BANK FOR INTERNATIONAL SETTLEMENTS

Banking Regulation, Market Liquidity, and the Macroeconomy

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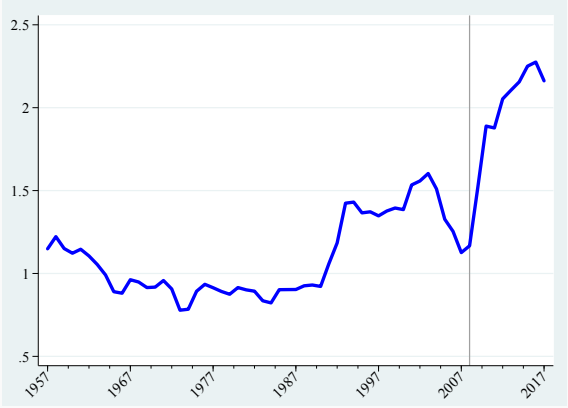
Backdrop / Motivation (I)

US Non–Financial Corporations' funding

Debt securities–to–loan ratio



Source: US Financial Accounts

- In the US, banks play a crucial role in corporate bond markets: 95% of trading volume is intermediated by banks
- For US NFCs, market funding has recently become twice as large as bank funding

Backdrop / Motivation (II)

- On the one hand, regulatory reforms make banks' traditional activities (risk, liquidity, maturity transformation) more efficient/resilient

- On the other hand, some reforms (like the leverage ratio) may have unintended adverse consequences on banks' market–making activities, and corporate bond markets

  - By forcing banks to fund all assets, regardless of their underlying risk and purpose, with a minimum of —costly— equity, the leverage ratio may discourage banks from holding bonds for market–making purposes, reduce market liquidity, and raise firms' cost of funding

  - Greenwood, Hanson, Stein, Sunderam (2017): "*the Supplementary Leverage Ratio is (...) discouraging some banks from investing in the safest assets (...). We would urge that the SLR be dialed back (...)*"

  - FT (24 Sept 2018): "*Regulatory changes have made it more expensive for banks to hold large inventories of bonds, which has hindered their role as liquidity providers in fixed income markets*"

Question of the paper

- Does leverage ratio regulation hinder the functioning of bond markets?
  - Does it push up bid–ask spreads? Does it reduce trading volumes?
- Taking these effects into account, what is the net impact of banking regulation on the economy and welfare?
- Study these questions through the lens of a [dynamic] general equilibrium model
  - Novelty: the dual role of banks as both lenders and market–makers

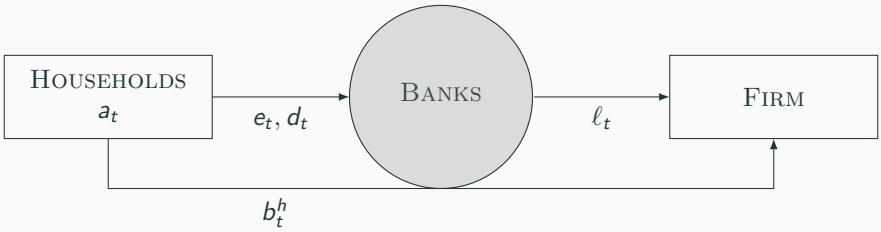
Main Takeaways

- Regulation has a varied impact on measures of corporate bond market liquidity
  - → It raises the bid–ask spread
  - → But it also raises the volume of trades

- The regulator accepts a higher bid–ask spread, to improve banks' funding liquidity and the efficiency of financial intermediation
  - → The impact on market liquidity is not necessarily an unintended consequence

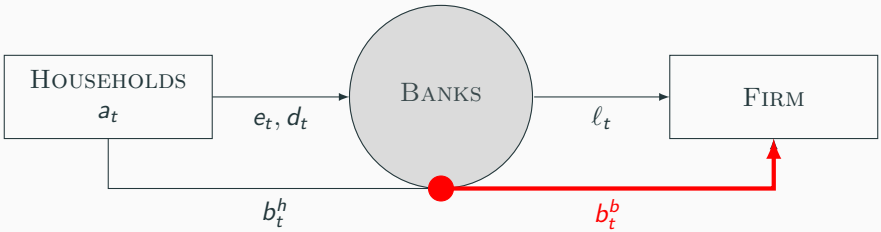
- Exempting bonds from the leverage ratio would only marginally reduce the bid–ask spread and have no effect on the real economy and welfare after re–calibration

