Long-Term Finance and Investment with Frictional Asset Markets

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Corporate debt trades in frictional secondary markets

- Decentralized, over-the-counter markets
- **Trade is costly** as it takes time to find a counterparty

A Liquidity Theory of the Yield Curve

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This paper

- Borrowing costs at different horizons: Term-structure of liquidity spreads
- Effects on maturity choices and investment

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A liquidity theory of the yield curve

- **Main result:** Trading frictions generate an upward sloping yield curve
- **Why?** Long-term bonds expect to trade more in secondary markets

Implications of a steep yield curve

- Expensive to finance long-term projects
- Lower productivity if longer term projects are more productive

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- **Financial development**

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  $\rightarrow$ Investment at longer maturities and higher productivity projects

Long-Term Finance & Investment

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Empirical analysis: Measure slope of liquidity spreads

- US $\approx$ 5 bps per year
- Argentina $\approx$ 40 bps per year

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Quantitative application

- Corporate debt maturity is 3 years shorter in Argentina than in the US
- Calibration suggests that liquidity explains 50% of maturity differences
- Large aggregate effects $\rightarrow$ room for policy interventions

Outline

1. **Theory:** A liquidity theory of the yield curve
2. **Empirical analysis:** Measure slope of liquidity spreads
3. **Quantitative application:** Financial development
4. **Policy & extensions**

Theory

Environment

- Continuous time, infinite horizon

Agents

- **Production sector:** borrowers
- **Financial sector:** lenders

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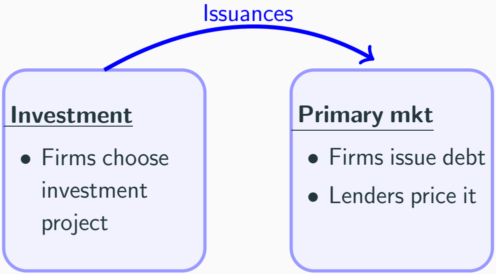
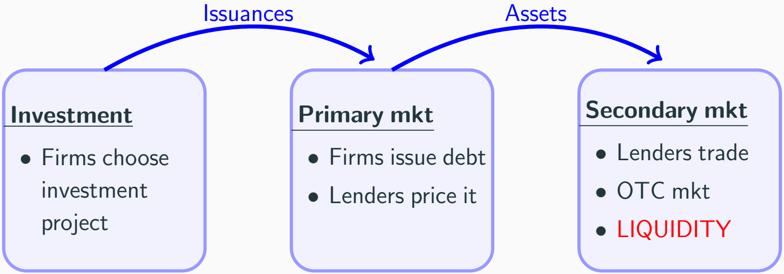
Financial markets

- **Securities:** bonds of maturity τ $\rightarrow$ endogenous maturity
- **Primary market:** borrowers issue bonds to lenders
- **Secondary market:** shocks to private valuations generate trade
- Decentralized OTC secondary market $\rightarrow$ endogenous liquidity

Investment

- Firms choose investment project


Issuances
Investment
Firms choose investment project
Primary mkt
Firms issue debt
Lenders price it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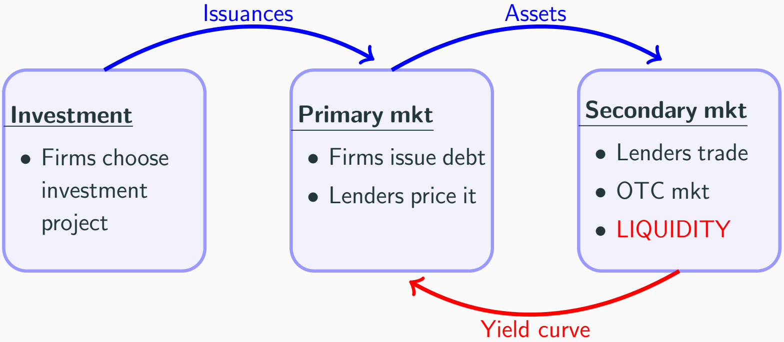
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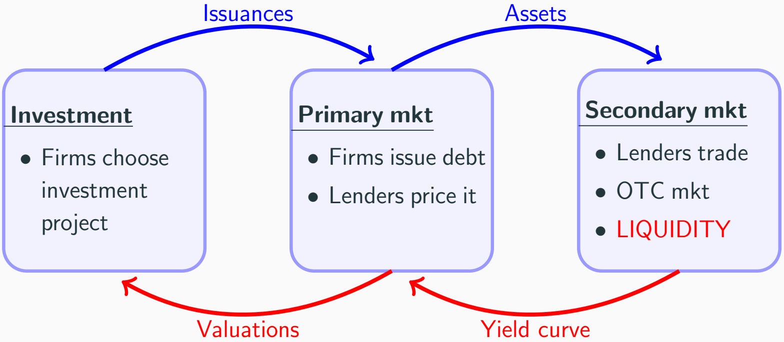
Yield curve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Valuations
Yield curve

Production Sector

Projects

- Menu of back-loaded investment projects, indexed by duration $\tau \geq 0$
- Investment cost $I(\tau)$ and return $F(\tau)$

$$\tau^* = \arg\max -I(\tau) + e^{-\rho\tau} F(\tau)$$

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Financing

- No internal funds, finance with bonds
- Assumption: Match maturity of bonds and duration of investment
- Model with rollover later
- $P(\tau, \lambda)$: Price of a bond with maturity τ and liquidity λ

Maturity choice problem

$$\tau(\lambda) = \arg\max_{\tau, B} e^{-\rho\tau} \left(F(\tau) - B\right)$$

$$B P(\tau, \lambda) = I(\tau)$$

Financial Sector: Primary Market

- Firms issue bonds
- Lenders buy the securities
- Large mass of lenders in the primary market
- Free entry condition

$$P(\tau, \lambda) = D^H(\tau, \lambda)$$

Financial Sector: Secondary Market

- Continuum of securities index by residual maturity $y \in [0, \tau]$
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  - High valuation $D^H(y, \lambda)$: With intensity η becomes low valuation
  - Low valuation $D^L(y, \lambda)$: Pay holding cost h, are sellers in secondary market

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- **Matching**
  - All assets trade in the same market
  - Matching $M(\mu^S, \mu^B) = A\left(\mu^S\right)^{\alpha}\left(\mu^B\right)^{1-\alpha}$, market tightness $\theta = \frac{\text{sellers}}{\text{buyers}}$
  - Liquidity: Sellers meet with buyers at rate $\lambda = A\theta^{\alpha-1}$
  - All meetings trade and sellers receive a fraction γ of total surplus

Valuations

High valuation

$$\rho D^H(y;\lambda) = \eta \left(D^L(y;\lambda) - D^H(y;\lambda) \right) - \frac{\partial D^H(y;\lambda)}{\partial y}$$

Low valuation

$$\rho D^L(y;\lambda) = -h + \lambda\gamma \left(D^H(y;\lambda) - D^L(y;\lambda) \right) - \frac{\partial D^L(y;\lambda)}{\partial y}$$

Maturity

$$D^H(0,\lambda) = D^L(0,\lambda) = 1$$

Term-structure of liquidity spreads

1. How does liquidity affect prices in primary market?
2. Equilibrium maturity & liquidity
3. Financial development

How does Liquidity Affect Prices?

