Maturity Walls

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January 16, 2025

Motivation

- Maturity walls: a majority of debt scheduled to mature within short period ($<$ 2 yrs)
  - Large source of rollover risk
  - Failure to rollover $\longrightarrow$ cut investment, fire workers, and default
  - Common feature 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
- Pose understudied risks to the aggregate economy
  - May amplify aggregate shocks if many firms refinance maturity walls during crisis

Research Questions

1. Why do firms concentrate debt payments, 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

- Construct novel measure of debt maturity dispersion
    - 47% firms choose maturity walls (firms w/ 1 bond outstanding)
    - Maturity walls associated w/ higher credit risk (higher expected defaults and credit spread)
    - Why choose maturity wall? Large fixed costs to issue bonds (underwriter fee $\downarrow$ issuance size)
- Develop dynamic heterogeneous firm credit risk model where:
    - Receive persistent income shocks
    - Pick level of long-term debt
    - Choose to concentrate or disperse debt payments
- Mechanism
    - Tax benefit of debt $\longrightarrow$ firms want to borrow
    - Trade-off: Fixed debt (convex equity) issuance costs $\longrightarrow$ concentrate (disperse) payments
    - Interaction btwn costs & benefits determines level and dispersion of debt payments
- Estimate model via SMM, externally validate, & quantify risks of maturity walls

Preview of results

1. How much do maturity walls matter for firm credit risk?
   - In equilibrium: account for 8% of firm defaults
   - Causal effect: ↑ default rates by 36 bps (25%) & borrowing costs by 30 bps (21%)

2. Are firms less risky if it is cheaper to issue debt?
   - Solve for counterfactual economy w/ lower debt issuance costs
   - Higher eqm default (1 pp) & credit spreads (1.2 pp) b/c firms ↑ borrowing compared to baseline

3. Do maturity walls amplify an aggregate credit shock to firm defaults?
   - Firms w/ maturity walls due at shock are most likely to default
   - Account for 16% of firm defaults

4. What do we get wrong by omitting maturity walls?
   - Underestimate transmission of credit shock to default rates by 14% – 60%

Literature

Determinants of corporate debt structure:

- Stohs and Mauer (1996); Huang, Oehmke, Zhong (2019); Choi, Hackbarth, and Zechner (2018, 2021); Mota and Siani (2024)

  Contribution: First to focus on maturity walls & impacts on firm default risk

Long-term debt and firm dynamics:

- Leland and Toft (1996); Chatterjee & Eyigungor (2012); Arellano & Ramanarayanan (2012); Diamond and He (2014); He and Milbradt (2016); Geelen (2019); DeMarzo and He (2021); Dangl and Zechner (2021); Jungherr and Schott (2021), Chaderina (2023)

  Contribution: Literature assumes stylized schedule of debt payments, at odds with data

  Incorporate maturity walls to fill gap

Financial heterogeneity and aggregate shocks:

- Crouzet (2017); Ottonello and Winberry (2020); Jungherr, Meier, Reinelt, Schott (2022); Crouzet and Tourre (2023)

  Contribution: Aggregate implications of maturity walls

Roadmap

Empirical Facts

Model

Mapping Model to Data

Model Mechanics

Quantitative Exercises

Empirical Facts

Data

Mergent FISD: Universe of Corporate Bond Issuances

Bank Debt

- Focus: Non-financial corporate bonds
- Bonds excluded: foreign currency, asset-backed, convertible, and foreign issuer bonds
- Provides terms and history of bond issue
  - date of issuance, maturity at issuance, coupon payments, and repurchases
  - credit spreads, yield at issuance, underwriter fees
- Construct amount of debt outstanding by maturity for all (parent) firm-year pairs

Compustat: Balance sheet information

Sample Period: Annual, 1995 - 2019

Constructing a measure of debt payment dispersion

Share of debt due in m years:

$$s_{m,t} = \frac{\overbrace{b_{m,t}}^{\text{Debt due in } m \text{ yrs}}}{\sum_{m=1}^{M} b_{m,t}}$$

Standard deviation of debt maturity dates:

$$\sigma_{Mat,t} = \sqrt{\sum_{m=1}^{M} s_{m,t}(m - \underbrace{\mu_{Mat,t}}_{\text{Avg. Mat}})^2}$$

- Low $\sigma_{Mat,t} \longrightarrow$ concentrated debt payments

When measuring payment dispersion, two features are desirable:

1. How large $s_{m,t}$
2. Size of neighboring debt payments (i.e: $s_{m-1,t}$ and $s_{m+1,t}$)
   - Firm A: pays $1/2$ debt in $m = 1$ and $m = 2$ ($\sigma_{Mat} = 0.5$ years, $HI_{Mat} = 0.5$)
   - Firm B: pays $1/2$ debt in $m = 1$ and $m = 20$ ($\sigma_{Mat} = 9.5$ years, $HI_{Mat} = 0.5$)
   - Reasonable to think rollover risk between firms is different

σ_{Mat} and HI_{Mat}

Summary of Empirical Facts

1. 47% of firms have maturity walls More
   Primarily made up of firms with 1 bond outstanding

2. Maturity walls are not byproduct of firms financing over life cycle More

3. Maturity walls are associated with higher credit risk More
   $\uparrow$ 1 pp prob. default & 25 bps credit spread

4. Firms face economies of scale in bond issuance More
   Consistent with presence of fixed issuance costs

Next: Quantitative model informed by these facts

- Firm optimally choose:
  i. How much to borrow
  ii. How concentrated their debt payments are
- Key trade-off: convex equity costs (rollover risk) v. fixed debt issuance costs

Model

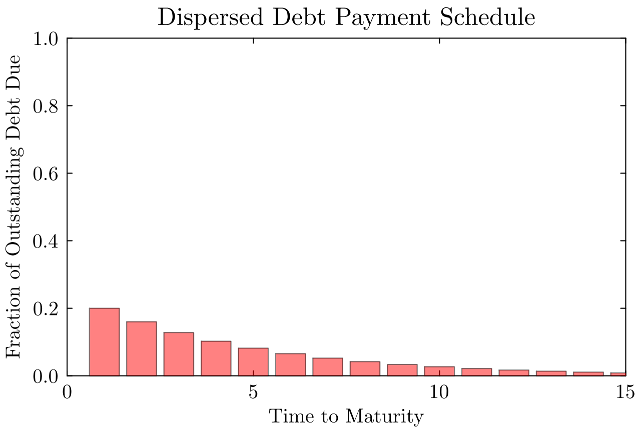
Firms

- Continuum of risk neutral firms that maximize dividend stream over infinite horizon
- Heterogeneous in states $\mathcal{S} \equiv (b_D, b_C, y, \eta, \varepsilon)$
  - 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 $Pr(\eta = 1) = \lambda$
  - $\varepsilon(b'_D, b'_C)$: iid manager pref. shocks over debt choices $\varepsilon \sim$ Type 1 EV$(0, \sigma_\varepsilon)$
- Firm chooses:
  - $b'_D \in \mathcal{B_D} \equiv \{b_{1,D}, b_{2,D}, \ldots, b_{n_D,D}\}$
  - $b'_C \in \mathcal{B_C} \equiv \{b_{1,C}, b_{2,C}, \ldots, b_{n_C,C}\}$