Macro–model: real flows between agents



a_t: Savings; e_t: Equity; d_t: Deposits; b_t: Bonds; ℓ_t: Loans

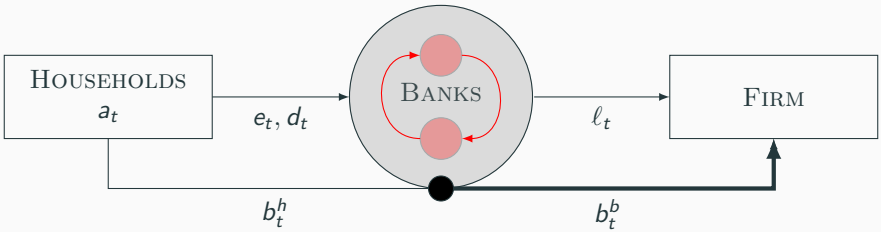
Macro–model: real flows between agents



Frictions on the secondary bond market $\rightarrow$ Bond inventory constraint: $b_t^b \geq (1+\kappa) b_t^h$

a_t: Savings; e_t: Equity; d_t: Deposits; b_t: Bonds; ℓ_t: Loans

Macro–model: real flows between agents



Frictions on the secondary bond market $\rightarrow$ Bond inventory constraint: $b_t^b \geq (1+\kappa) b_t^h$

Frictions on the interbank market $\rightarrow$ Regulatory leverage constraint: $\frac{e_t}{d_t + e_t} \geq \tau$

a_t: Savings; e_t: Equity; d_t: Deposits; b_t: Bonds; ℓ_t: Loans

Households' "preferred habitat"

- A continuum of households incur idiosyncratic financial transaction costs

- Household "(q^d, q^e, q^{b^h})" earns net returns $q^d r_t^d$, $q^e r_t^e$ and $q^{b^h} r_t^{b^h}$ on deposits, equity, and bonds, and invests in the asset with the highest net return $\approx$ "preferred habitat"

$$\max_{\{a_{t+1}, c_t\}_{t=0,\ldots,\infty}} \mathbb{E}_q \left[\mathbb{E}_t \left(\sum_{i=0}^{\infty} \beta^\tau \max_{\{\mathbb{1}^j_{t+1+i}\}_{j \in \{b^h, d, e\}}} u(c_{t+i}) \right) \right]$$

$$s.t. : c_t + a_{t+1} = r_t a_t + \pi_t \quad \text{with} \quad r_t \equiv \mathbb{Q}_t^d r_t^d \frac{d_t}{a_t} + \mathbb{Q}_t^{b^h} r_t^{b^h} \frac{b_t^h}{a_t} + \mathbb{Q}_t^e r_t^e \frac{e_t}{a_t}$$

- For a household, it is costly to move away from its preferred habitat

Banks arbitrage between loans and bonds

- Banks maximize profits by choosing *ex ante* whether they invest in loans (ℓ_t) or bonds (b_t^b)

- Once banks have lent to the firm, they learn their idiosyncratic "loan servicing cost"
  - Bank q^ℓ gets unit return $q^\ell r_t^\ell$, with $q^\ell \in [0,1]$
  - High–q^ℓ banks purchase loans from low–q^ℓ banks on an "interbank" market, against claims that promise return $r_t^i \rightarrow$ the minimum return of a loan is r_t^i
  - There is a threshold $\overline{q}_t^\ell = \frac{r_t^i}{r_t^\ell}$, above (below) which banks borrow (lend) from (to) other banks

- Banks face a bond portfolio management cost and get unit return $\mathbb{Q}^{b^b} r_t^b$ on bonds

