Bank Regulation: Capital and Liquidity Requirements

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Introduction

- Dodd-Frank Act (DFA) reformed U.S. bank regulations
  (1) Capital requirements
    - Hold sufficient equity to fund assets
    - Intent: limit **insolvency default** risk

  (2) Liquidity requirements
    - Hold sufficient liquid assets relative to runnable debt
    - Intent: limit **liquidity default** risk and asset firesales

Introduction

- Pre-DFA
  - Capital requirements at **4%** (**leverage** and **risk-weighted**)
  - No liquidity requirements
- Post-DFA
  - Capital requirements raised to **6%**
  - New liquidity requirement:

$$\frac{\text{Liquid Assets}}{\text{Runnable Debt}} \geq \mathbf{100\%}$$

- Ongoing debate over policy efficacy
  - Too stringent, too lax?

Research Question

- **Question**: What was the impact of DFA bank regulation?
  - **Marginal** effects of capital, liquidity regulation?
  - How do the requirements **interact**?
- Approach
  (1) Model: dynamic GE with heterogeneous banks
    - Policy role: addresses moral hazard and firesale risk

  (2) Baseline economy, calibrated to pre-DFA
    - U.S. Call Reports

  (3) Evaluate DFA
    - Decompose effects of capital and liquidity requirements
    - Optimal policy

  (4) Extensions: unanticipated aggregate shocks

What's New

Bank Capital Requirements

- Van den Heuvel [2008], Corbae and D'Erasmo [2010], Nguyen [2015], Davydiuk [2018], Begenau and Landvoigt [2018], Begenau [2019], Pancost and Robatto [2019]

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Bank Capital + Liquidity Requirements

- Adrian and Boyarchenko [2013], Covas and Driscoll [2014], De Nicolo et al. [2014], **Corbae and D'Erasmo** [2018], Kara and Ozsoy [2019], Van den Heuvel [2019]

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Firesale and Liquidity Risk

- Schleifer and Vishny [1992], Lorenzoni [2008], **Bianchi and Bigio** [2018]

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Contribution: comprehensive treatment of

(1) regulatory framework

(2) bank portfolio problem

(3) default risk (insolvency + liquidity)

Summary of Main Results

Dodd-Frank Act

- Threefold reduction in banking sector default risk
- Welfare **improving**
  - Mostly attributed to capital requirements
- Liquidity requirements alone **increase** total default risk

Policy Interactions

- Capital requirement: **complementary** effect on bank liquidity
- Liquidity requirement: **adverse** effect on bank equity

Optimal Policy

- Joint optimal policy
  - Capital requirement: **6.75%**
  - Liquidity requirement: **95%**

Model

Model Agents

1. Banks
   - intermediate between HH and loan projects
   - hold portfolio of assets + liabilities
   - subject to liquidity + insolvency default
2. Money market lenders
   - provide wholesale funding to banks
   - wholesale funds subject to early withdrawal shocks
3. Outside investors
   - buy firesold securities on secondary, spot market
4. Government
   - provides deposit insurance
5. Households
   - pay lump sum tax
   - equity owners of bank, money market sectors

Economy Illustration

Key Friction

- Banks can default
  (1) insolvency default
  (2) liquidity default
- Banks don't internalize the **costs of default**
  - Due to deposit insurance, limited liability
- Implication: unregulated banks are **excessively risky**
- Capital and Liquidity requirements reduce default risk
  - Tension between default risk and profitability

Banks

What is a Bank?

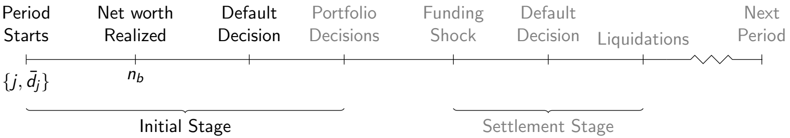
- A bank is a chartered firm with intermediation technology
- Bank charter includes
  - deposit insurance
  - regulatory requirements
- Intermediation technology affects cost of
  - lending
  - debt funding

Decisions: Two Stages

(1) Initial stage
  - insolvency default decision
  - portfolio decisions

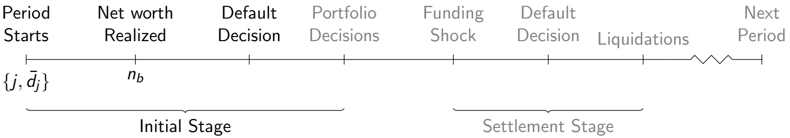
(2) Settlement stage: given funding shock,
  - liquidity default decision
  - asset liquidations

Initial Stage



- j: fixed technology type $j = 1, 2, ..., J$
  - affects cost of lending, deposit-taking
  - probability mass p_j
- $\bar{d}_j$: deposit borrowing constraint
  - fixed and stochastic component
- n_b: initial net worth

Initial Stage



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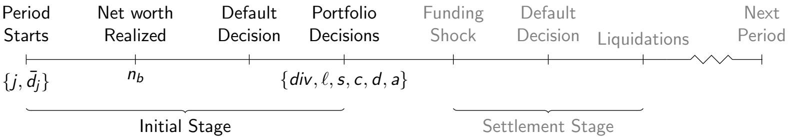
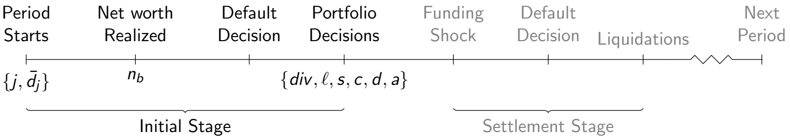
limited availability of deposit funding

Initial Stage



Assets	Liabilities
loans ℓ	deposits d
securities s	wholesale a
cash c	equity

Initial Stage



origination cost $\theta_j \frac{\ell^2}{2}$;
idiosyncratic risk

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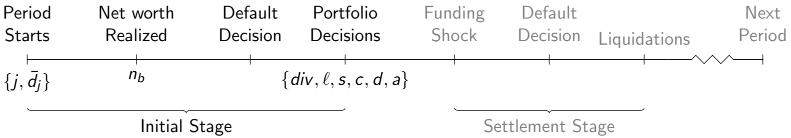
Initial Stage



risk-free gov.'t bond

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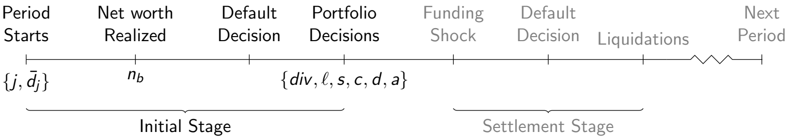
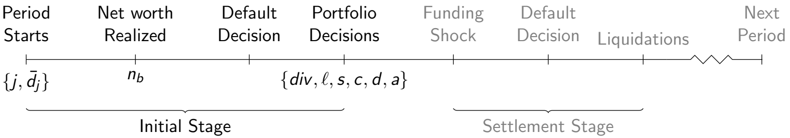
Initial Stage