Price in primary market

$$P(\tau, \lambda) = \underbrace{e^{-\rho\tau}}_{\text{Expectation hypothesis}} - \underbrace{\mathcal{L}(\tau, \lambda)}_{\text{Illiquidity cost}}$$

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- No secondary market: Intensity η pays h between shock and maturity
- Secondary market: Intensity λ recovers γ of gains from trade

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$$\mathcal{L}(\tau,\lambda) = h \int_0^\tau e^{-\rho y} s^L(y) dy$$

- $s^L(y)$: Adjusted probability that security of age y is held by a low valuation

$$\dot{s}^H = -\eta s^H + \lambda\gamma s^L \qquad s^H(0) = 1$$
$$\dot{s}^L = \eta s^H - \lambda\gamma s^L \qquad s^L(0) = 0$$

Illiquidity Cost & Long-Term Finance

Illiquidity cost $\mathcal{L}(\tau, \lambda)$

1. Increasing in maturity: $\frac{\partial \mathcal{L}(\tau,\lambda)}{\partial \tau} \geq 0$
2. Decreasing in liquidity: $\frac{\partial \mathcal{L}(\tau,\lambda)}{\partial \lambda} \leq 0$
3. Liquidity is more important for long-term assets: $\frac{\partial^2 \mathcal{L}(\tau,\lambda)}{\partial \tau \partial \lambda} \leq 0$

Key result for long-term finance

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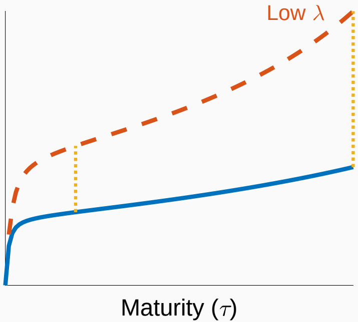
Key result for long-term finance

Intuition: Consider a low-valuation agent

- Can get out of the position by: (i) trading; or (ii) maturity
- If τ is short $\rightarrow$ liquidity is not important (can wait for maturity)
- If τ is longer $\rightarrow$ more costly to wait $\rightarrow$ liquidity is more important

- **Interest rate:** $r(\tau,\lambda) = \rho + \mathsf{cs}^{liq}(\tau,\lambda)$
- **Liquidity spread:** $\mathsf{cs}^{liq}(\tau,\lambda) = \frac{-\log(1-e^{\rho\tau}\mathcal{L}(\tau,\lambda))}{\tau}$

Liquidity spread



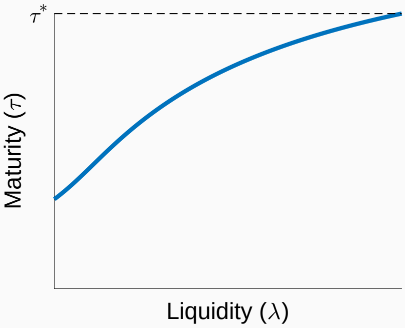
Liquidity is more important for long-term assets

$$\max_{\tau} \quad e^{-\rho\tau} F(\tau) - e^{\mathsf{cs}^{\mathsf{liq}}(\tau,\lambda)\tau} I(\tau)$$

Equilibrium Maturity

$$\max_{\tau} \quad e^{-\rho\tau} F(\tau) - e^{\text{cs}^{\text{liq}}(\tau,\lambda)\tau} I(\tau)$$

$$\frac{\partial F(\tau)}{\partial \tau} = \rho F(\tau) + e^{r(\tau,\lambda)\tau} \frac{\partial I(\tau)}{\partial \tau} + \underbrace{e^{r(\tau,\lambda)\tau} I(\tau)\, \text{cs}^{\text{liq}}(\tau,\lambda)\left(1 + \epsilon_{\text{cs}^{\text{liq}}}(\tau,\lambda)\right)}_{\text{Financial cost}}$$



Equilibrium Liquidity

- Free entry to the secondary market

$$c = \beta(1-\gamma)\int_0^{\tau} \frac{\mu^L(y)}{\int_0^{\tau} \mu^L(y)} \left(D^H(y;\lambda) - D^L(y;\lambda)\right) dy$$

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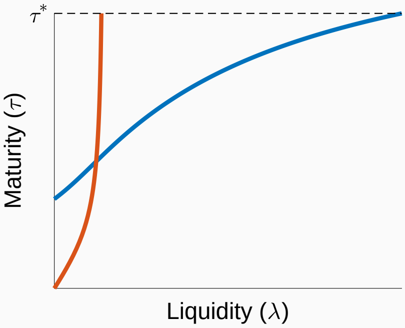
Equilibrium



Financial Development

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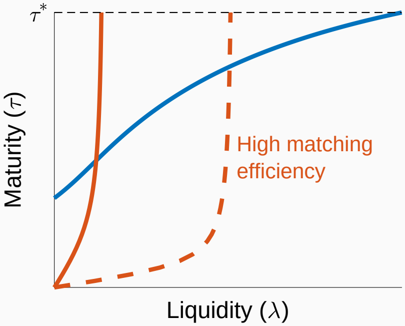

- High efficiency $\rightarrow$ flatten yield curve $\rightarrow$ Investment at longer horizons

Empirical Analysis

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Interest rate:

$$r(m) = \text{treasury rate } (m) + \text{default spread}(m) + \text{liquidity spread } (m)$$

Want: Slope of liquidity spread

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Strategy

- Interest rates of corporate bonds at issuance
- $s_{i,t,m}$: spread wrt treasuries for firm i, issuance day t, maturity m
- **Sample:** Firms that issue two or more bonds on the same day t

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- $s_{i,t,m}$: spread wrt treasuries for firm i, issuance day t, maturity m
- **Sample:** Firms that issue two or more bonds on the same day t

$$s_{i,t,m_2} - s_{i,t,m_1} = \beta(m_2 - m_1) + \gamma \mathbf{X}_{i,t} + \epsilon_{i,t,m_1,m_2}$$

Controls $\mathbf{X}_{i,t}$: time, industry, firm-time, and/or credit-rating FE

- β measures the slope of credit spreads (default & liquidity)

Significant Slope with Maturity

	(1)	(2)	(3)	(4)
Maturity difference	7.876***	6.247***	4.877***	5.836***
	(0.234)	(0.359)	(0.299)	(0.325)
Observations	23,614	23,614	23,614	19,320
R-squared	0.046	0.104	0.173	0.858
FE	No	Time	Time, Industry	Firm-Time

Data: corporate debt issuances in the US for 2000-2017 (FISD).