- If $r_t^i > \mathbb{Q}^{b^b} r_t^b$, then banks prefer to invest in loans, rather than in bonds

Frictions on the secondary bond market

- Banks sell bonds to households, but must hold an inventory of κ per intermediated bond

- They charge households a fee ω_t for making the bond market ("bid–ask" spread):

$$\omega_t = \kappa \frac{\overbrace{\mathbb{E}_{t-1}\left(\Psi_{t-1,t}(1+\Delta_t)\left(r_t^i - \mathbb{Q}^{b^b} r_t^b\right)\right)}^{\text{Opportunity cost of holding bonds}}}{\mathbb{E}_{t-1}\left(\Psi_{t-1,t}(1+\Delta_t) r_t^b\right)}$$

Frictions on the interbank market

- Frictions hinder *ex post* reallocation of corporate loans from low–q^ℓ to high–q^ℓ banks
  - The loan servicing cost q^ℓ is private information
  - Banks can terminate loans early, get private benefits ζ, and abscond/default

- High–q^ℓ banks have to limit their borrowing to ϕ_t:

$$\phi_t = \frac{\ell_t}{\zeta}\left(r_t^i - r_t^d \frac{1 - \frac{e_t}{d_t + e_t}}{1 - \frac{b_t^b}{d_t + e_t}} + ...\right)$$

Pecuniary externality and regulation

- Pecuniary externality: More capital ($\frac{e_t}{d_t+e_t}$) raises the borrowing limit (ϕ_t), which raises the equilibrium interbank rate (r_t^i), improves lending efficiency ($\overline{q}_t^\ell$), raises the borrowing limit,...

- As price takers, banks do not internalise these effects and have too little capital *ex ante*

$\rightarrow$ Regulation requires banks to hold a minimum level of capital: $\frac{e_t}{d_t+e_t} \geq \tau \Leftrightarrow \frac{e_t}{\ell_t+b_t^b} \geq \tau$

Key mechanism 1: the regulator's trade–off

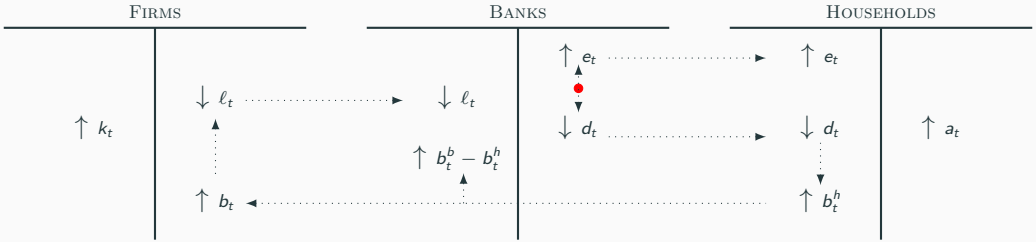
- A regulator sets $\tau^\star$ to maximize welfare, i.e. to minimize aggregate transaction costs:

$$\overbrace{\underbrace{(1-\mathbb{Q}_t^{\ell})r_t^{\ell}\ell_t}_{\text{Loans}}+\underbrace{(1-\mathbb{Q}^{b^b})r_t^b(b_t^b-b_t^h)}_{\text{Bonds}}}^{\text{Banks' transaction costs}}+\overbrace{\underbrace{(1-\mathbb{Q}_t^{d})r_t^{d}d_t}_{\text{Deposits}}+\underbrace{(1-\mathbb{Q}_t^{b^h})r_t^{b^h}b_t^h}_{\text{Bonds}}+\underbrace{(1-\mathbb{Q}_t^{e})r_t^{e}e_t}_{\text{Equity}}}^{\text{Households' transaction costs}}$$