Firms

- Debt Prices:
  - Priced by representative lender
  - Firm specific prices $\{q_D(b'_D, b'_C, y), q_C(b'_D, b'_C, y)\}$ that depends on debt choices
- Frictions:
  - Tax benefit of debt: deduct per-period coupon payment $(b_D + b_C)\tilde{c}$ off pre-tax income (y)
  - Convex equity issuance cost: α
  - 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

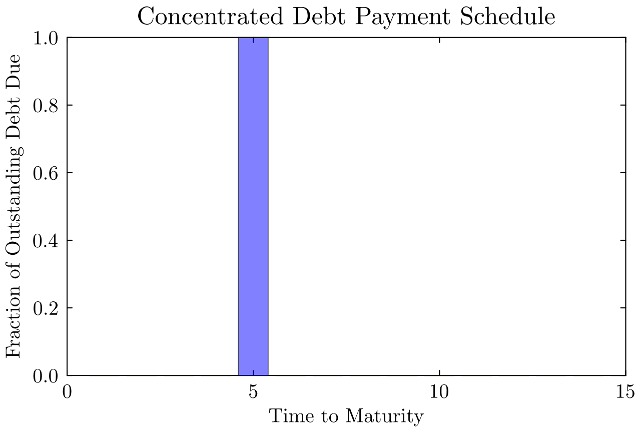
Modeling dispersed and concentrated debt payments



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

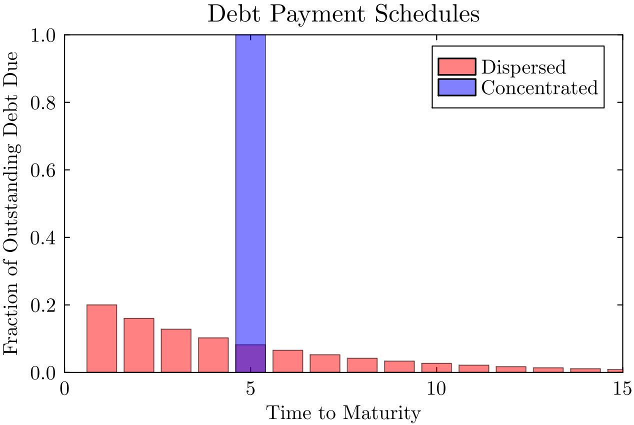
Modeling dispersed and concentrated debt payments



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

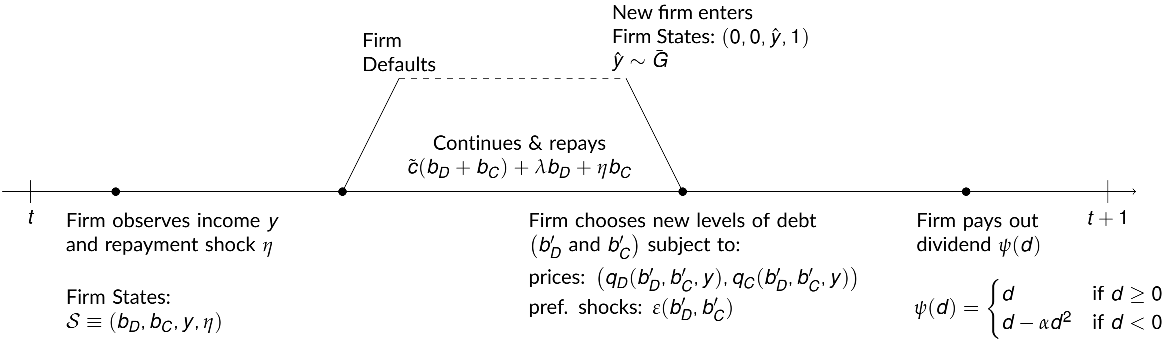
Modeling dispersed and concentrated debt payments



Remarks:

- Firm required to pay $\overbrace{\tilde{c}(b_D + b_C)}^{\text{Coupon}} + \overbrace{\lambda b_D + \eta b_C}^{\text{Principal}}$ 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's Problem Lender's Problem Equilibrium Definition

Mapping Model to Data

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
  - $log(y') = \rho_y log(y) + \sigma_y \varepsilon_y, \quad \varepsilon_y \sim N(0,1)$
  - 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

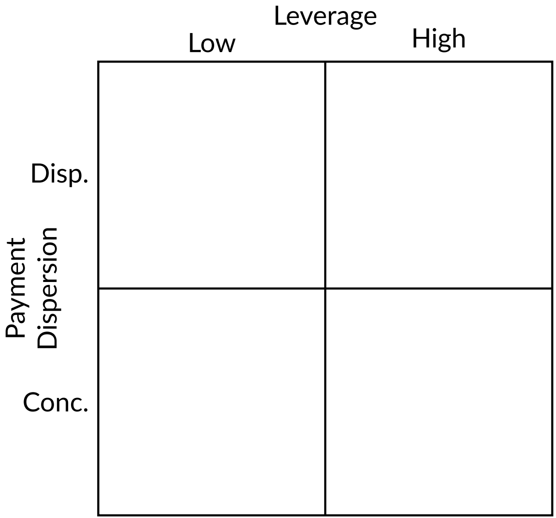
Parameter	Description	Value	SE	Target/Reference	Data	Model
Externally Calibrated						
β	Discount factor	0.960	–	4% Annual Risk Free Rate	–	–
$\tilde{c}$	Per-period coupon payment	$1/\beta - 1$	–	Eqm price of riskless debt is 1	–	–
τ	Corporate tax rate	0.300	–	Hennessy & Whited (2007)	–	–
ρ_y	Persistence: 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

Model Mechanics

1. Joint choice of debt level and dispersion
2. Default / spreads depends on debt payment dispersion

Choosing leverage & dispersion bundles

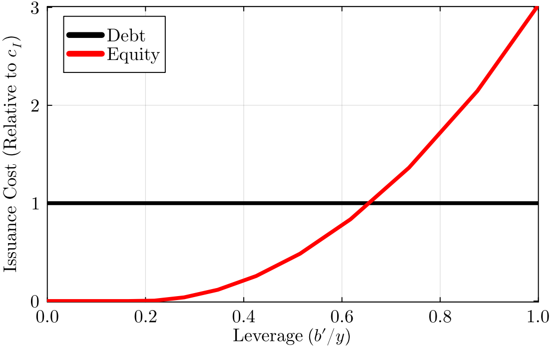


Choosing leverage & dispersion bundles: Dispersion choice

Leverage

Payment Dispersion	Low	High
Disp.	X	
Conc.		X

Cost difference between debt and equity issuance



Estimated model:
Avg debt cost / equity cost $\approx$ 3

More

Choosing leverage & dispersion bundles: Leverage choice

Firm chooses between two bundles:

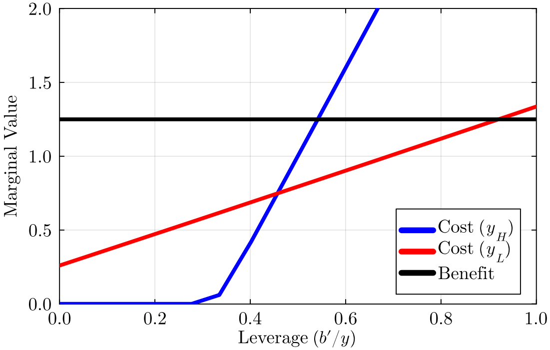
1. Low leverage, concentrated debt payment
2. High leverage, dispersed debt payments

Equate marginal benefit w/ marginal cost

Decrease in firm income (y)

- More likely to inject equity for low b/y
  $\Longrightarrow$ Increase in MC curve
- For given b/y, b lower in level
  $\Longrightarrow$ Flattening of MC curve

Marginal benefit & marginal cost of higher leverage



External validation of model mechanics

Model Predictions

- High leverage $\Longrightarrow$ dispersed debt payments
- High income $\Longrightarrow$ concentrated debt payments (because lowly levered)

Untargeted Conditional Correlations

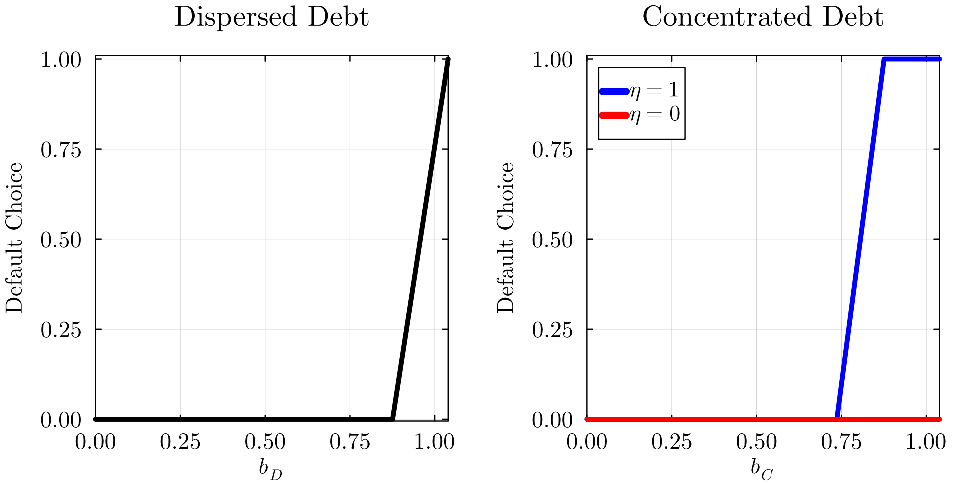
	St. Dev Maturity Dates (σ_{Mat})	
	Data	Model
Leverage	0.182	0.189
Income (Profit)	-0.071	-0.033
Additional Firm Controls	Yes	–

Note: Additional controls include: Size, Age, Average Maturity, Cash, Fraction of Bond Debt, IG Dummy

Model Mechanics

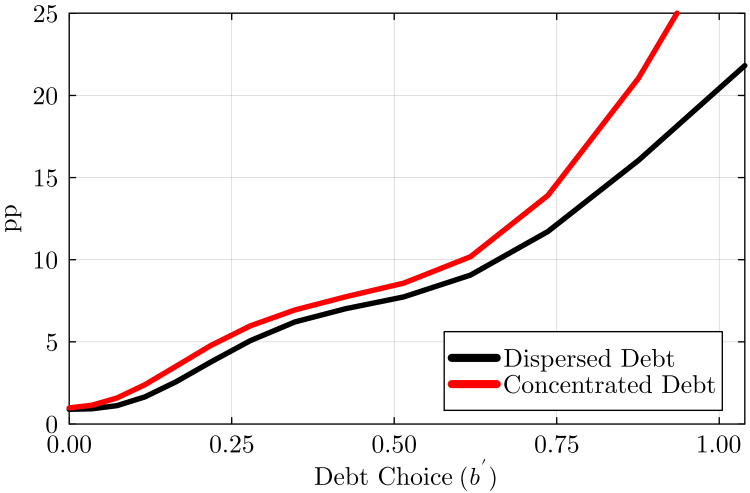
1. Joint choice of debt level and dispersion
2. Default / spreads depends on debt payment dispersion

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 ⟶ lower interest rates



Takeaway: Interest rates price in firm def. risk ⟶ borrowing cost $b_C >$ borrowing cost b_D Bond Price Eqs

External validation of model mechanics II

Model Predictions

- High leverage $\Longrightarrow$ higher credit spread
- Dispersed debt payments $\Longrightarrow$ lower credit spread

Untargeted Conditional Correlations

	Credit Spread (bps)	
	Data	Model
Leverage	29.69	72.80
σ_{Mat}	-12.35	-19.79
Income (Sales)	-36.93	-46.55
Additional Firm Controls	Yes	—

Note: Additional controls include: Size, Age, Average Maturity, Cash, Fraction of Bond Debt, IG Dummy

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?

How much do maturity walls contribute to credit risk?

In equilibrium:

- 8% of defaults are from firms failing to repay maturity walls

Causal effect of maturity walls on credit risk:

- Can't compare two firms w/ & w/o maturity wall, since it is endogenous choice
- Use structural model to generate exogenous variation in debt structure

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

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

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?

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)

- Corporate bond underwriters have market power
- Economically significant:
  - Mean market power: 12.2 bps (16%) of underwriter fee
  - Max market power: 19.4 bps (25%) of underwriter fee

How does eliminating underwriter market power affect firm's spreads, default, and market value?

- Counterfactual equilibrium: underwriter fee in perfectly competitive economy
- Reduce underwriter fee by mean/max percentage of underwriter market power estimates

How does underwriter market power impact default & spreads?

Underwriter fees (c_I):

- Pushes firms to concentrate debt issuance and payments
- Reducing c_I: firm can disperse debt payments at lower cost

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

In economy with competitive underwriter market

- $\uparrow$ risk from borrowing more $>$ $\downarrow$ reduced risk from debt composition changes
- Credit spreads & default rates are higher

Counterfactual equilibrium: competitive underwriter market

	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%

Takeaway: Firm's borrowing increases $\longrightarrow \uparrow$ credit spreads & default rates

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?