Slope $\approx$ 5bps per year & maturity difference $\approx$ 4 years $\rightarrow$ Δ spread 20 bps

▶ Data description

It is Liquidity!

Identification assumption: Default spreads are constant in maturity
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Validations:

1. Similar estimates for sample of **safe but illiquid bonds** (AAA-A)
2. **CDS:** implied yield have smaller slope than the liquidity component
3. Use CDS to control for default component $\rightarrow$ direct measure of liquidity
4. External validation: calibrated model matches **level** of liquidity spreads

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Intuition: Sample of same firm issuing two or more bonds on the same day

- **Default** $\rightarrow$ characteristic of the **firm**
- **Liquidity** $\rightarrow$ characteristic of the **security**

Validation I: Safe but Illiquid Bonds

	(1)	(2)	(3)	(4)
Maturity difference	3.545***	3.684***	4.046***	3.620**
	(0.261)	(0.245)	(0.336)	(1.081)
Observations	15,471	15,471	11,956	867
R-squared	0.103	0.135	0.126	0.212
FE	Time	Time, Rating	Time	Time
Sample	All	All	Aaa-A	Aaa

Data: corporate debt issuances in the US for 2000-2017 (FISD). Subset of rated issuances.

Safe but illiquid bonds have similar slope than the entire sample

▶ Small credit losses and rating transitions for Aaa-A

Validation II: Slope on Corporate CDS

Estimate slope on CDS

$$cds_{i,t,m_2} - cds_{i,t,m_1} = \beta(m_2 - m_1) + \gamma \mathbf{X}_{i,t} + \epsilon_{i,t,m_1,m_2}$$

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	(1)	(2)	(3)	(5)
Maturity difference	2.494***	2.412***	2.359***	2.219***
	(0.046)	(0.230)	(0.224)	(0.042)
Observations	1,119,540	1,119,540	1,119,540	1,119,540
R-squared	0.003	0.023	0.027	0.860
FE	No	Time	Time, Industry	Firm-Time

Data: corporate CDS for the US in 2000-2017 (Markit).

CDS imply a smaller slope for the default component (about 1/3 of total slope)

Validation III: Slope on Non-Default Component of Credit Spreads

- Match credit spreads $s_{i,t,m}$ with CDS $cds_{i,t,m}$
- Liquidity spread: $liq_{i,t,m} = s_{i,t,m} - cds_{i,t,m}$

$$liq_{i,t,m_2} - liq_{i,t,m_1} = \beta(m_2 - m_1) + \gamma \mathbf{X}_{i,t} + \epsilon_{i,t,m_1,m_2}$$

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	(1)	(2)	(3)
Maturity difference	13.035**	9.215**	5.247***
	(3.272)	(2.672)	(0.885)
Observations	2,479	2,479	2,479
R-squared	0.180	0.361	0.903
FE	Time	Time, Industry	Firm-Time

Data: corporate debt issuances and CDS in the US for 2000-2017. Source: FISD and Markit.

Similar slope even when we use CDS to control for default

US vs Argentina

	US		Argentina	
	Corporate	Sovereign CDS	Corporate	Sovereign CDS
Maturity difference	6.462***	0.895***	50.04***	9.529***
	(0.947)	(0.0357)	(7.377)	(0.104)
R-squared	0.019	0.728	0.930	0.577
Observations	2,102	99	35	99
Maturity difference	4.03		1. 64	

Data: corporate debt issuances and sovereign CDS in the US and Argentina for 2017 from, FISD, Markit and MAE. Include time FE.

Target moments: (slope on corporate - slope on CDS) $\times$ maturity difference

1. US: $(6.5 - 0.9) \times 4 \approx 22$ bps
2. Argentina: $(50 - 10) \times 1.6 \approx 64$ bps

Quantitative Analysis

Quantitative Analysis: Calibration

1. **Calibration:** Data of US corporate debt markets
2. **Counterfactuals:** Variations in trading frictions

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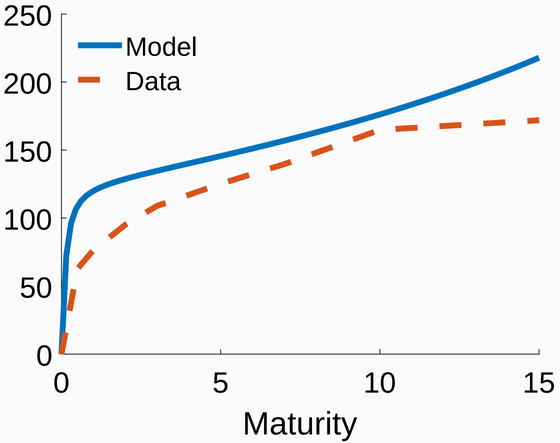
1. Parameters set externally

Parameter		Value
Matching function elasticity	α	0.50
Bargaining power of sellers	γ	0.50
Discount factor	ρ	0.02
Default rate	δ	0.03
Investment cost	κ	1.00

2. Target moments

Parameter		Value	Target	Value
Matching efficiency	A	26.00	Expected time to sell (weeks)	2.00
Intensity of liquidity shocks	η	0.58	Turnover rate (annual)	57%
Holding cost	h	0.29	Slope liquidity spread (bps)	22
$F(\tau) = Z\tau$	Z	1.91	Maturity (years)	5.37
Search cost	c	0.28	Market tightness	1.00

Validation I: Level of Liquidity Spreads



Model gets the **level** right, only the slope was a calibration target

Data: Spreads for high-quality corporate bonds, rated above A.

Validation II: CDS and International Issuances

Theory: *An increase in liquidity flattens the yield curve and firms borrow at longer horizons*

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Theory: An increase in liquidity flattens the yield curve and firms borrow at longer horizons

- **Credit default swaps** (Saretto Tookes 2013)
  - Bonds of firms with CDS trade in more liquid markets
  - Firms with CDS increase maturity by 1.5 years relative to firms without
- **International issuances** (Cortina Didier Schmukler 2017)
  - Developing countries are less liquid than international financial centers
  - Firms from developing countries that issue in international markets increase maturity by 1.6 years, relative to previous issuances in domestic market

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	Data	**Model**
Maturity difference: CDS	0.68-1.79	1.70
Maturity difference: International issuances	1.6	1.70

Note: Assume firms without CDS trade OTC, with CDS trade in centralized market. Assume domestic markets are OTC and international are centralized.