Assets	Liabilities
loans ℓ	deposits d
securities s	wholesale a
cash c	equity

no interest income;
settlement properties

Initial Stage



Assets	Liabilities
loans ℓ	deposits d
securities s	wholesale a
cash c	equity

insured, stable

uninsured, runnable

Initial Stage Dynamic Program

- Define choice set as $\mathrm{y} = \big(div, \ell, s, c, d, a\big)$

- Given no default, the bank solves

$$V^b(n_b; j, \bar{d}_j) = \max_{\mathrm{y}} \quad div + E_{\delta'}\left[\underbrace{max\Big\{0, \overbrace{\tilde{V}^b(\mathrm{y}; j, \bar{d}_j, \delta')}^{\text{Value if operate}}\Big\}}_{\text{liquidity default}}\right]$$

$$\begin{aligned} s.t. \quad & \text{market constraints} \\ & \text{regulatory constraints} \\ & \text{non-negativity constraints} \end{aligned}$$

Market Constraints

- budget constraint

$$div + \underbrace{s + c + \ell}_{\text{Assets}} + \boldsymbol{\theta_j}\frac{\ell^2}{2} = n_b + \underbrace{a + d}_{\text{Debt}}$$

- collateral constraint

$$(1+h)s \geq a$$

given haircut $h \geq 0$

- deposit constraint

$$d \leq \bar{d}_j$$

- financial friction

$$div \geq 0$$

Regulatory Constraints

- <u>leverage requirement $\left(\frac{\text{Equity}}{\text{Assets}}\right)$</u>

$$\frac{\ell + s + c - [a + d]}{\ell + s + c} \geq \phi^{lev}$$

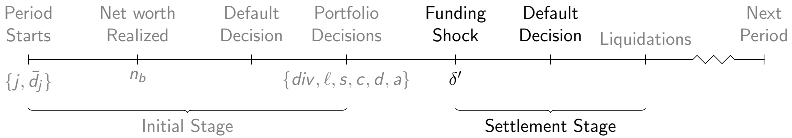
- <u>risk-weighted capital requirement $\left(\frac{\text{Equity}}{\text{Loans}}\right)$</u>

$$\frac{\ell + s + c - [a + d]}{\ell} \geq \phi^{cr}$$

- <u>liquidity requirement $\left(\frac{\text{Liquid Assets}}{\text{Runnable Debt}}\right)$</u>

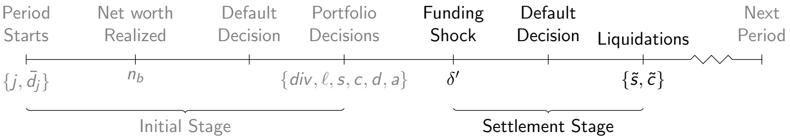
$$\frac{c + (1 - h^s)s}{a} \geq \phi^{lr}$$

Settlement Stage



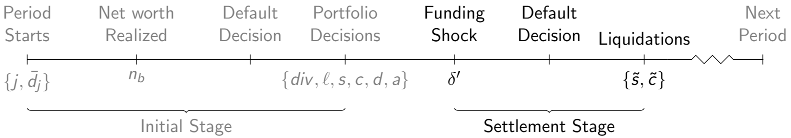
- δ': wholesale funding shock
  - fraction $\delta' \in [0, 1]$ of funds withdrawn
  - idiosyncratic risk

Settlement Stage



- $\tilde{s}$: securities liquidation
  - liquidation price p^*
- $\tilde{c}$: cash settlement

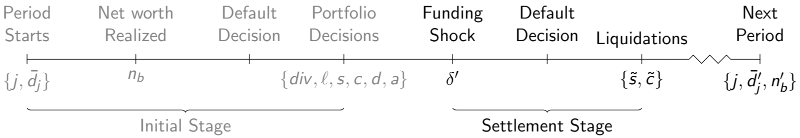
Settlement Stage



- $\tilde{s}$: securities liquidation
  - liquidation price p^*
- $\tilde{c}$: cash settlement

sold on spot market
to outside securities investors

Settlement Stage



- n_b' : after-tax net worth

$$n_b' = \tau \max\Big\{0, \underbrace{i_\ell' \ell + i_s(s - \tilde{s}) - r^d d - r^a (1 - \delta')a}_{\text{earnings before taxes}}\Big\} +$$

$$+ \ell + s - \tilde{s} + c - \tilde{c} - d - (1 - \delta')a$$

Settlement Stage Dynamic Program

$$\tilde{V}^b(\mathrm{y}; j, \bar{d}_j, \delta') = \max_{\tilde{s},\tilde{c}} \quad \boldsymbol{\gamma}\beta E_{i'_\ell, \bar{d}'}\left[\underbrace{max\{0, \overbrace{V^b(n'_b; j, \bar{d}'_j)}^{\text{Value if operate}}\}}_{\text{insolvency default}}\right]$$

$$s.t. \quad \delta' a = p^* \tilde{s} + \tilde{c}$$

$$s.t. \quad \tilde{c} \in [0, c] \quad \text{and} \quad \tilde{s} \in [0, s]$$

$$s.t. \quad n'_b \text{ law of motion}$$

where $\boldsymbol{\gamma}\beta \leq \beta$ (i.e. banks less patient than households)

Settlement Stage Dynamic Program

$$\tilde{V}^b(\mathrm{y}; j, \bar{d}_j, \delta') = \max_{\tilde{s},\tilde{c}} \quad \gamma\beta E_{i'_\ell,\bar{d}'}\left[\underbrace{max\{0, \overbrace{V^b(n'_b; j, \bar{d}'_j)}^{\text{Value if operate}}\}}_{\text{insolvency default}}\right]$$

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settlement decisions constrained by
Initial Stage portfolio decisions