Macroeconomic implications of maturity walls on market freezes

- Firms with maturity walls are more exposed to rollover risk

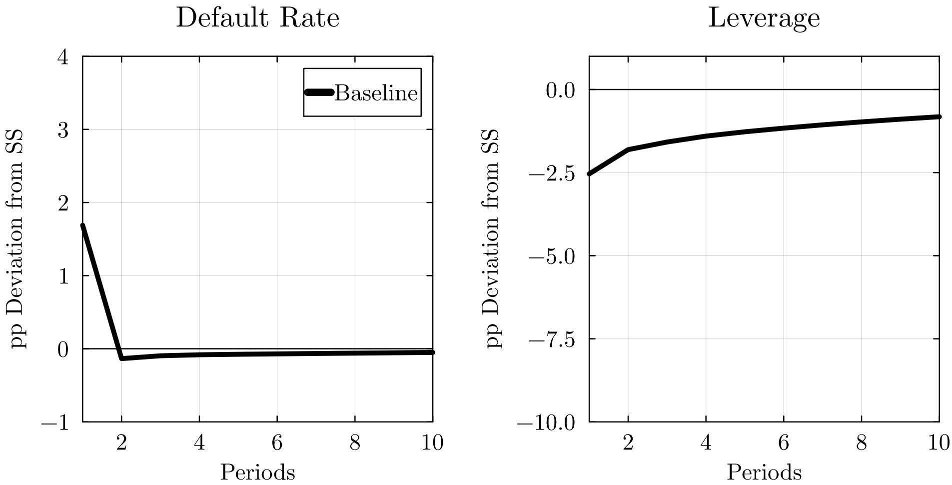
- $\sim$50% of firms have maturity wall

- What are macro implications of maturity walls on credit market freeze?
  - Credit market freeze $\longrightarrow$ large decline in volume of transactions in primary market

- Credit Market freeze: unanticipated one period shock where
  i. debt market shuts down (no new borrowing or early pre-payment)
  ii. equity issuance cost rises (calibrated to match $\uparrow$ in default rate observed in GFC)

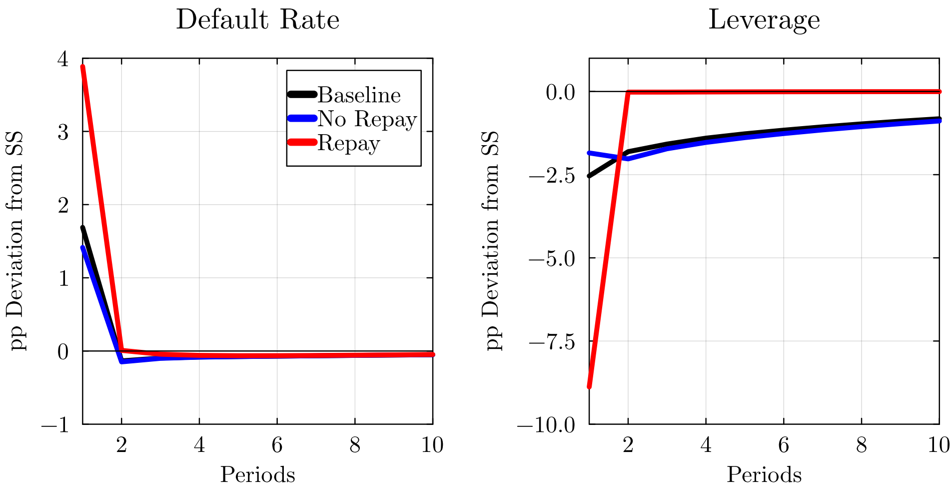
- Firms may be “unlucky” at having to repay maturity wall at time of market freeze
  - Unable to rollover
  - Amplifies default

Aggregate effects of credit market freezes



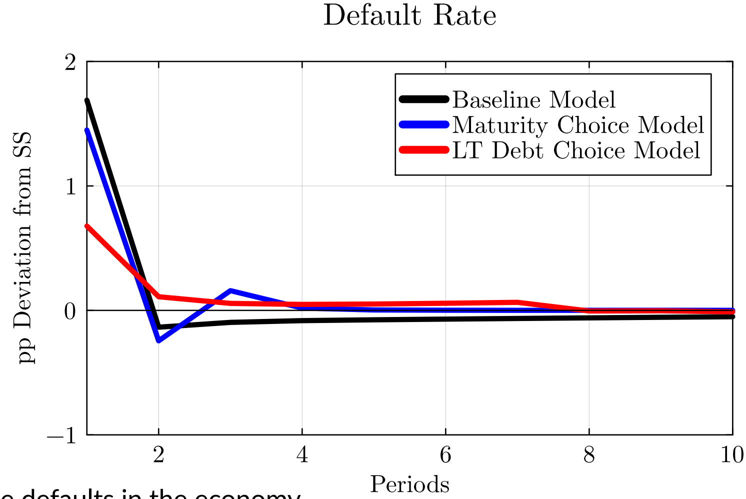
Default rate increases by 168 bps in market freeze

Heterogeneous effects of credit market freezes



16% of defaults are by firms who need to pay b_C at time of market freeze (2x from baseline)

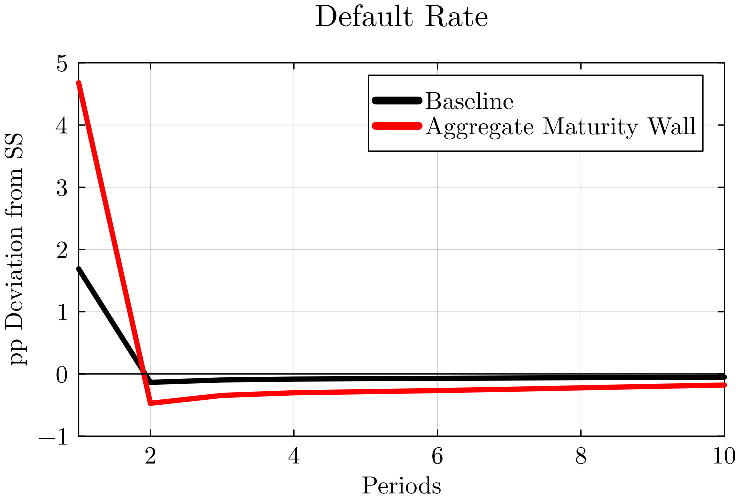
What do we miss without concentrated debt payments?



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)

Aggregate maturity wall during credit market freeze



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

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
- Joint determination of leverage and maturity walls is important

Today I showed:

- Maturity walls $\uparrow$ default rates by 36 bps (25%) & borrowing costs by 30 bps (21%)
- Removing market power in underwriter market $\rightarrow$ higher eqm default compared to baseline
- Miss up to 60% of defaults during credit market freeze by omitting maturity walls
- Aggregate maturity walls amplify defaults during credit market freeze 299 bps

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):