▶ Additional validation: Real effects

Experiment: Variations in Trading Frictions

Change matching efficiency A (other parameters at calibrated values)

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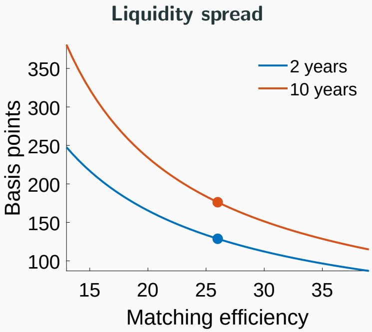

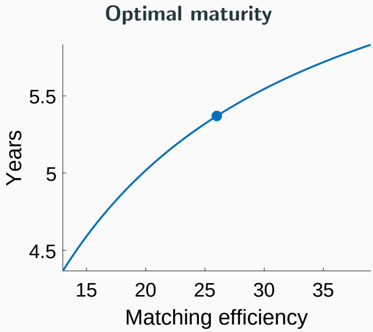

- Trading frictions have more severe effects on long-term rates
- Large effect on maturity choice $\approx$ 6 months per 100 bps on the 10y spread
- Maturity increases 1.7 years with centralized markets

Experiment: US vs Argentina

- Liquidity spread difference in Argentina: 67 bps
- Decrease matching efficiency to match slope of liquidity
- What are the effects on maturity and aggregates?

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	US		**Argentina**	
	Data	Model	Data	Model
Liquidity (bps)				
Increase 6.4 - 2.3 years	22	22	163	134
Increase 3.2 - 1.5 years	9	10	67	67
Maturity (years)	5.4	5.4	2.4	3.6
Output	1.0	1.0	0.4	0.7

- Liquidity explains about 50% of maturity differences

▶ Model with labor ▶ Alternative measure of liquidity, more countries

Extensions & Robustness

1. Rollover

- Rollover short-term debt to finance long-term projects
- Total financial cost: Liquidity and issuance cost
- Illiquid market $\rightarrow$ increase total cost $\rightarrow$ shorter duration projects

2. Policy

- Interventions to improve liquidity and long-term finance

3. Segmented markets

- Markets segmented by maturity
- Secondary market is effectively a market for long-term assets

4. Default

- Liquidity spread increases with default, particularly at longer horizons

▶ Segmented markets ▶ Default

Rollover

Model with Rollover

Investment and financial choices

1. **Project:** Duration of investment τ
2. **Financing:** Number of debt issuances J and maturity $\{y_j\}_{j=1}^{J}$
   Interest rate $r(y, \lambda) = \rho + cs^{liq}(y, \lambda)$, issuance cost Φ

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Firm's problem

$$\max_{\tau, J, \{y_j\}_{j=1}^{J}} \quad e^{-\rho\tau}\left(F(\tau) - B(J)\right)$$

$$B(j) = e^{r(y_j,\lambda)y_j}\left(B(j-1) + \Phi + I(y_j)\right) \quad \text{for } j = 1, \ldots, J$$

$$B(0) = 0 \qquad \text{and} \qquad \sum_{j=1}^{J} y_j = \tau$$

Two sub-problems

1. **Project**

$$\max_{\tau} \quad e^{-\rho\tau}\left(F(\tau) - \text{FIN}^{\text{COST}}(\tau,\lambda)\right)$$

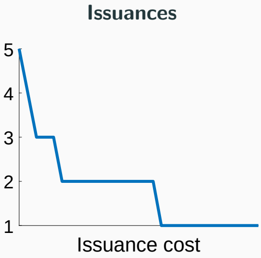
2. **Financial cost**

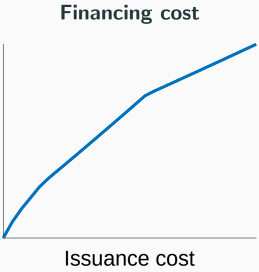
$$\text{FIN}^{\text{COST}}(\tau,\lambda) = \min_{J,\{y_j\}_{j=1}^{J}} \sum_{i=1}^{J} (\Phi + I(y_i))\, e^{\sum_{s=i}^{J} r(y_s) y_s} \quad \text{s.t.} \quad \sum_{j=1}^{J} y_j = \tau$$

Trade-offs

- Issuance cost $\Phi \rightarrow$ longer maturities and less rollover
- Illiquidity $cs^{liq}(y,\lambda) \rightarrow$ shorter maturities and more rollover

- How does the issuance cost affect the financial cost for a given project?

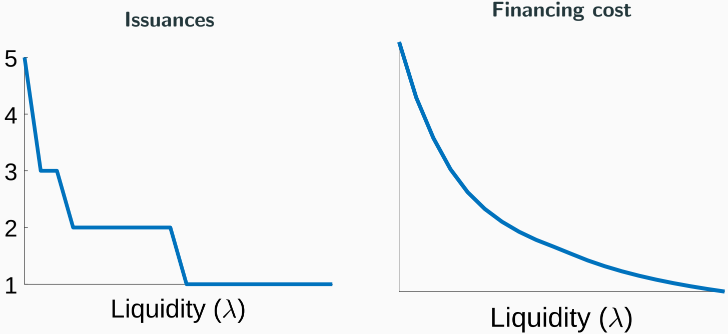




Higher Issuance cost

1. Less issuances, longer maturities
2. Higher financing cost

- How does liquidity affect the financial cost for a given project?



Higher liquidity

1. Less issuances
2. Lower financing cost

Frictions in Primary vs Secondary Markets

- **Frictions in primary market:** Issuance cost Φ
- **Frictions in secondary market:** Liquidity λ

	Benchmark with rollover	**Higher frictions secondary market**	**Higher frictions primary market**
Duration of investment	8.1	4.7	5.3
Issuances	18	23	1

- Frictions in the **secondary** reduce duration of investment by 3.4 years
- Frictions in the **primary** reduce duration of investment by 2.8 years

▶ Quantitative results ▶ Maturity structure

Policy analysis

How can we improve the liquidity of financial markets?

Government-sponsored intermediaries (GSIs)

- Act as intermediaries in secondary markets
  - Subject to search frictions and holding costs as private agents
  - Participate in secondary markets
  - Potentially behave different than private agents (e.g. different prices)

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Government-sponsored intermediaries (GSIs)

- Act as intermediaries in secondary markets
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  - Participate in secondary markets
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- Interpretation: Hybrid between existing policies
  - Government-sponsored enterprises (GSEs)
  - Large-scale asset purchases (QEs)
  - Priority sector lending (India)

GSIs: Instruments

Policy objective

- Steady state welfare: profits of production sector
  - Production sector has positive profits
  - Financial sector is competitive and makes zero profits
- Subject to equilibrium conditions and budget constraint

GSIs: Instruments

Policy objective

- Steady state welfare: profits of production sector
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  - Financial sector is competitive and makes zero profits
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Policy instruments

1. Size: Measure of government agents in the secondary market
2. GSIs **buying** prices
   - Higher than in private meetings → Relax holding cost of low valuation
3. GSIs **selling** prices
   - Lower than in private meetings → Stimulate entry to the secondary market
4. Finance GSI
   - Distortionary corporate taxes, balanced budget