Settlement Stage Dynamic Program

$$\tilde{V}^b(\mathrm{y}; j, \bar{d}_j, \delta') = \max_{\tilde{s},\tilde{c}} \quad \boldsymbol{\gamma}\beta E_{i'_\ell,\bar{d}'}\left[\underbrace{max\{0, \overbrace{V^b(n'_b; j, \bar{d}'_j)}^{\text{Value if operate}}\}}_{\text{insolvency default}}\right]$$

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where $\boldsymbol{\gamma}\beta \leq \beta$ (i.e. banks less patient than households)

lower γ banks discount the *cost* of default
(i.e. foregone dividends)

Other Financial Intermediaries

1. Money market lenders
2. Securities spot market

Money Market and Securities Spot Market

Money Market Lenders

- Provide wholesale funding a_m and issue dividends div_m
- Not covered by deposit insurance
- Equity shares held by households

Securities Spot Market

- Downward-sloping demand for liquidated bank securities
- External investors with limited demand
  - e.g. segmented markets

Money Market Lender Problem Outside Securities Investor Problem

Residual Claimants

1. Government
2. Households

Government and Households

Government

- Sets lump sum tax to balance budget
- Deposit insurance: fraction ξ of bank assets lost in default

Households

- CRRA utility and discount with β
- Choices over consumption, deposit savings and equity shares
  - Equity in money market and banking sectors

Deposit Insurance Formula | Household Problem | Economy Illustration

Equilibrium

1. Concept
2. Characterization

Equilibrium Concept

- Stationary recursive competitive equilibrium
- Invariant bank distribution $\lambda^j(n_b, \bar{d}_j)$
- Market clearing
  1. equity markets (banking, money market) at price (p_b, p_m)
  2. deposits at rate R^d
  3. wholesale funding at rate R^a
  4. liquidated securities at price p^*

Equilibrium Definition

Equilibrium Bank Portfolio Decisions

Equilibrium Bank Portfolio Decisions

- Debt funding pecking order
  - Deposits preferred to wholesale funds ($d \succ a$)

Cost of Funds

Illustration

Equilibrium Bank Portfolio Decisions

- Debt funding pecking order
  - Deposits preferred to wholesale funds ($d \succ a$)

Cost of Funds

Illustration

- Interior asset portfolio
  - Risk-return tradeoff for securities & loans
  - Cash as precautionary buffer

Proposition

In the Settlement Stage, banks always settle with available cash before liquidating securities.

Wholesale Size Correlations

The Impact of Bank Regulations

The Impact of Bank Regulations

- Capital requirements target equity ratios Illustration
  - Reduce insolvency default risk
- Liquidity requirements target liquidity ratios Illustration
  - Reduce liquidity default risk

The Impact of Bank Regulations

- Capital requirements target equity ratios Illustration
  - Reduce insolvency default risk
- Liquidity requirements target liquidity ratios Illustration
  - Reduce liquidity default risk
- Policy Interactions
  (i) Capital requirements **improve** bank liquidity Mechanism
  - higher cap req $\rightarrow$ lower liquidity default

The Impact of Bank Regulations

- Capital requirements target equity ratios Illustration
  - Reduce insolvency default risk
- Liquidity requirements target liquidity ratios Illustration
  - Reduce liquidity default risk
- Policy Interactions
  (i) Capital requirements **improve** bank liquidity Mechanism
  - higher cap req $\rightarrow$ lower liquidity default

  (ii) Liquidity requirements **deteriorate** bank equity Mechanism
  - higher liq req $\rightarrow$ higher insolvency default

The Impact of Bank Regulations

- Capital requirements target equity ratios — Illustration
  - Reduce insolvency default risk
- Liquidity requirements target liquidity ratios — Illustration
  - Reduce liquidity default risk
- Policy Interactions
  (i) Capital requirements **improve** bank liquidity — Mechanism
    - higher cap req $\rightarrow$ lower liquidity default

  (ii) Liquidity requirements **deteriorate** bank equity — Mechanism
    - higher liq req $\rightarrow$ higher insolvency default

Main Idea: capital requirements reduce both types of default

Quantitative Results

1. Calibration
2. DFA Analysis
3. Optimal Policy

External Calibration

- Use Call Reports to externally calibrate bank j technology
  (1) loan origination $\boldsymbol{\theta_j} \frac{\ell^2}{2}$

  (2) deposit borrowing constraint process

$$\bar{d}_j' = \boldsymbol{\bar{\mu}_{d,j}} + \boldsymbol{\rho_j} \bar{d}_j + \epsilon'$$

  where $\epsilon' \sim N(0, \boldsymbol{\sigma_j^\epsilon})$

- Choose $J = 3$ bank types
  - Partition panel data by size (total assets)
    - j=1: \$1-\$10 billion
    - j=2: \$10-\$50 billion
    - j=3: >\$50 billion

Call Report Data | Cost Function Estimation | Deposit Process $\bar{d}$

Key Externally Calibrated Parameters

Parameter	Label	Value	Source/Target
β	HH Discount Factor	0.99	$R^d = 1.01$
$\boldsymbol{\xi}$	Default Recovery	0.65	FDIC
$\boldsymbol{\phi^{lev}}$	Leverage Requirement	0.04	Pre-DFA
$\boldsymbol{\phi^{cr}}$	Capital Requirement	0.04	Pre-DFA
$\boldsymbol{\phi^{lr}}$	Liquidity Requirement	0	Pre-DFA
μ	Mean Loan Return	1.04	Call Reports
τ	Corporate Tax Rate	0.32	Call Reports
h	Collateral Haircut	-0.79	Call Reports

Funding Shock δ'

Internally Calibrated Parameters

Parameter	Value	Label	Target	Model (%)	Data (%)
γ	0.961	Bank Discount	Default Rate	0.79	1.04
$i_s - r^d$	0.56	Risk-free Spread	Loan-Security ratio	3.7	3.4
$\tilde{\alpha}$	-0.02	Firesale Elasticity	Deposit-Wholesale Ratio	3.4	3.2
σ	0.04	Volatility Loan Return	Risk-weighted Eq Ratio	5.2	9.6
$\bar{\mu}_{d,1}$	0.012	Capacity Constraint	Deposit Share	71.7	73.3
$\bar{\mu}_{d,2}$	0.034	Capacity Constraint	Deposit Share	84.3	58.2
$\bar{\mu}_{d,3}$	0.011	Capacity Constraint	Deposit Share	44.8	45.3

Cross-Section Correlations

Non-Targeted Moments

- Model captures cross-sectional size correlations with equity and liquidity ratios[1]

Label	Model (%)	Data (%)
$Corr$(Size,RWE)	-0.29	-0.22
$Corr$(Size,Liq)	0.21	0.21
Liquidity Ratio	73.3	53.1
Return on Equity	7.2	11.0
Leverage Ratio	5.2	7.3

[1] RWE= risk-weighted equity ratio. Liq= liquidity ratio.

