

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Which firms are holding maturity walls?

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

Firms w/ maturity walls associated w/:

- $\uparrow$ leverage, concerned about rollover risk
  $\rightarrow$ disperse payments
- $\uparrow$ revenue, less concern about rollover risk
  $\rightarrow$ concentrate payments
- $\uparrow$ Q, more concern about rollover risk
  (investment opportunities valuable to firm)
  $\rightarrow$ 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***	3.617***	48.041***	41.883***
	(0.415)	(0.497)	(9.972)	(9.607)
Avg. Bond Maturity	-0.281	-0.389*	-3.444	-3.291
	(0.203)	(0.201)	(3.413)	(3.297)
Maturity Wall	2.805***	2.649***	25.979***	64.405***
	(0.474)	(0.449)	(8.561)	(12.077)
Leverage $\times$ Maturity Wall		2.401***		69.966***
		(0.612)		(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/ ↑ prob. default & credit spreads
- Large maturity walls associated w/ ↑ credit risk

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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

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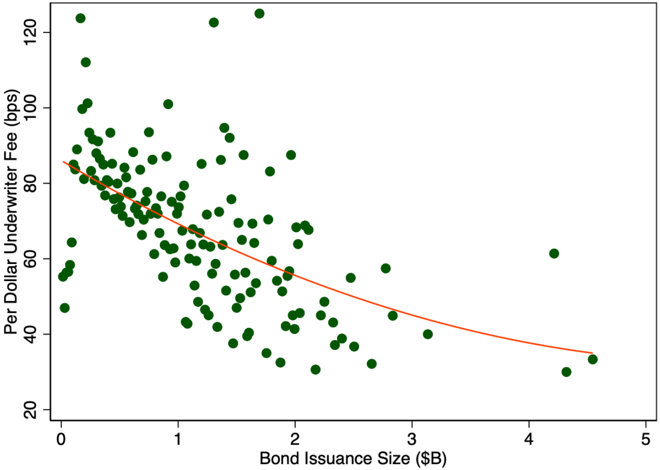
- Underwriter spread (Fee / Iss. Size)
  - $<$ \$1B issue: 80 bps
  - $>$ \$3B issue: 40 bps



Takeaway: Economies of scale consistent with large fixed issuance costs

Bond Issuance Freq Robustness

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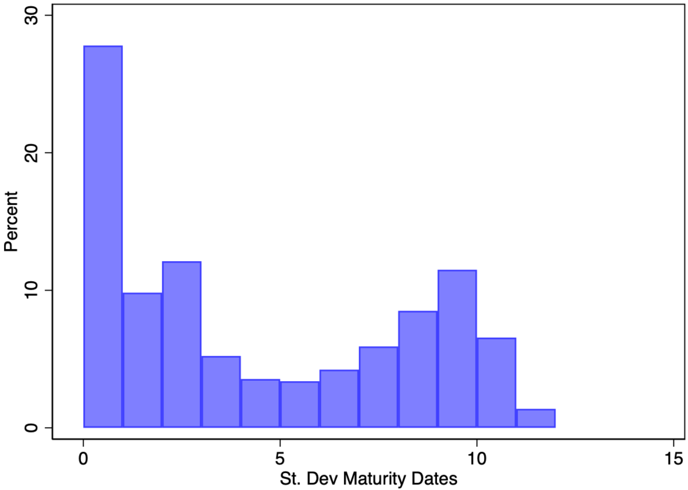
Firms concentrate debt maturity dates (weighted by firm age)



Average: 3.1 years   Median: 4.5 years

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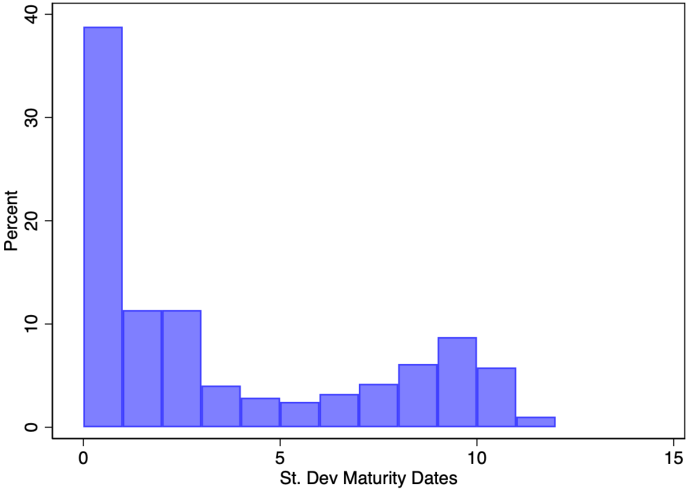
Firms concentrate debt maturity dates (weighted by firm size)