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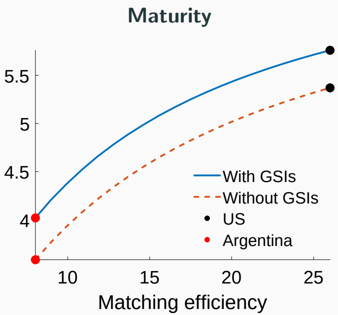
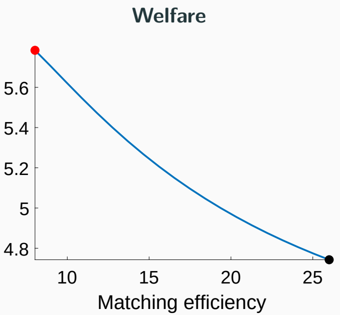
Mechanisms

- Direct: Private agents trade at better terms with government agents
- Equilibrium: Outcomes improve in private meetings

▶ Model details

Effects of GSIs

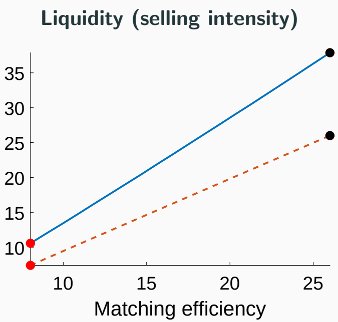


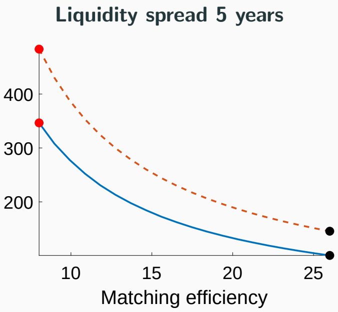


GSIs are more effective in markets with severe trading frictions

	US	Argentina
Maturity	7%	12%
Welfare	5%	6%

Effects of GSIs across countries





Important nonlinearities

- Larger effects on liquidity in developed financial markets...
- ...but larger effects on interest rates in markets with severe frictions

▶ Robustness: More efficient interventions

Conclusions

- **A liquidity theory of the yield curve**
  - Model of maturity choices with decentralized asset markets
  - Result: firms in economies with severe frictions invest at shorter horizons
  - Why? Ability to trade is more important for long-term finance
- **Empirical analysis:** Measure slope of liquidity spreads
- **Quantitative application:** Finance & development
  - Trading frictions are quantitatively important for maturity and investment
  - Can explain about 50% of maturity differences between Argentina and US

Appendices

Appendices

1. Related literature
2. Empirical evidence
3. Model: Additional details
4. Empirical Analysis: Additional details
5. Quantitative: Additional details
6. GSIs
7. Rollover
8. Segmented markets
9. Default

Related Literature

Empirical literature on liquidity:

- **Liquidity is a significant determinant of interest rates**
- **Upward sloping liquidity spreads**
- Longstaff Mithal Neis '05, Edwards Harris Piwowar '07, Bao Pang Wang '11, Krishnamurthy Vissing-Jorgensen '12

Contribution: *Theory and aggregate consequences*

Theory:

- **Trading frictions:** Duffie Gârleanu Pedersen '05; He Milbradt '14
- **Yield curve:** Gürkaynak Wright '12, Geromichalos Herrenbrueck Salyer '16
- **Maturity choice:** Diamond '91; Leland Toft '96

New: *Liquidity-Maturity interactions, effects on investment and aggregates*

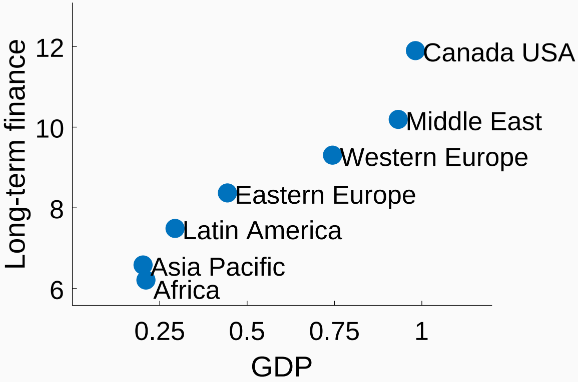
Financial development:

- **Finance & development:** Buera Kabobski Shin '11; Cole Greenwood Sanchez '16

New: *Secondary market trading, maturity, policies*

Empirical evidence

Firms Borrow at Shorter Maturities in Developing Countries



Maturity of corporate bonds at issuance in domestic markets. Cortina Didier and Schmukler '17.

Maturity of Different Securities

Firms borrow at shorter maturity in developing countries

- **Firm's balance-sheet data:** Demirgüç-Kunt Maksimovic '98, Fan Titman Twite '12
- **Bonds issuances:** Cortina Didier and Schmukler '17
- **Bank data:** World Bank '15

Total amount raised as % of GDP

	Total	**Corporate bonds**	**Syndicated loans**	**Equity**
Advanced	14	6	7	1
Developing	5	2.5	1.5	1

Source: Cortina, Didier and Schmukler '17, data for 2013.

- In both set of countries **50%** of amount raised is with bonds

Trading Frictions are More Severe in Developing Countries

Lower turnover and higher Bid-Ask spreads in developing countries

	Turnover relative to US	**Bid-Ask Spreads** bps above US
Corporate bonds in Asia		
Malaysia	65	
Japan	40	
India	25	
New Zealand	25	
Thailand	20	
Korea	5	
Sovereign bonds in Latin America		
Mexico	23	6
Argentina	9	29
Colombia	6	3
Brazil	4	4
Chile	4	5
Peru	2	14
Venezuela	2	74

Source: BIS. Bid-Ask Spread for US treasuries is 1.2 basis points

Model

Production and Investment

- Menu of back-loaded investment projects, indexed by duration $\tau \geq 0$
- Investment cost $I(\tau)$ and return $F(\tau)$, $\tau^* = \arg\max -I(\tau) + e^{-\rho\tau}F(\tau)$

- **Investment phase:** Until age τ
  - Productivity grow at rate ζ per unit of time $dz = \zeta dt$ and $z(\tau) = \zeta\tau$
  - Cost κ per unit of time
  - $I(\tau)$: Investment cost

$$I(\tau) = \kappa \frac{1 - e^{-\rho\tau}}{\rho}$$

- **Production phase:** After age τ
  - Produce $y(\tau) = z(\tau)$
  - Discount ρ, exit shock at Poisson rate δ
  - $F(\tau)$: Return

$$F(\tau) = y(\tau) \int_0^{\infty} e^{-(\rho+\delta)t} dt$$

$$F(\tau) = Z\tau \qquad Z = \frac{\zeta}{\rho + \delta}$$

Illiquidity Cost

$$\mathcal{L}(\tau, \lambda) = h \int_0^\tau e^{-\rho y} s^L(y) dy$$

$$\mathcal{L}(\tau, \lambda) = h \frac{\eta}{\eta + \lambda\gamma} \left(\frac{1 - e^{-\rho\tau}}{\rho} - \frac{1 - e^{-(\rho+\eta+\lambda\gamma)\tau}}{\rho + \eta + \lambda\gamma} \right)$$

What is Financial Development?