Dodd-Frank Analysis (Levels)

Label	Pre-DFA	DFA	Partial DFA I (6% CR,0% LR)	Partial DFA II (4% CR,100% LR)
RW Equity Ratio				
Leverage Ratio				
Liquidity Ratio				
Insolvency Default				
Liquidity Default				
Total Default				

Wholesale Funding Use

Dodd-Frank Analysis (Levels)

Label	Pre-DFA	DFA	Partial DFA I (6% CR,0% LR)	Partial DFA II (4% CR,100% LR)
RW Equity Ratio	5.2	6.4		
Leverage Ratio	4.1	6.0		
Liquidity Ratio	73.3	100.1		
Insolvency Default	**0.79**	**0.23**		
Liquidity Default	**0.14**	**0**		
Total Default	**0.93**	**0.23**		

DFA significantly reduced default risk: 0.93% to 0.23% (annualized)

Wholesale Funding Use

Dodd-Frank Analysis (Levels)

Label	**Pre-DFA**	**DFA**	**Partial DFA I** (6% CR,0% LR)	**Partial DFA II** (4% CR,100% LR)
RW Equity Ratio	5.2	6.4	6.3	
Leverage Ratio	4.1	6.0	6.0	
Liquidity Ratio	73.3	100.1	72.4	
Insolvency Default	0.79	0.23	0.22	
Liquidity Default	**0.14**	0	**0.09**	
Total Default	0.93	0.23	0.31	

capital requirements alone reduce liquidity default risk

Wholesale Funding Use

Dodd-Frank Analysis (Levels)

Label	**Pre-DFA**	**DFA**	**Partial DFA I** (6% CR,0% LR)	**Partial DFA II** (4% CR,100% LR)
RW Equity Ratio	5.2	6.4	6.3	5.2
Leverage Ratio	4.1	6.0	6.0	4.0
Liquidity Ratio	73.3	100.1	72.4	102.7
Insolvency Default	**0.79**	0.23	0.22	**0.96**
Liquidity Default	0.14	0	0.09	0
Total Default	0.93	0.23	0.31	0.96

liquidity requirements increase insolvency default risk

Wholesale Funding Use

Dodd-Frank Analysis (% Change)

Label	**Pre-DFA**	**DFA**	**Partial DFA I** (6% CR,0% LR)	**Partial DFA II** (4% CR,100% LR)
Aggregate Lending	–	-2.0	-1.8	-10.0
Aggregate Balance Sheet	–	-15.7	-18.9	-9.2
Aggregate Wholesale Funding	–	-86.0	-88.6	-32.7
Household Consumption	–	0.74	0.70	-1.97

Bank Growth/Level Data

Dodd-Frank Analysis (% Change)

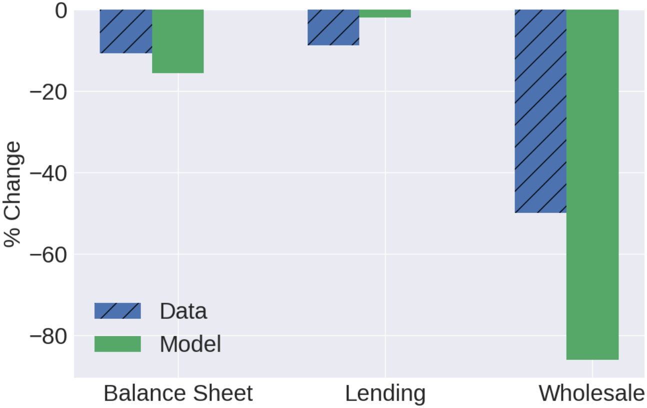
Label	**Pre-DFA**	**DFA**	**Partial DFA I** (6% CR,0% LR)	**Partial DFA II** (4% CR,100% LR)
Aggregate Lending	–	-2.0	-1.8	-10.0
Aggregate Balance Sheet	–	-15.7	-18.9	-9.2
Aggregate Wholesale Funding	–	-86.0	-88.6	-32.7
Household Consumption	–	**0.74**	**0.70**	-1.97

welfare gains driven almost entirely
by capital regulation

Bank Growth/Level Data Consumption Breakdown

Dodd-Frank and Banking Sector Aggregates

- Look at post-DFA aggregate data, relative to trend



Optimal Policy

- Welfare criterion: HH lifetime consumption
- Joint optimal policy
  - Capital requirement: **6.75%**
  - Liquidity requirement: **95%**
- Higher CRs reduce wholesale funding usage
  - Socially *easier* to require banks to hold more liquid assets
- Other aggregate changes
  - Lending: **-3.4%**
  - Total balance sheet: **-20.5%**

Illustration

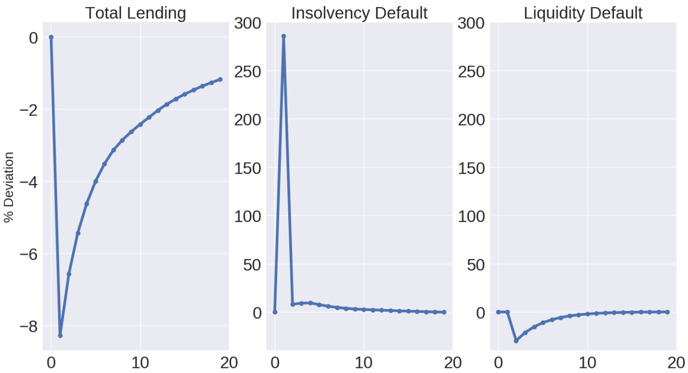
Extensions

1. Unanticipated Aggregate Shocks

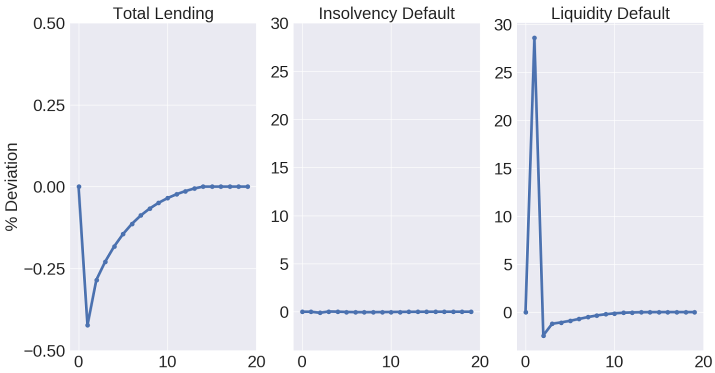
Aggregate Shocks

- Consider two types of aggregate shocks
  1. Loan returns
  2. Wholesale funding withdrawal
- Objects of interest:
  - Total lending
  - Insolvency default
  - Liquidity default
- Today: pre-DFA economy
  - Future: compare pre- and post-DFA economies