Average: 3.8 years   Median: 2.7 years

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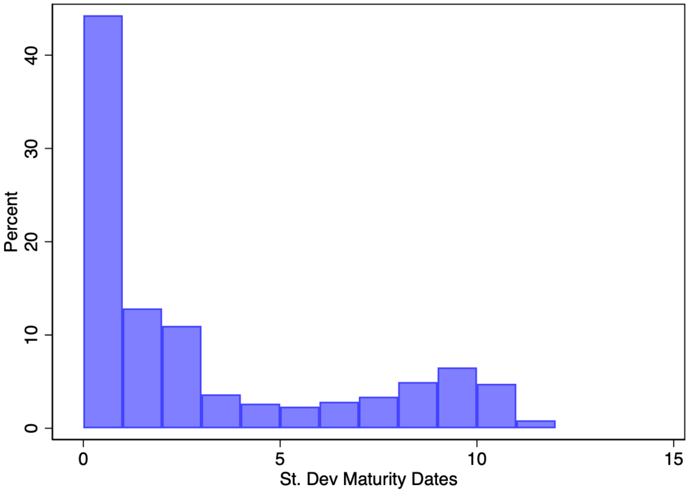
Firms concentrate debt maturity dates (weighted by firm leverage)



Average: 3.3 years Median: 1.8 years

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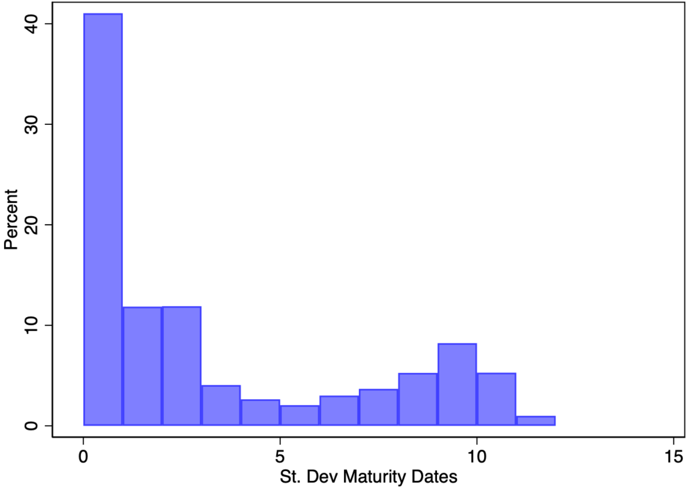
Firms concentrate debt maturity dates (weighted by bond debt pct)



Average: 3.4 years Median: 1.9 years

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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

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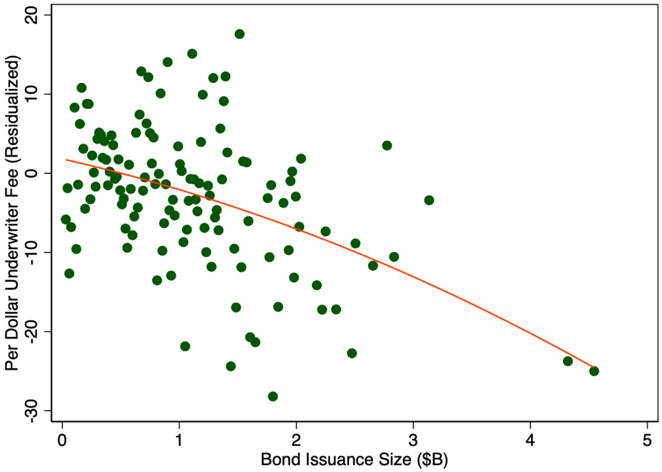
Economies of scale robust to firm and bond controls



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Do firms behave differently before large repayment dates?