- Lower costs for banks are balanced against higher costs for households

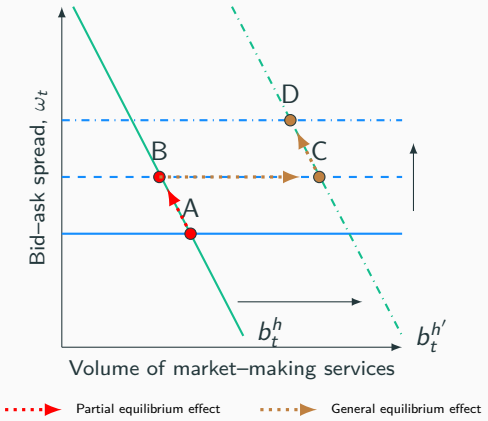
- Savers bear the cost of regulation (not firms or banks)

Key mechanism 2: general equilibrium effects of capital regulation



$\rightarrow$ Leverage regulation induces households to demand more bonds, which lowers the equilibrium bond yield

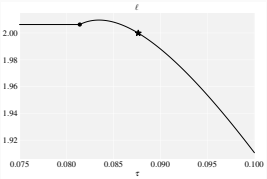
Key mechanism 3: banking regulation and market liquidity



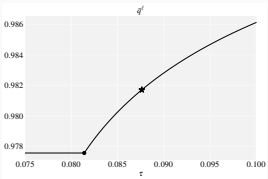
Regulation: bank–based versus market–based intermediation

Bank–based intermediation:

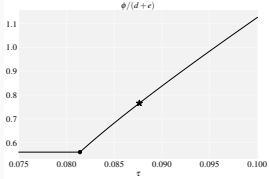
Corporate loans



Lending efficiency

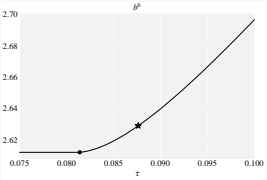


Interbank loans

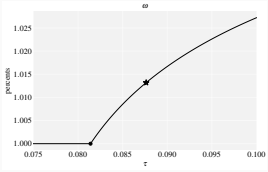


Market–based intermediation:

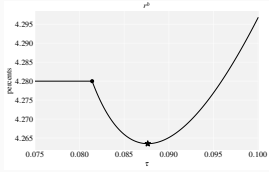
Bond issuance



Bid-ask spread



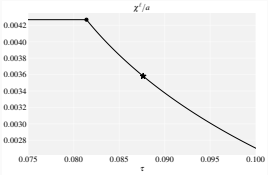
Firms' unit cost of funding



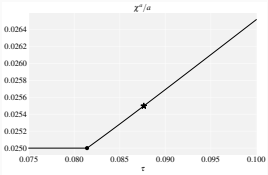
Optimal leverage ratio

Banks' versus households' transaction costs

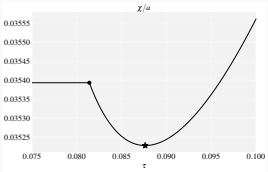
Banks



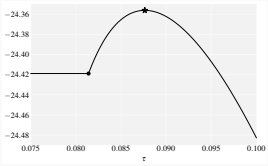
Households



Aggregate



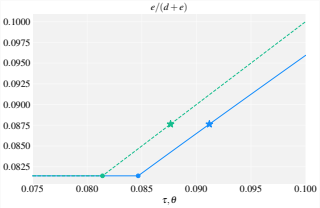
Welfare



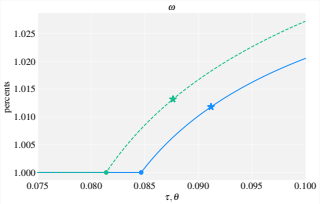
Narrow versus comprehensive leverage regulation

- Should the regulator exempt bonds (and re–calibrate)?
- $\frac{e_t}{\ell_t} \geq \theta$ ("Narrow") versus $\frac{e_t}{\ell_t + b_t^b} \geq \tau$ ("Comprehensive")