-1% Shock to Loan Returns

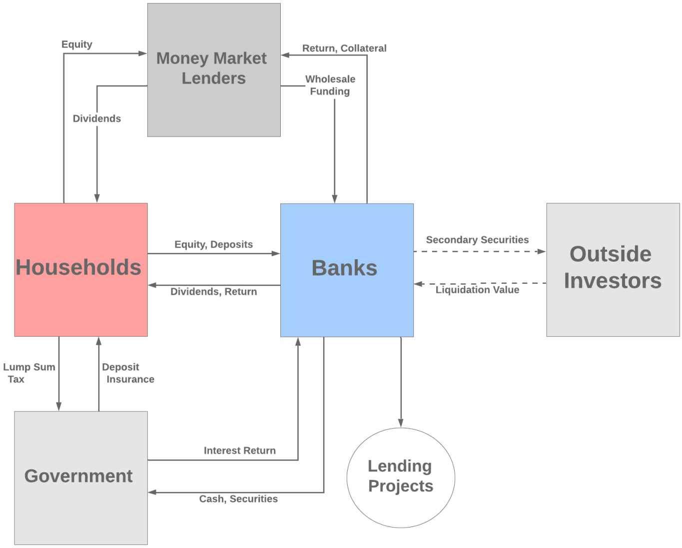


-10% Wholesale Funding Withdrawal



Thank You!

Economy Illustration



Return

Money Market Lenders Problem

- For each unit of lending a_m, lender receives fractions
  1. α^c : payoffs from collateral seizures
  2. α^w : payoffs from early withdrawals
  3. $1 - \alpha^c - \alpha^w$: payoffs from repayment at maturity
- (α^c, α^w) are equilibrium objects
- Money market lenders solve

$$V^m(n_m) = \max_{a_m, div_m} \quad div_m + \beta V^m(n_m')$$

$$s.t. \quad div_m + a_m = n_m$$

$$s.t. \quad n_m' = a_m \left[\alpha^c (1+h) + \alpha^w + (1 - \alpha^c - \alpha^w) R^a \right]$$

Return

Outside Securities Investor Problem

- Investors purchase securities in the Settlement Stage on a spot market
- Investors solve the static problem

$$\max_{s_o} \quad (s_o)^{\alpha} - p^* s_o$$

Return

Deposit Insurance

- In default, fraction ξ of assets are lost
- For a bank in liquidity default, deposit insurance covers

$$R^d d - \xi\left[(1+i_\ell')\ell + (1+i_s)s + c - (1+h)a\right]$$

- For a bank in insolvency default, deposit insurance covers

$$R^d d - \xi\left[(1+i_\ell')\ell + (1+i_s)(s-\tilde{s}) + (c-\tilde{c}) + \delta' a - (1-\delta')(1+h)a\right]$$

- In each case, wholesale funding lenders seize collateral first
- Aggregate deposit insurance is summed using the invariant bank distribution $\lambda(n_b, j, \bar{d})$

Return

Households

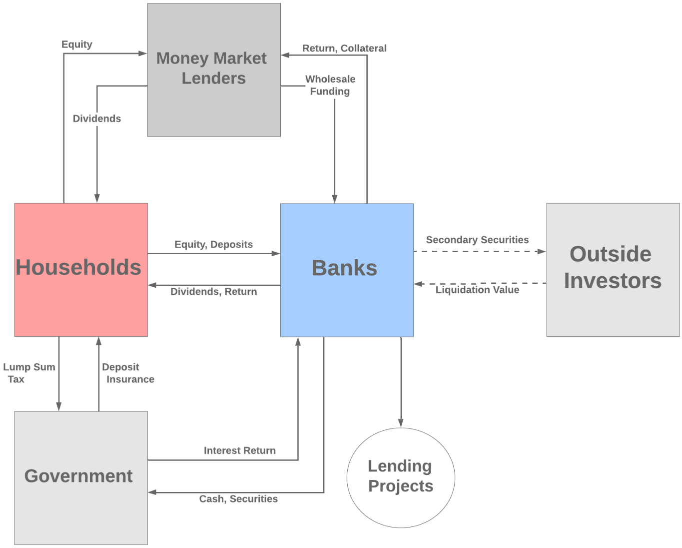
Each period, given networth n_h, solve

$$\begin{aligned} V^h(n_h) = & \max_{c_h, d_h, \{e_i\}} \quad u(c_h) + \beta V^h(n_h') \\ & s.t. \quad c_h + d_h + \sum_{i \in \{b,m\}} e_i p_i = n_h \\ & s.t. \quad n_h' = (1 + r^d) d_h + \sum_{i \in \{b,m\}} e_i (p_i + Div_i) + T + \omega \end{aligned}$$

where p_i is share price and Div_i is dividend for share $i \in \{b, m\}$

Return

Economy Illustration



Return

Equilibrium

Given the idiosyncratic exogenous processes $\left\{i_l, \delta, \{\bar{d}_j\}_{j=1}^J\right\}$, a stationary recursive competitive equilibrium is defined as a set of prices $\{R^d, R^a, p_b, p_m, p^*\}$, initial stage bank policy functions $\mathrm{g_b}(n_b, j, \bar{d}_j) =$ $\left\{\ell(n_b, j, \bar{d}_j), s(n_b, j, \bar{d}_j), c(n_b, j, \bar{d}_j), d(n_b, j, \bar{d}_j), a(n_b, j, \bar{d}_j), div(n_b, j, \bar{d}_j)\right\}$, settlement stage bank policy functions $\tilde{\mathrm{g_b}}(\mathrm{y}, \delta', j, \bar{d}_j) = \left\{\tilde{c}(\mathrm{y}, \delta', j, \bar{d}_j), \tilde{s}(\mathrm{y}, \delta', j, \bar{d}_j)\right\}$, household policy functions $\mathrm{g_h}(n_h) = \left\{c_h(n_h), d_h(n_h), s_b(n_h), s_m(n_h)\right\}$, aggregate wholesale lending a_m, aggregate security liquidations s_o and marginal bank distributions $\{\lambda^j(n_b, \bar{d}_j)\}_{j=1}^J$ such that