	Cash	Investment	$\mathbf{1}_{\text{Buyback}}$
s_1	-0.002	0.007	-0.241***
	(0.007)	(0.008)	(0.052)
s_2	-0.003	0.002	-0.228***
	(0.008)	(0.008)	(0.051)
s_3	-0.002	0.003	-0.217***
	(0.007)	(0.008)	(0.049)
s_4	-0.006	0.002	-0.253***
	(0.007)	(0.008)	(0.048)
s_5	-0.007	0.002	-0.222***
	(0.006)	(0.007)	(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

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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

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

(Continuing) Firm's Problem

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

Subject to:

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

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

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

(Continuing) Firm's Problem

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

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$$+ \underbrace{q_D(b_D', b_C', y) I_D}_{\substack{\text{Dispersed debt} \\ \text{issuance revenue}}} + \underbrace{q_C(b_D', b_C', y) I_C}_{\substack{\text{Concentrated debt} \\ \text{issuance revenue}}} - \underbrace{c_I(\mathbb{1}_{I_D > 0} + \mathbb{1}_{I_C > 0})}_{\text{Debt issuance cost}}$$

$$I_D = b_D' - (1-\lambda) b_D$$
$$I_C = b_C' - (1-\eta) b_C$$

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

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Lender's Problem

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

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

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Price of unit of dispersed debt

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

Price of unit of concentrated debt

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

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

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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 Back to main slides

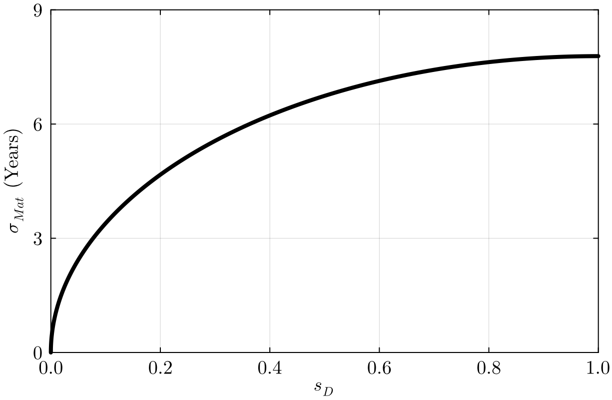
Constructing σ_{Mat} in the model

Let

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

The mapping from s_D to σ_{Mat} is

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



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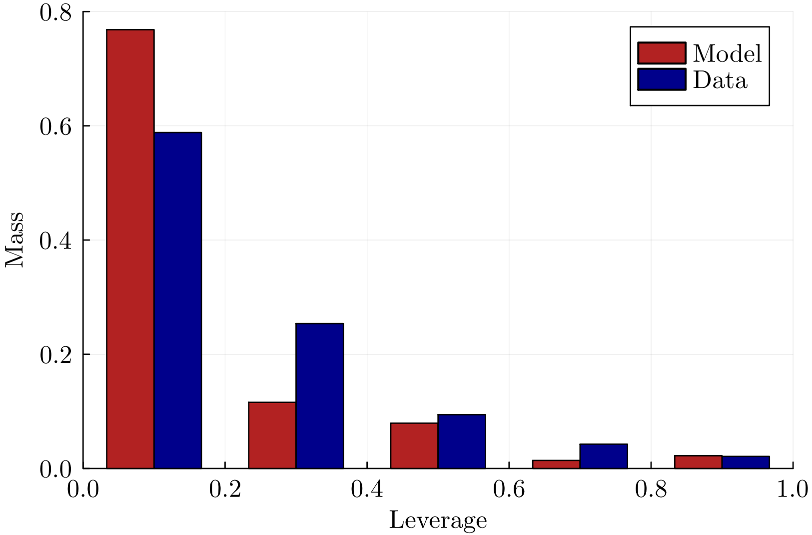
Model Fit: Market Leverage Distribution



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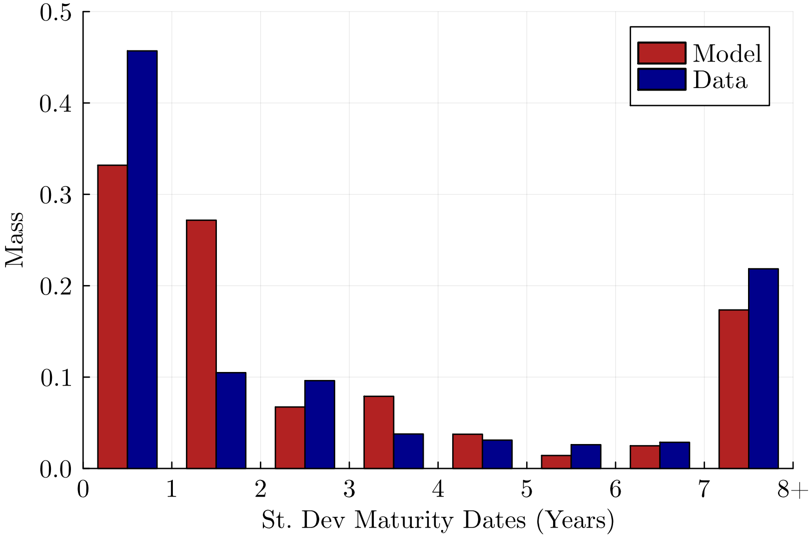
Model Fit: St. Dev of Maturity Dates Distribution