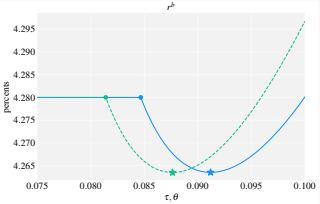
Leverage ratio



Bid-ask spread



Firms' funding cost

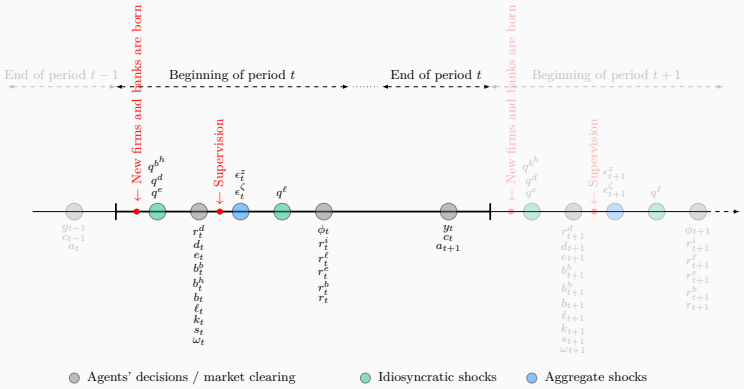


Narrow leverage regulation, Leverage regulation, ★/★ Optimal requirements, ●/● non regulated equilibrium.

Additional takeaways

- Market liquidity is part of the regulatory trade–off
- The cost of regulation is borne by savers, and regulation has distributional effects among them (e.g. depositors versus bondholders versus shareholders)
- Calibrated general equilibrium effects of regulation are material
- *Dynamics [TBC]*

Timeline


End of period $t-1$
Beginning of period t
End of period t
Beginning of period $t+1$
New firms and banks are born
Supervision
q^{b^h} q^d q^e
ϵ_t^z ϵ_t^ζ
q^ℓ
y_{t-1} c_{t-1} a_t
r_t^d d_t e_t b_t^p b_t^h b_t ℓ_t k_t s_t ω_t
ϕ_t r_t^i r_t^ℓ r_t^e r_t^b r_t
y_t c_t a_{t+1}
r_{t+1}^d d_{t+1} e_{t+1} b_{t+1}^p b_{t+1}^h b_{t+1} ℓ_{t+1} k_{t+1} s_{t+1} ω_{t+1}
ϕ_{t+1} r_{t+1}^i r_{t+1}^ℓ r_{t+1}^e r_{t+1}^b r_{t+1}
Agents' decisions / market clearing
Idiosyncratic shocks
Aggregate shocks

Firms arbitrage between bonds and loans

- Firms finance their production with bonds and loans, and maximize their expected profit

$$\max_{k_t, b_t, \ell_t} \mathbb{E}_{t-1}\left(\Psi_{t-1,t}\left(z_t k_t^{\alpha} + (1-\delta)k_t - r_t^{\ell}\ell_t - r_t^{b} b_t\right)\right)$$

$$k_t = \ell_t + b_t$$
$$r_t^{b} = r_t^{\ell}$$
$$r_t^{\ell} = \alpha z_t k_t^{\alpha-1} + 1 - \delta$$

Banks' maximisation problem

- Banks choose deposits and bond holdings to maximise their expected return on equity:

$$\max_{d_t, b_t^b} \mathbb{E}_{t-1}\left(\Psi_{t-1,t}\left[r_t^i \ell_t + \left(1-\mu\left(\overline{q}_t^{\ell}\right)\right)\left(\mathbb{Q}_t^{\ell} r_t^{\ell} - r_t^i\right)\left(\ell_t + \phi_t\right) + \mathbb{Q}^{b^b} r_t^b \left(b_t^b - b_t^h\right) + \omega_t r_t^b b_t^h - r_t^d d_t\right]\right)$$

$$s.t.: \ell_t = d_t + e_t - b_t^b \quad \text{and} \quad b_t^b \geq (1+\kappa) b_t^h \quad \text{and} \quad e_t \geq \tau(\ell_t + b_t^b)$$

$$\Rightarrow \omega_t = \kappa \frac{\overbrace{\mathbb{E}_{t-1}\left(\Psi_{t-1,t}(1+\Delta_t)\left(r_t^i - \mathbb{Q}^{b^b} r_t^b\right)\right)}^{\text{Opportunity cost of bonds versus loans}}}{\mathbb{E}_{t-1}\left(\Psi_{t-1,t}(1+\Delta_t) r_t^b\right)}$$