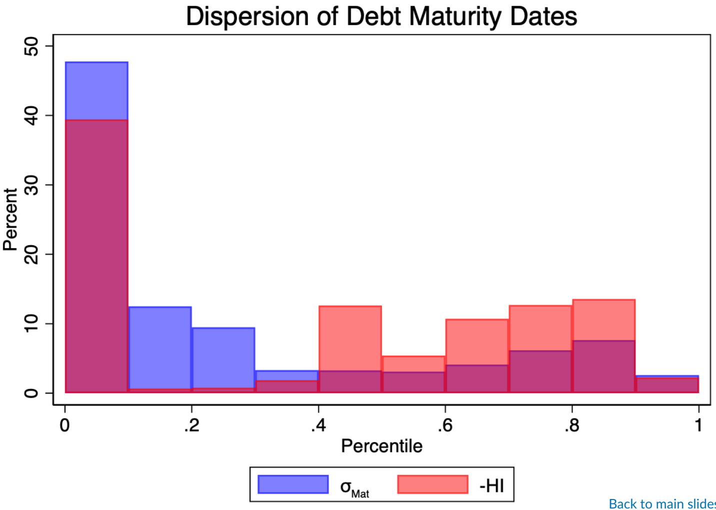
- Bond debt accounts for 55% of aggregate corporate borrowing
- Bank debt accounts for 10% of aggregate corporate borrowing

Back to main slides

Constructing a measure of maturity walls

$$HI_{Mat,t} = \sum_{m=1}^{M} s_{m,t}^2$$

- High $HI_{Mat} \longrightarrow$ concentrated debt payments
- σ_{Mat} picks up in maturity walls missed by $_{Mat}$



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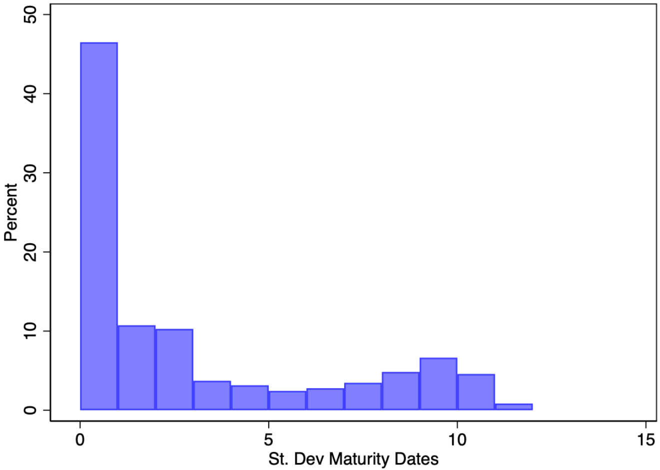
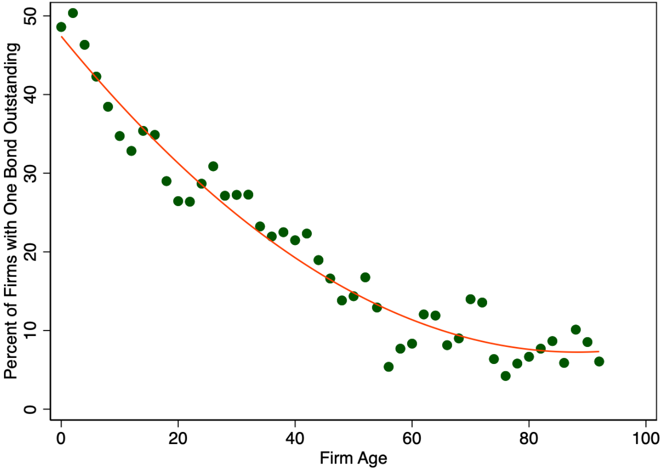
Fact 1: 47% of firms have maturity walls



Weighted by age Weighted by size Weighted by leverage Weighted by bond fraction Back to main slides

- 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
- Maturity wall proxy going forward:
  Firms w/ 1 bond outstanding

Fact 2: Maturity walls not driven by financing over firms' life cycle



Young firms ($\leq$ 5)

- $\sim$ 50% have one bond outstanding

Old firms ($\geq$ 30)

- $\sim$ 20% have one bond outstanding
- *Could have* chosen to have multiple bonds outstanding but didn't

Fraction of bond debt Back to main slides

Which firms are holding maturity walls?

	1{One Bond} (1)	(2)
Leverage	-0.107***	-0.111***
	(0.007)	(0.008)
Profit	0.082***	0.076***
	(0.006)	(0.006)
Size	-0.277***	-0.281***
	(0.012)	(0.013)
Age	-0.025***	-0.023***
	(0.007)	(0.008)
No. Bonds Outstanding	-0.038***	-0.035***
	(0.008)	(0.008)
Avg. Bond Maturity	-0.023***	-0.021***
	(0.007)	(0.008)
Observations	12564	11852
R^2	0.282	0.295
Fixed Effects	Year	Ind & Year

Firms w/ maturity walls associated w/:

- $\uparrow$ leverage, concerned about rollover risk
  $\rightarrow$ disperse payments
- $\uparrow$ profit, less concern about rollover risk
  $\rightarrow$ concentrate payments

Fact 3: Firms with maturity walls appear more risky

	Prob. Default (pps)	Credit Spread (bps)
Leverage	4.690***	44.808***
	(0.402)	(9.504)
Avg. Bond Maturity	-0.420**	-3.688
	(0.203)	(3.361)
1{One Bond}	0.955*	24.478**
	(0.490)	(12.387)
Observations	6692	1269
R^2	0.407	0.690
Firm Controls	Yes	Yes
FEs	Yes	Yes

Takeaway: Firms w/ maturity walls associated w/ ↑ prob. default & credit spreads

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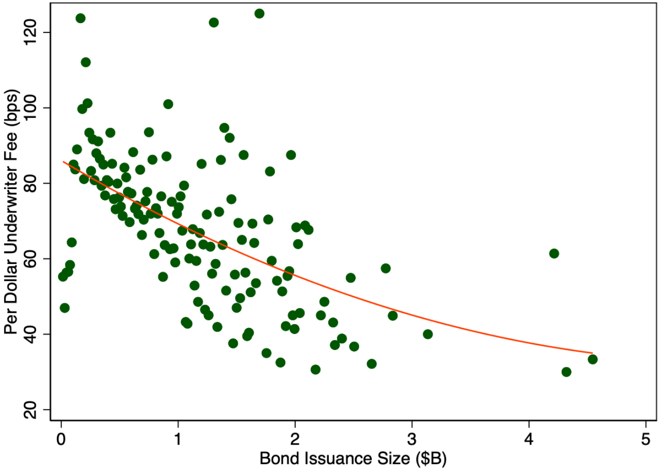
Fact 4: Firms face economies of scale issue bonds

Underwriter fees:

- Cost to *issue* corporate bond (fixed + variable cost)

- Spread out fixed cost by issuing larger amounts

- Underwriter spread (Fee / Issue 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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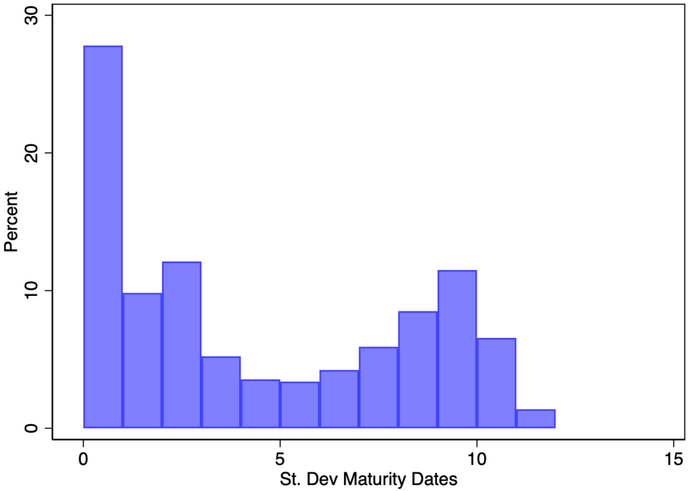
Firms concentrate debt maturity dates (weighted by firm age)