In the model

1. Increase in matching efficiency
2. Decrease in search costs

Interpretations

1. Technology to execute trades
   - **Clearing houses** such as Euroclear or Clearstream
   - Emerging economies: Different institutions to liquidate securities and make payments
2. Add securities such as **mutual funds** or ETF
   - Agents with more needs for trade $\rightarrow$ increase liquidity
3. Private information rents reduce trade
   - Larger in developing countries due to weak **credit bureaus**
   - Bethune Sultanum Trachter 2017

▶ Back

Empirical Analysis

Summary Statistics of Corporate Bond Characteristics

Bond characteristic	Mean	Median	SD
# of Bond Issuances per Firm/Month	6.69	3.00	7.46
Maturity at Issue (years)	6.95	5.00	6.45
Coupon Rate (pct.)	3.28	3.70	2.70
Nominal Effective Yield (pct.)	3.34	3.74	4.10
Nominal Effective Treasury Yield (pct.)	2.73	2.50	1.60
Credit Spread (bps.)	60	59	369

Note: Number of issuers = 994; number of bonds = 35,513, of which 23,182 bonds are rated.

▶ Back

High Quality Corporate Bonds: Safe but Illiquid Assets

- **Expected credit losses**

Rating	Average 1982-2014	Maximum 2008
Aaa	0.00%	0.00%
Aa	0.03%	0.48%
A	0.03%	0.37%

- **Default rates**

Rating	Average 1920-2014	Maximum 2008
Aaa	0.00%	0.00%
Aa	0.06%	0.72%
A	0.09%	0.55%

- **Five years transitions (cumulative)**

	Aaa-A	Baa-B	Caa-C	Default
Aaa-A	88.70%	10.62%	0.15%	0.52%

Source: Moody 2015. ▶ Back

Quantitative Analysis

Empirical Evidence: Real Economy

Theory: When the yield curve flattens firms invest in longer-term, higher return projects

- **Real effects:**
  - When it becomes more expensive to borrow long-term, firms invest in shorter-term projects
  - If term spread increase by 1 standard deviation, duration of investment drops by 0.58 standard deviations
  - Dew-Becker 2012
- **Cross-sectional variation & business cycles:**
  - Maturity Extension Program (MEP): Exogenous shock that flattened the corporate yield curve
  - Firms with more dependence on long-term debt benefited relatively more after MEP: More long-term issuances, higher stock market returns, more investment, and larger employment growth
  - Foley-Fisher Ramcharan Yu 2016

▶ Back

Alternative Production Functions

- Production with labor and productivity: $y = z^{1-\sigma} l^{\sigma}$
- Calibrate for the US with $\sigma \in \{0, 0.2, 0.5, 0.8\}$
- Experiment: Low matching efficiency to match liquidity as in Argentina

Labor share	0.0 (benchmark)	0.2	0.5	0.8
Δ Maturity (years)	-1.8	-1.52	-1.25	-1.08
Δ Output (%)	-30	-25	-20	-17

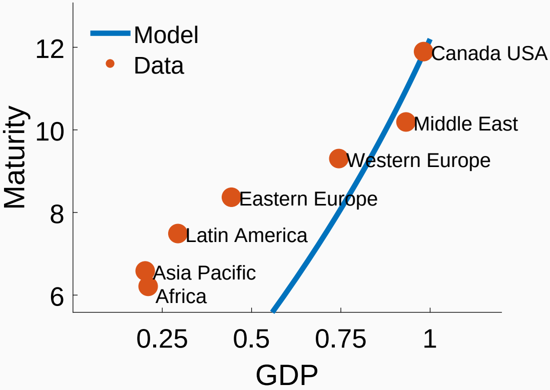
▶ Back

Bank net Interest Margin

- Bank net interest margin
  - Difference between the interest income and paid out to lenders
  - Literature interpret as intermediation costs
  - This paper: liquidity cost
  - Source: Bankscope
- Maturity: issuance in domestic markets (Thomson Reuters SDC)
- Difference between advanced and developing economies

	Data	Model	
		Endogenous	Exogenous
Δ Liquidity spread (bps)	295	295	295
Δ Maturity (years)	-3.60	-3.45	-3.09
Δ Output (%)	-60	-20	-17

Financial Development: Model & Data



Trading frictions

- High explanatory power for developed countries
- Explains about half of the relationship for emerging countries

▶ Back

GSIs

Financial sector: Life-cycle of corporate bonds

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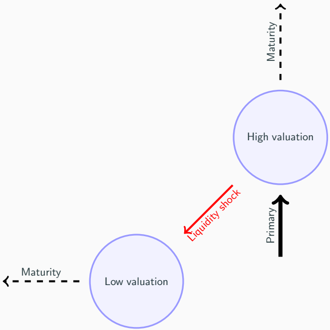

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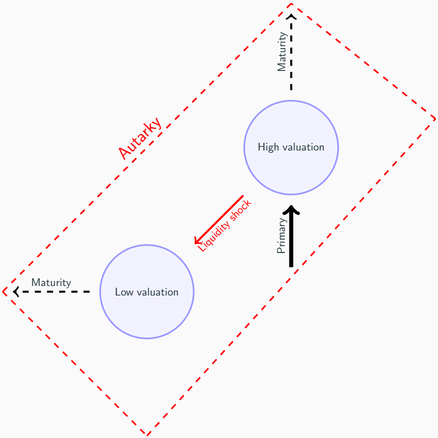

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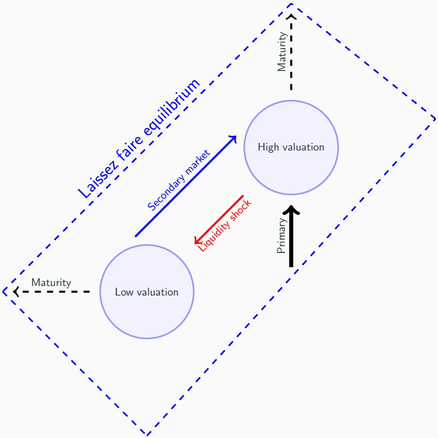

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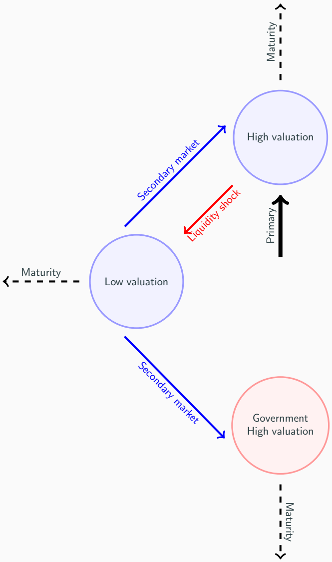