Calibration

Targets

Target	Values	Data sources
r^b	1.0428	Federal Reserve Bank of Saint Louis FRED database; *Moody's seasoned Baa corporate bond yield©; BAA*
r^i	1.0194	Federal Reserve Bank of Saint Louis FRED database; *Federal funds effective rate; RIFSPFF_N.A*
b/ℓ	1.3019	US Financial Accounts; Firms; *Bond–to–loan ratio; FL104122005.A/FL104123005.A*
$e/(d+e)$	0.0814	US Financial Accounts; Depository institutions; *Leverage ratio; (FL704194005.A-FL704190005.A)/FL704194005.A*
$(b^b - s_t)/(d+e)$	0.0386	US Financial Accounts; Depository institutions; *Liquidity ratio; FL703063005.A/FL704194005.A*
ω	0.0100	Adrian et al. (2017) *Bid–ask spread on corporate bonds*
$\chi^i/(d+e)$	0.0230	FDIC Tables CB07 and CB09; banks' total non–interest expenses to total assets
χ^a/a	0.0250	Foerster et al. (2017); Households; *Asset–management–expenses–to–total–asset ratio*

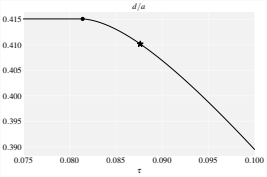
Parameters

	Parameter	Value
Intertemporal Elast. of Subst.	σ_c	4.5000
Capital elasticity	α	0.3000
Capital depreciation rate	δ	0.0600
Exogenous TFP	z	1.0000
Regulatory leverage ratio	τ	0.0814
Private benefit	ζ	0.0545
Bond inventory	κ	0.0318
Distribution – $\mu(q^\ell)$	λ_ℓ	44.0351
Distribution – $\mu_d(q^d)$	λ_d	25.7263
Distribution – $\mu_e(q^e)$	λ_e	0.2324
Distribution – $\mu_{b^h}(q^{b^h})$	λ_{b^h}	20.3558
Bond management cost	$\mathbb{Q}^{b^b}$	0.6633
Discount factor	β	0.9926

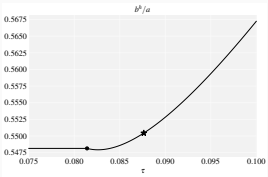
Regulation: households' portfolio re–balancing and returns on assets

Portfolio re-balancing:

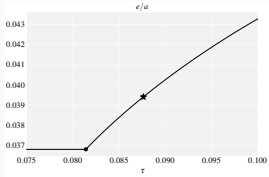
Deposits



Bonds

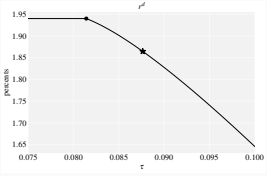


Equity

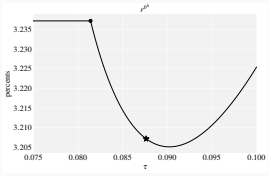


Returns on assets:

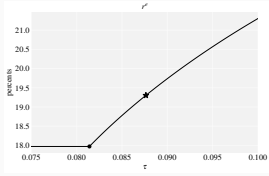
Deposits



Bonds



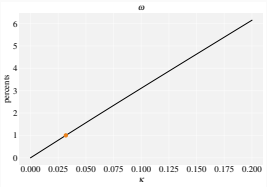
Equity



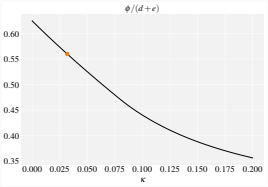
Funding Liquidity, Market Liquidity, and Optimal Regulation

Exogenous variation in market liquidity (variation in κ)

Bid-ask spread

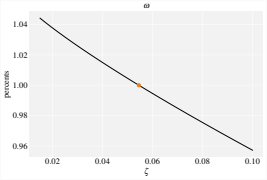


Banks' borrowing limit



Exogenous variation in funding liquidity (variation in ζ)

Bid-ask spread



Banks' borrowing limit