Average: 3.1 years   Median: 4.5 years

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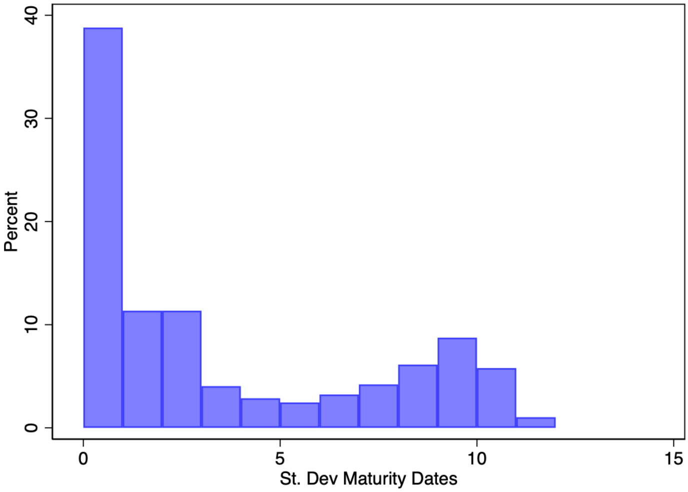
Firms concentrate debt maturity dates (weighted by firm size)



Average: 3.8 years Median: 2.7 years

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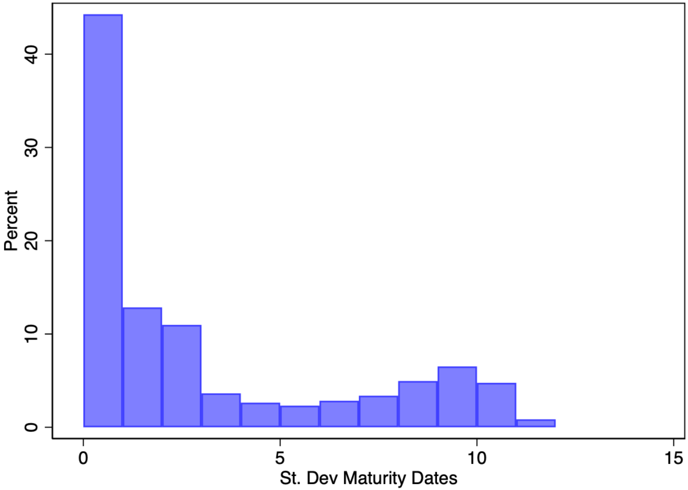
Firms concentrate debt maturity dates (weighted by firm leverage)



Average: 3.3 years Median: 1.8 years

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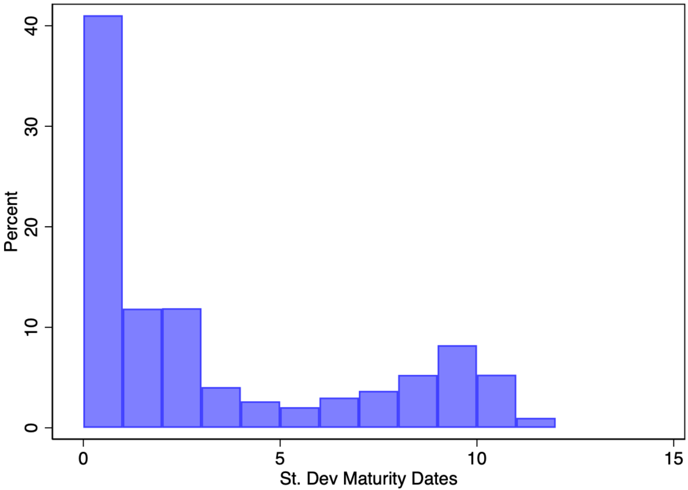
Firms concentrate debt maturity dates (weighted by bond debt pct)



Average: 3.4 years   Median: 1.9 years

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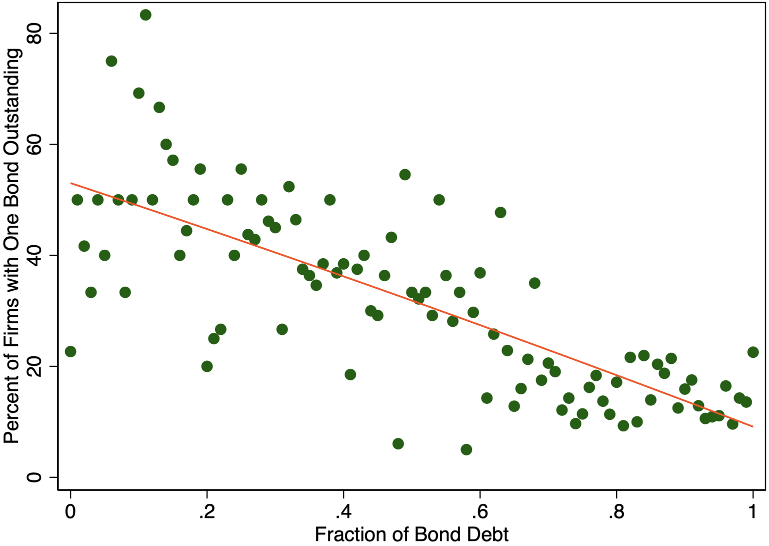
Fact 2: Maturity walls not driven by financing over firms' life cycle



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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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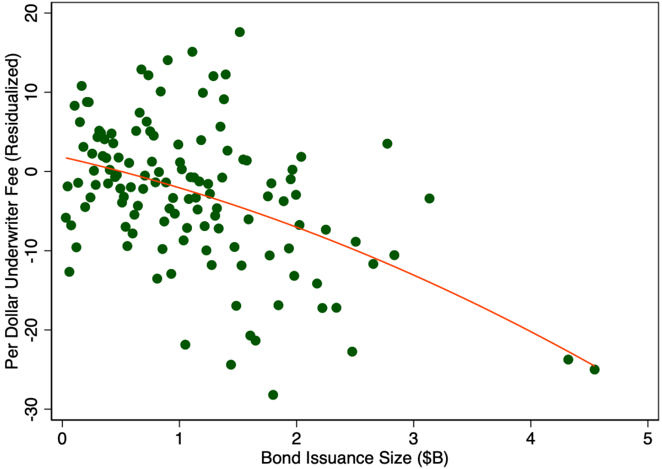
Economies of scale robust to firm and bond controls



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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

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

Subject to:

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

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

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

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

Lender's Problem

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

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

Full Definition

Price of unit of dispersed debt

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

Price of unit of concentrated debt

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

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

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 $y \sim \bar{G}$

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

- $\delta(\mathcal{S}')$: default decision in state $\mathcal{S}' \equiv (b'_D, b'_C, y', \eta', \varepsilon')$
- $\tilde{V}(y) = \psi((y - c_F)(1-\tau)) + \beta \mathbb{E}_{\{y'\}} \max\left\{\tilde{V}(y'), 0\right\}$
- $\mathcal{R}(b_D, b_C, y) = \min\left[1, \chi \tilde{V}(y) / b_D + b_C\right]$

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Price of unit of dispersed debt

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

Price of unit of concentrated debt

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

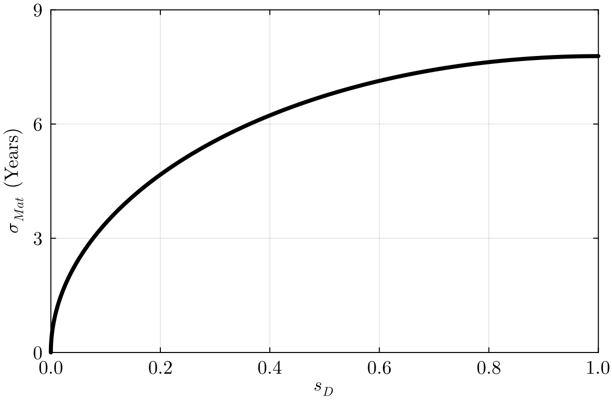
Constructing σ_{Mat} in the model

Let

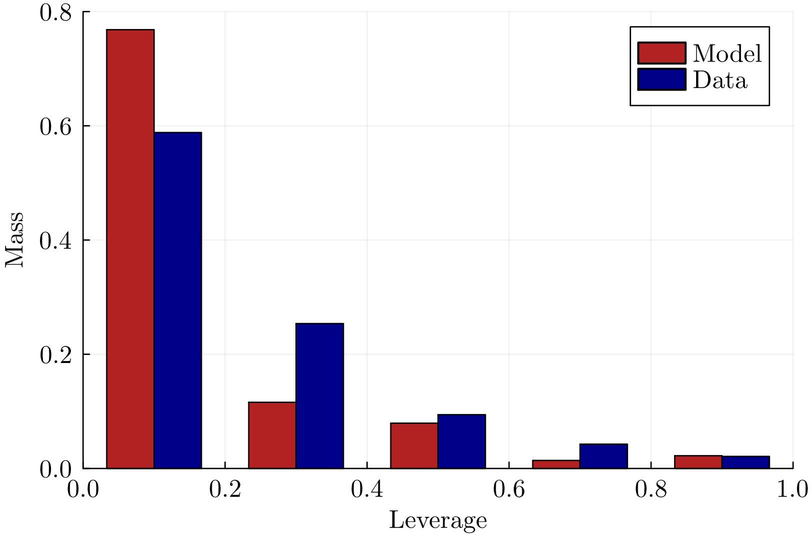
$$s_D = \frac{b_D}{b_D + b_C}$$

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



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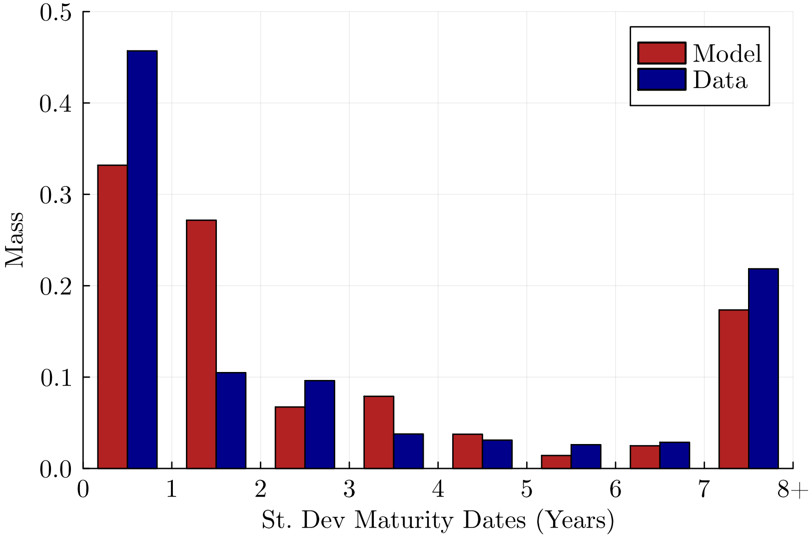
Model Fit: St. Dev of Maturity Dates Distribution



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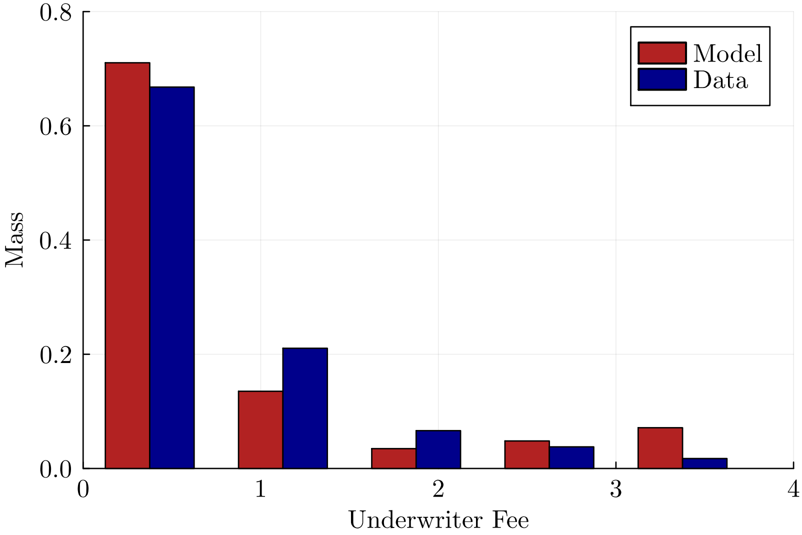
Model Fit: Underwriter Fee Distribution



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Relative cost difference between debt and equity issuance

- b_D smooths equity issuance costs More
- b_C less frequent debt issuances More

Low b: debt costs $>$ equity issuance costs

- Optimal to minimize number of debt issuances w/ b_C

High b: debt costs $<$ equity issuance costs

- Optimal for firm to substitute to b_D to smooth equity issuance costs

Takeaway: Relative costs of debt and equity issuance influence choice of b_D vs b_C