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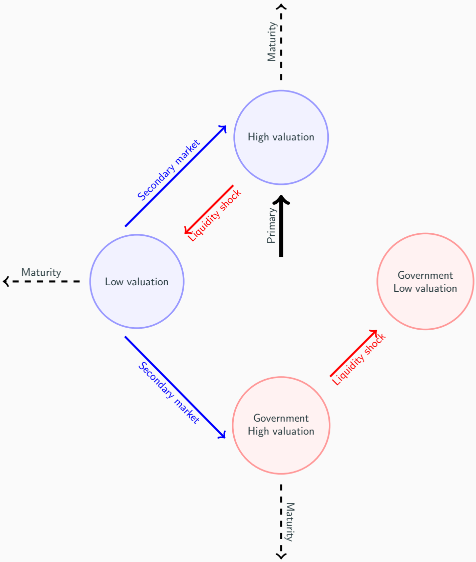

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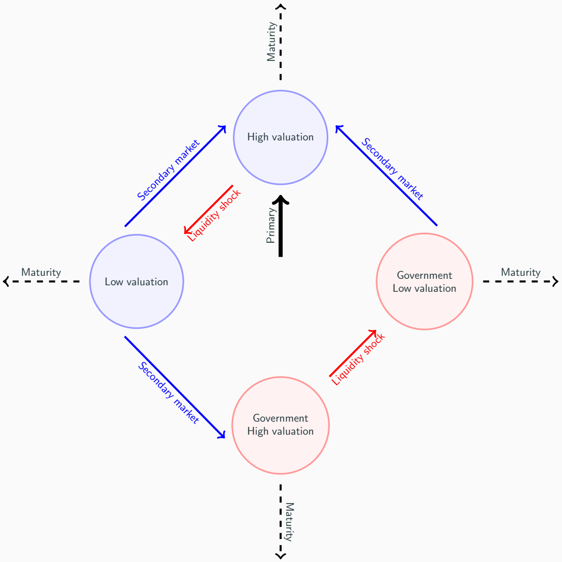

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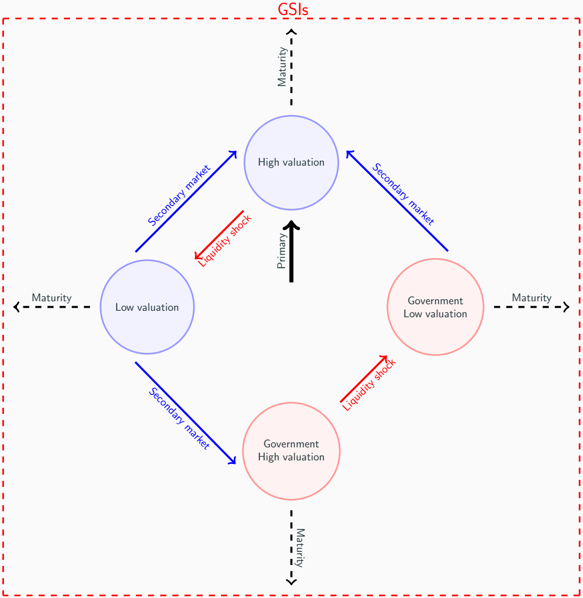

Policies

Policy instruments: Buying price, selling price, size of GSIs, tax rate

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1. Buy
   - Relax holding costs of low valuation agents
   - $P^{S,P-G}(y) = \gamma^{GB} D^H(y) + (1-\gamma^{GB}) D^L(y)$
   - Policy instrument: γ^{GB}

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   - $P^{S,P-G}(y) = \gamma^{GB} D^{H}(y) + (1 - \gamma^{GB}) D^{L}(y)$
   - Policy instrument: γ^{GB}

2. Sell
   - Stimulate private entry in secondary market
   - $P^{S,G-P}(y) = \gamma^{GS} D^{H}(y) + (1 - \gamma^{GS}) D^{L}(y)$
   - Policy instrument: γ^{GS}

Policies

Policy instruments: Buying price, selling price, size of GSIs, tax rate

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   - $P^{S,P-G}(y) = \gamma^{GB} D^H(y) + (1 - \gamma^{GB}) D^L(y)$
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   - Stimulate private entry in secondary market
   - $P^{S,G-P}(y) = \gamma^{GS} D^H(y) + (1 - \gamma^{GS}) D^L(y)$
   - Policy instrument: γ^{GS}
3. Size of GSIs: Choose measure of government buyers $\mu^{B,G}$
4. Tax rate: Balanced budget

Government budget constraint

- Balanced budget:

$$\underbrace{x^c f(\tau)\mu^F}_{\text{Corporate taxes}} + \underbrace{\left[\mu^{G,H}(0) + \mu^{G,L}(0)\right]}_{\text{Maturity of holding securities}} + \underbrace{\lambda \int_0^\tau \mu^{L,G}(y) P^{S,G-P}(y) sy}_{\text{Sell securities}} =$$

$$\underbrace{\mu^{B,G} c}_{\text{Search costs}} + \underbrace{\mu^{B,G}\beta \int_0^\tau \frac{\mu^{L,P}(y)}{\mu^{L,P}+\mu^{L,G}} P^{S,P-G}(y)dy}_{\text{Buy securities}} + \underbrace{h\int_0^\tau \mu^{L,G}(y)dy}_{\text{holding costs}}$$

- Given policy $\mu^{B,G}, \gamma^{GB}, \gamma^{GS}$ tax rate x^c adjust to have a balanced budget

Optimal policy

- Welfare:
  - Lenders' sector is competitive: Free entry condition in primary and secondary markets
  - Borrowers have positive profits $\rightarrow$ measure of welfare

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- Government's problem:

$$\max_{x^c,\mu^{G,B},\gamma^{S,GB},\gamma^{S,GS}} e^{-\rho\tau}\left((1-x^c)F(\tau)-I(\tau)e^{r(\tau)\tau}\right)$$

s.t. balanced budget & equilibrium $r(\tau)$

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s.t. balanced budget & equilibrium $r(\tau)$

- GSIs effects:
  - Direct: Higher taxes $\rightarrow$ lower welfare ....
  - Equilibrium: GSIs increase liquidity which reduces credit spreads $r(\tau)$
  - Next: Equilibrium effect dominates direct effect

▶ Back

Robustness

	Liquidity	Spread 5 years	Maturity	Welfare gains	Output
Low trading frictions (US)					
No GSIs	13.00	146	5.37		
Benchmark policy	18.94	101	5.76	4.74	6.02
Gov. 10% more efficient	19.22	99	5.78	5.16	6.31
Gov. 50% more efficient	20.08	95	5.84	6.46	7.19
Gov. transactions	21.48	89	5.91	7.98	8.36
High trading frictions (Argentina)					
No GSIs	3.70	483	3.58		
Benchmark policy	5.28	346	4.02	5.78	10.67
Gov. 10% more efficient	5.39	340	4.05	6.49	11.39
Gov. 50% more efficient	5.72	321	4.15	9.04	13.74
Gov. transactions	6.12	301	4.28	13.68	17.01