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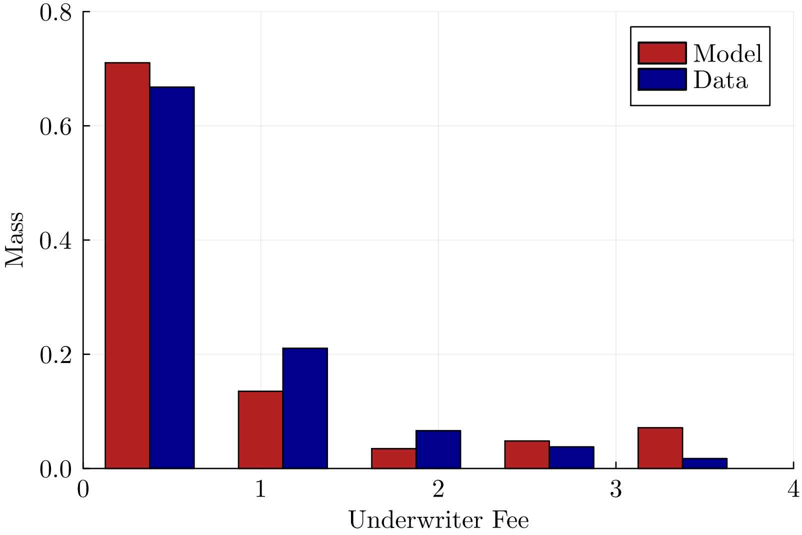
Model Fit: Underwriter Fee Distribution



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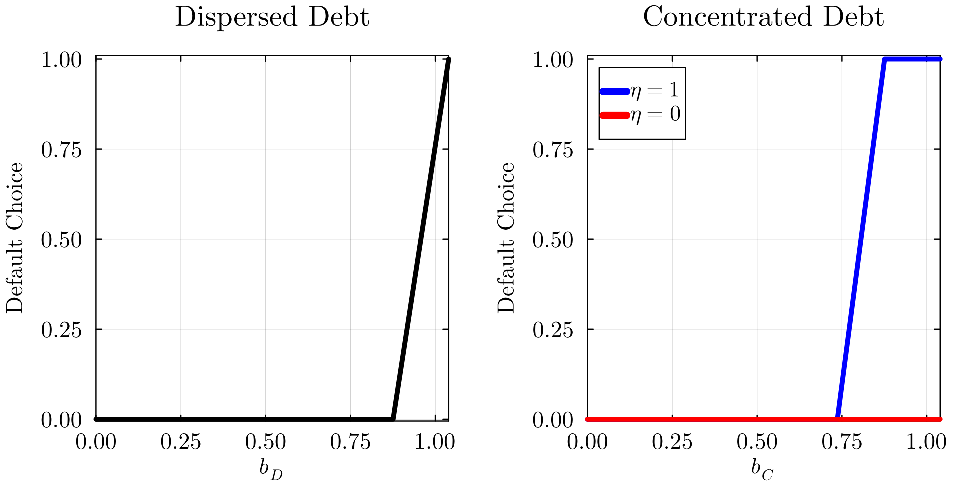
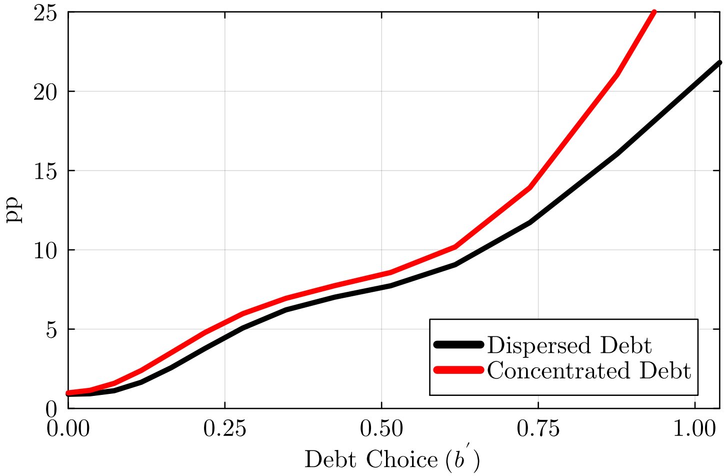
Default behavior depends on debt payment concentration choice



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

Dispersed debt payments $\longrightarrow$ lower interest rates



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

Bond Price Eqs Back to main slides

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

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

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