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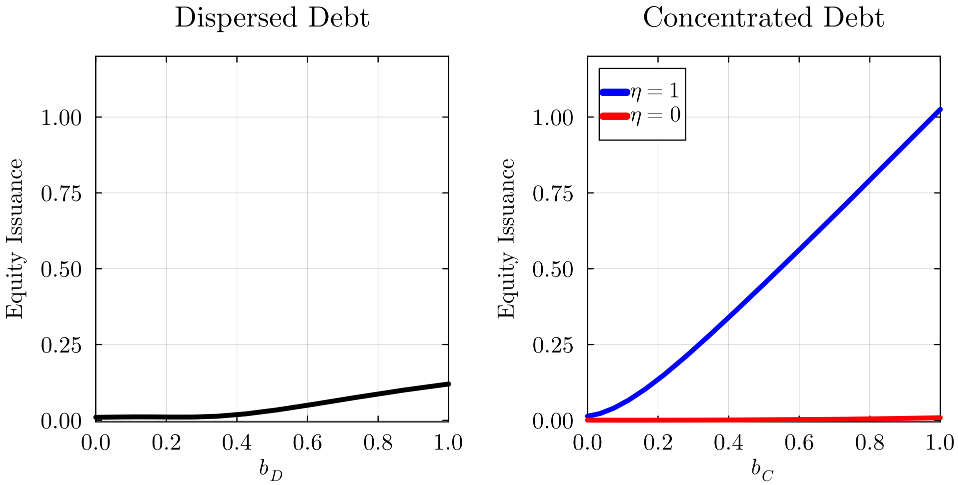
Dispersed debt smooths equity issuances



Firm *wants* to smooth equity issuances (rollover risk) b/c of convex costs

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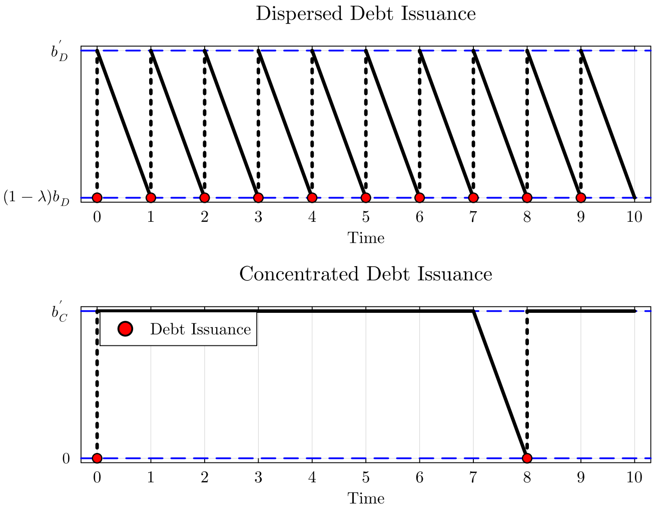
Dispersed debt requires repeated issuance cost payment



Note: y is held constant at y_M

At stable leverage ratio, costly to repeatedly issue dispersed debt b/c frequent top-ups

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

Price of unit of dispersed debt

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

Price of unit of concentrated debt

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

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

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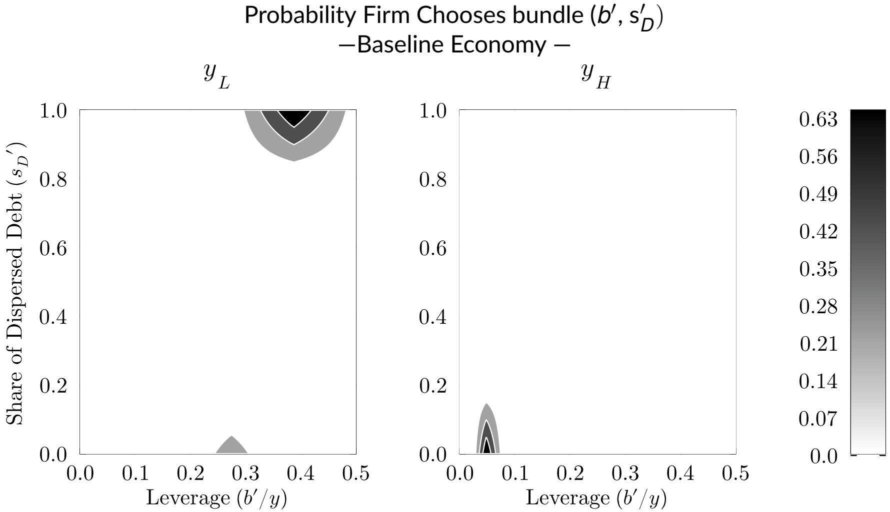
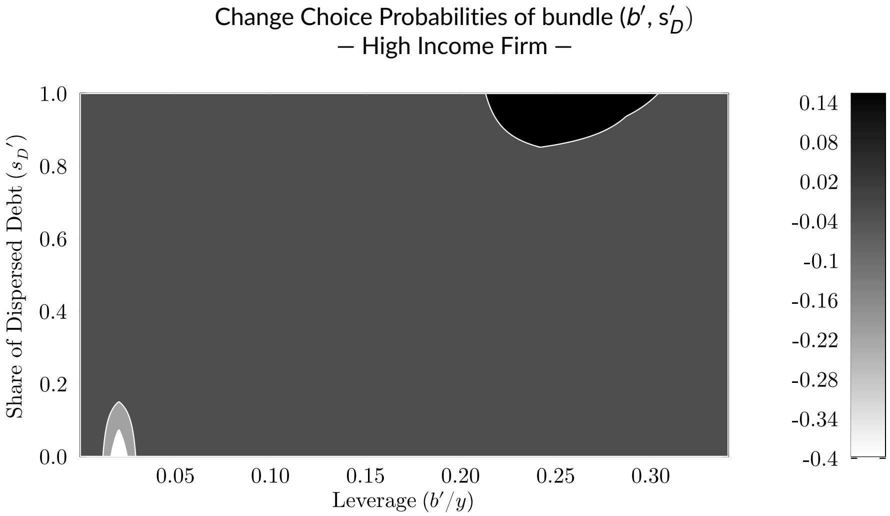
Counterfactual equilibrium: competitive underwriter market



Counterfactual equilibrium: competitive underwriter market



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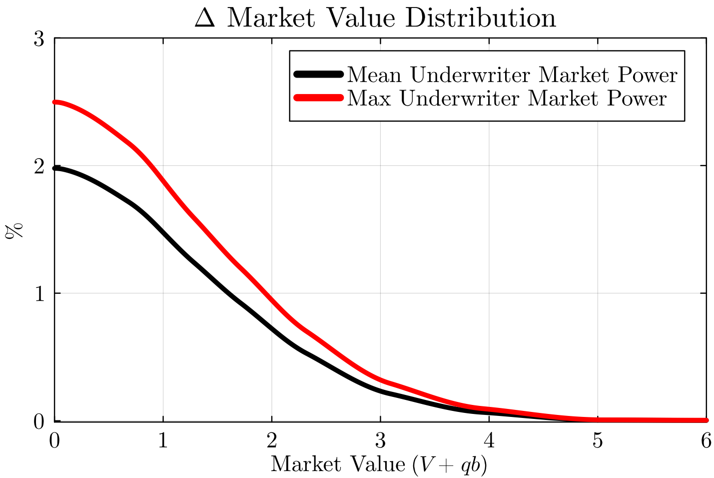
How does underwriter market power impact firm value?



- Average market value ↑ 0.85% – 1.01%

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