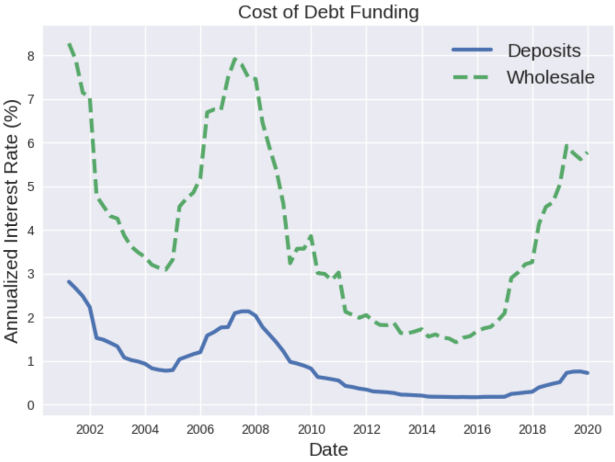
1. $V^h(n_h)$ and $\mathrm{g_h}(n_h)$ solve the household problem,
2. $V^b(n_b, j, \bar{d}_j)$, $\tilde{V}^b(\mathrm{y}, \delta', j, \bar{d}_j)$, $\mathrm{g_b}(n_b, j, \bar{d}_j)$ and $\tilde{\mathrm{g_b}}(\mathrm{y}, \delta', j, \bar{d}_j)$ solve the bank problem,
3. Money market lenders solve their problem
4. Outside securities investors solve their problem
5. The marginal distribution of banks follows law of motion

$$\lambda^j = \Gamma^j(\lambda^j) \qquad \forall j = 1, 2, ..., J$$

   for transition function Γ^j and is consistent with firm/household maximization
6. Market clearing
   - 6.1 $e_b = e_m = 1$ (Equity Shares)
   - 6.2 $\int_{N_b} \sum_j \sum_{\bar{d}_j} d(n_b, j, \bar{d}_j) d\lambda^j(n_b, j, \bar{d}_j) = d_h(n_h)$ (Deposits)
   - 6.3 $\int_{N_b} \sum_j \sum_{\bar{d}_j} a(n_b, j, \bar{d}_j) d\lambda^j(n_b, j, \bar{d}_j) = a_m$ (Wholesale Funds)
   - 6.4 $\int_{N_b} \sum_j \sum_{\bar{d}_j} \left[\sum_{\delta'} \pi_{\delta'} \tilde{s}(\mathrm{y}, \delta', j, \bar{d}_j)\right] d\lambda^j(n_b, j, \bar{d}_j) = s_o$ (Secondary Securities)

Return

Bank Debt Funding Costs



Return

Wholesale Funding Size Correlations

Empirical method:

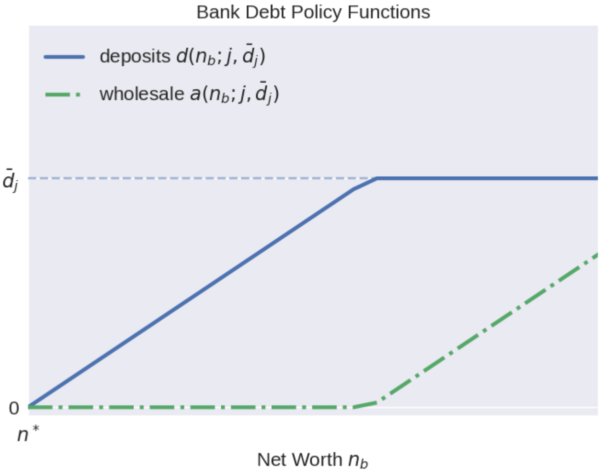
(1) Regress wholesale funding shares on bank size

(2) Control for fixed effects and other lines of business
   - use ratio of non-interest to interest income

(3) Look at full sample and sub-samples
   - Pre-DFA: 2001 Q1 - 2010 Q1
   - Post-DFA: 2010 Q2 - Present

Return

Debt Funding Pecking Order



Return

Interaction: Capital Requirements Improve Liquidity

(I) Higher capital requirements reduce bank profitability

(II) Bank responds by shrinking balance sheet

(III) Liability side: large substitution out of wholesale funds ($\downarrow \boldsymbol{a}$)

- debt funding preference for deposits

(IV) Asset side: stable liquid asset share ($\leftrightarrow \boldsymbol{c} + \boldsymbol{s}$)

(V) Net effect:

- increase in bank liquidity ($\uparrow \frac{\boldsymbol{c}+\boldsymbol{s}}{\boldsymbol{a}}$)
- reduction in liquidity default

Return

Interaction: Liquidity Requirements Deteriorate Equity

(I) Higher liquidity requirements reduce bank profitability

(II) Bank responds by shrinking balance sheet

(III) Asset side: large substitution into loans ($\uparrow \ell$)

- higher marginal benefit from DRS + balance sheet shrink

(IV) Liability side: stable equity share ($\leftrightarrow$ ***equity***)

(V) Net effect:

- decrease in risk-weighted equity ratios ($\downarrow \frac{\textit{\textbf{equity}}}{\ell}$)
- increase in insolvency default

Return

Wholesale Funding Size Correlations

WHOLESALE FUNDING SHARES REGRESSION

	(Pre-DFA) wholesale share	(Post-DFA) wholesale share	(Full Sample) wholesale share
Intercept	1,670***	675***	1,071***
	(11.4)	(4.37)	(5.07)
Size	**19.1*****	**-0.23**	**3.51*****
	(1.37)	(0.34)	(0.44)
Income Ratio	-26.5***	-1.25***	-2.02***
	(3.29)	(0.30)	(0.43)
Time FE	✓	✓	✓
Time Periods	37	39	76
Entities	842	1061	1407
R^2	0.017	0.001	0.002