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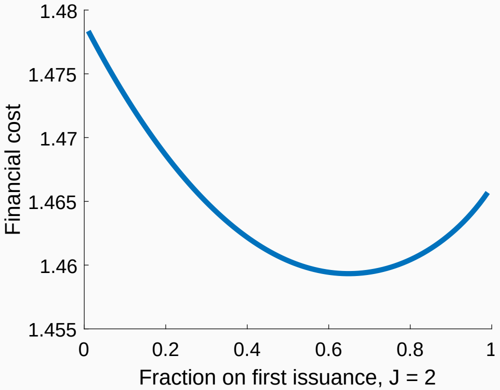
Rollover

Maturity structure

Maturity trade-offs:

- Equalize maturities to pay the same liquidity spread
- Decreasing maturity structure to postpone future issuance costs



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Liquidity generates similar effects on investment for different issuance costs

Secondary market	Issuances	Maturity: Project	Maturity: Bond	Interest rate
No rollover				
Centralized	1	7.1	7.1	5.0%
OTC	1	5.4	5.4	6.5%
Shut down	1	1.6	1.6	16.8%
		(OTC − Shut down: +3.8)		
Rollover with low issuance cost				
Centralized	11	9.3	0.8	5.0%
OTC	18	8.1	0.4	6.0%
Shut down	23	4.7	0.2	6.7%
		(OTC − Shut down: +3.4)		
Rollover with high issuance cost				
Centralized	1	7.1	7.1	5.0%
OTC	1	5.3	5.3	6.5%
Shut down	2	2.3	1.2	13.5%
		(OTC − Shut down: +3.0)		

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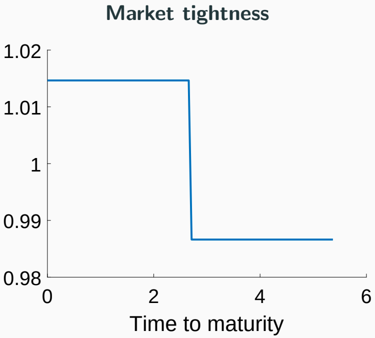
Segmented markets

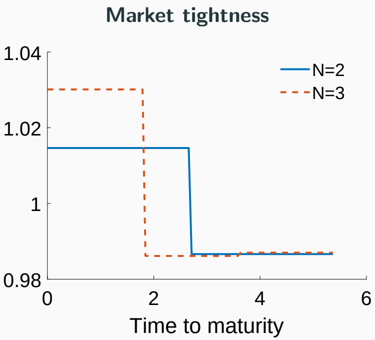
Segmented markets

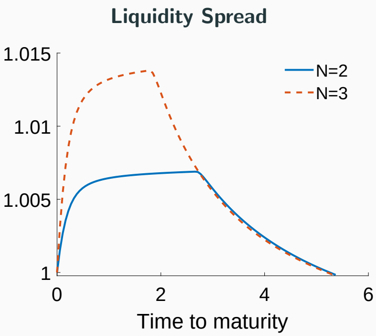
- **Benchmark:** **One** market for all assets of maturities $t \in [0, \tau]$
- **Concern:** Short-term assets have small gains which causes low entry
- **Segmented markets:** **Two** markets, short and long-term assets
- Short-term market: Increase the seller-to-buyer ratio
- Long-term market: Market tightness similar to one market

Relative to no segmentation: $N = 2$

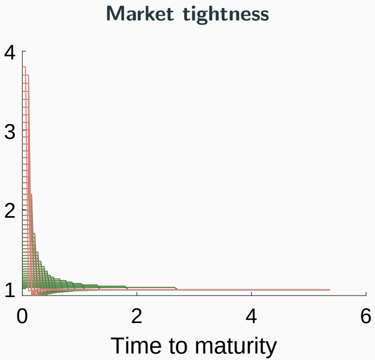


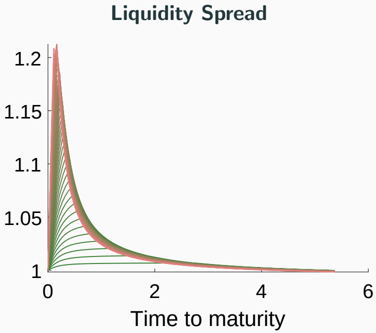
Relative to no segmentation: $N = 3$



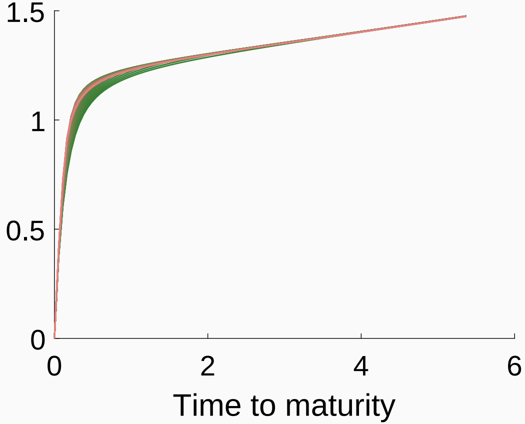


Relative to no segmentation: $N = 50$





Segmented markets: Liquidity spread for different degrees of segmentation



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Default

Credit spreads: Default & liquidity

- Introduce default
  - Default arrives at Poisson rate δ
  - Value zero after default
- Interest rate: $P(\tau, \lambda) = e^{-r(\tau,\lambda)\tau}$

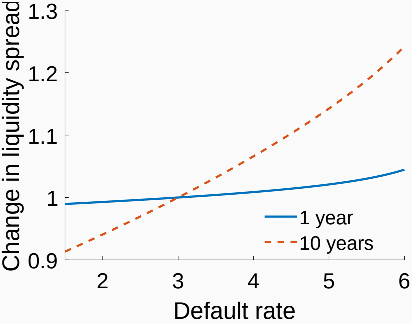
$$r(\tau, \lambda) = \underbrace{\rho}_{\text{Risk-free rate}} + \underbrace{\delta}_{\text{Default spread}} + \underbrace{\mathsf{cs}^{liq}(\tau, \lambda)}_{\text{Liquidity spread}}$$

$$\mathsf{cs}^{liq}(\tau, \lambda) = \frac{-\log\left(1 - e^{(\rho+\delta)\tau}\mathcal{L}(\tau, \lambda)\right)}{\tau}$$

- Variations of credit spreads across maturities $\rightarrow$ liquidity spread

Default & liquidity interactions

$$r(\tau, \lambda) = \underbrace{\rho}_{\text{Risk-free rate}} + \underbrace{\delta}_{\text{Default spread}} + \underbrace{\mathsf{cs}^{liq}(\tau, \lambda, \delta)}_{\text{Liquidity spread}}$$



- The liquidity spread is increasing in the default rate
- The spread for 10 years increases 20% if default rate doubles
- The spread for 1 year increases 2% if default rate doubles

Default amplifies the liquidity spread, particularly for long-term assets

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