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$

Return

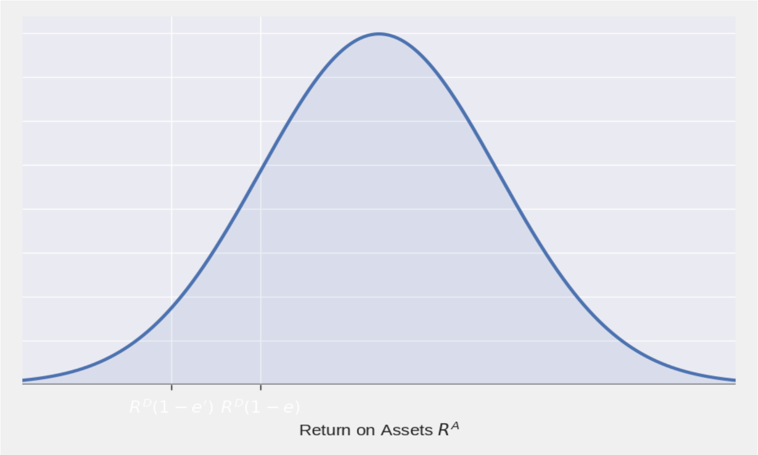
Call Report Data

- Source: U.S. Reports of Condition and Income (Call reports)
  - panel data
  - bank (charter)- level balance sheet data
- Frequency: quarterly
- Range: 2000-2020
- Restrictions: assets $>$\$1 billion

Return

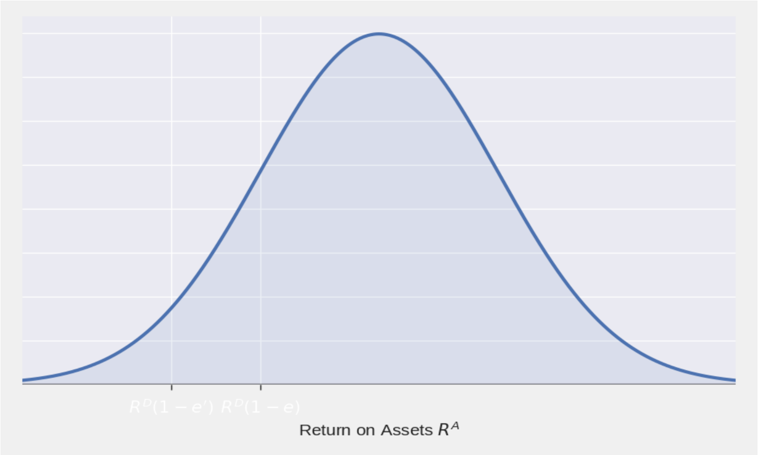
Capital Requirements Reduce Insolvency Default

$$Prob(\text{Insolvency Default}) = Prob(n_b \leq 0)$$



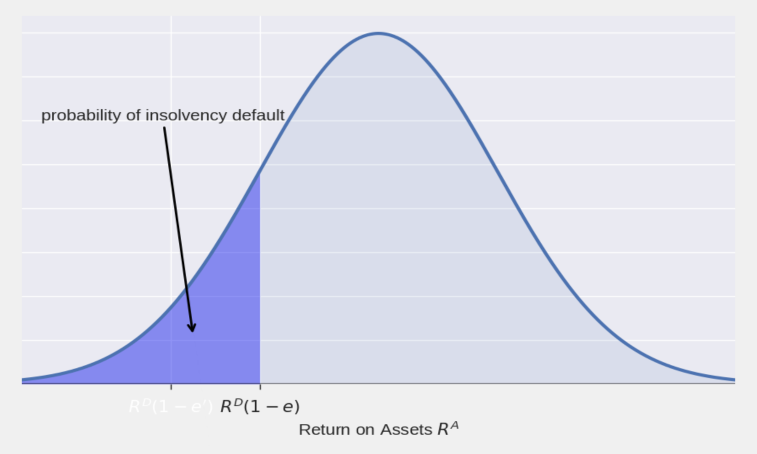
Capital Requirements Reduce Insolvency Default

$$Prob(\text{Insolvency Default}) = Prob(R^A \times Assets \leq R^D \times Debt)$$



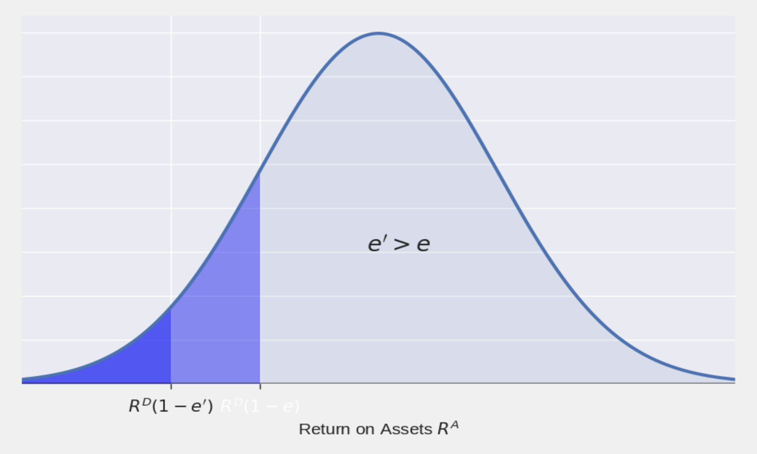
Capital Requirements Reduce Insolvency Default

$$Prob(\text{Insolvency Default}) = Prob(R^A \leq R^D(1-e))$$



Capital Requirements Reduce Insolvency Default

$$Prob(\text{Insolvency Default}) = Prob(R^A \leq R^D(1 - e'))$$



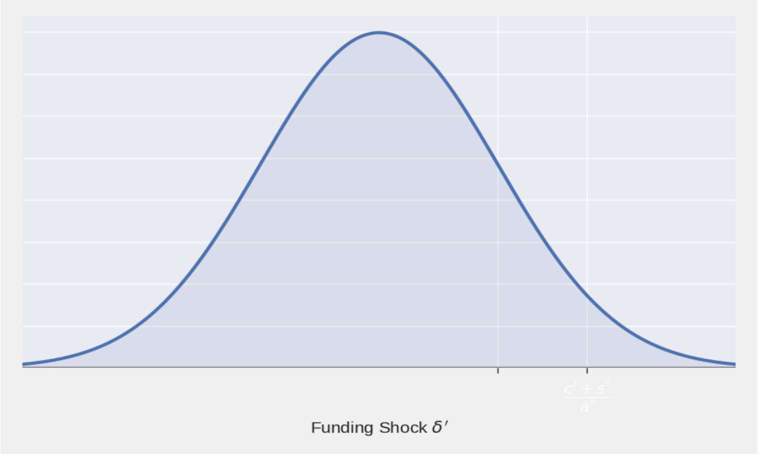
Return

Liquidity Requirements Reduce Liquidity Default

$$\mathit{Prob}(\text{Liquidity Default}) = \mathit{Prob}(\text{liq assets} < \text{funding withdrawal})$$

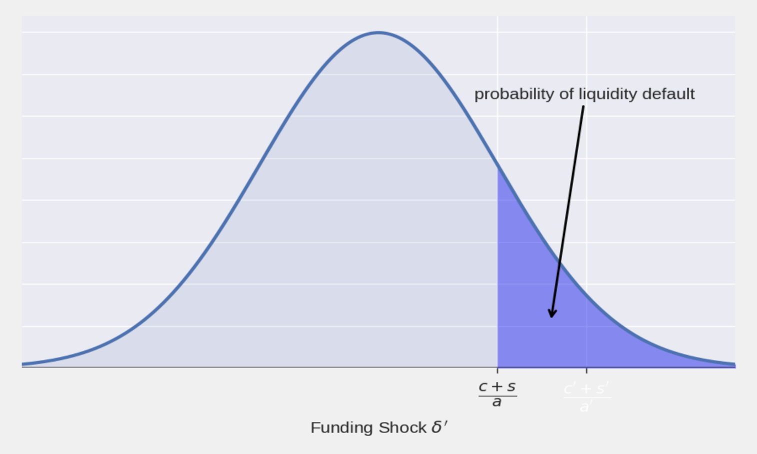
Liquidity Requirements Reduce Liquidity Default

$$Prob(\text{Liquidity Default}) = Prob(c + s < \delta' a)$$



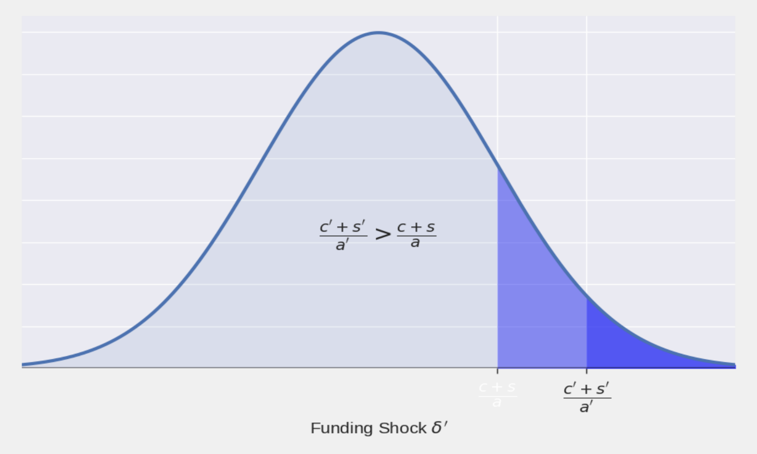
Liquidity Requirements Reduce Liquidity Default

$$Prob(\text{Liquidity Default}) = Prob(\delta' > \frac{c+s}{a})$$



Liquidity Requirements Reduce Liquidity Default

$$Prob(\text{Liquidity Default}) = Prob(\delta' > \frac{c' + s'}{a'})$$



Return

Cost Function Estimation

- Use Call Report panel data (FFIEC Form 041, 051) to infer bank θ's with empirical cost functions
- Construct data analogue to $\theta\frac{\ell^2}{2}$:
  - net non-interest expenditures
- Steps
  1. Filter data
  2. Create bank quantile groups (by size)
  3. Estimate quantile bank cost function
  4. Recover $\hat{\theta}$'s by equating model/empirical marginal costs

Cost Function Estimation

1. Filter data
   - Drop banks with assets $< \$1B$
   - Drop observations with negative (i) lending, (ii) labor expense, (iii) fixed input and (iv) borrowings
2. Create quantile groups
   - Quantile thresholds: $\{0.8, 0.95\}$
   - Corresponds to \$10 billion, \$50 billion
3. Estimate quantile bank cost function:

$$Cost_{it}^{q} = \beta_0^q + \alpha_t^q + \beta_1^q \ell_{it}^q + \beta_2^q {\ell_{it}^q}^2 + \underbrace{\sum_k \beta_k^q \ell_{it}^q x_{k,(i,t)}^q}_{\text{interactions}} + \sum_j \beta_j^q x_{j,(i,t)}^q$$

for each quantile group q

Cost Function Estimation

4. Define empirical and model marginal cost
   - Model marginal cost: $\theta\ell$
   - Empirical marginal cost:

$$MC^j(\ell, \mathrm{x}) = \hat{\beta}_1^j + \left[2\hat{\beta}_2^j + \sum_k \hat{\beta}_k x_k\right]\ell$$

5. Equate marginal cost functions to recover $\hat{\theta}$

$$\hat{\theta}_j = 2\hat{\beta}_2{}^j + \sum_k \hat{\beta}_k{}^j \bar{x}_k^j \quad \forall j = 1, 2, 3$$

Return

Loan Cost Function Estimates

Bank Group	**1**	**2**	**3**
Size	$<$10b	10-50b	$>$50b
Probability Mass	0.85	0.1	0.05
$\boldsymbol{\hat{\theta}_j}$	0.033	0.024	0.021

Funding Shock Process δ'

- Model: Intra-period, fraction δ' of wholesale funds withdrawn
  - δ' is a discrete, iid process: $\left\{ \left(\delta_1, \delta_2, ..., \delta_J\right), \left(p_1^\delta, p_2^\delta, ..., p_J^\delta\right) \right\}$

- Empirical Method:
  (i) create wholesale funds data analogue a_{it}
    - repo + fed funds + large time deposits (<1yr maturity) + trading liabilities + other borrowed money (<1yr maturity)

  (ii) Compute wholesale *run-off* rates $r_{it} = \frac{a_{i,t-1} - a_{i,t}}{a_{i,t-1}}$

  (iii) For specific t, generate cross-section distribution

  (iv) Pick percentiles $\{\bar{p}_1, \bar{p}_2, ..., \bar{p}_{J-1}\} \rightarrow \{\bar{r}_1, \bar{r}_2, ..., \bar{r}_{J-1}\}$

Funding Shock Process δ'

(v) for each $j = 1, 2, ..., J$

- if $j = 1$, then $\begin{cases} \delta_1 = \frac{\bar{r}_{min}+\bar{r}_1}{2} \\ p_1^{\delta} = \bar{p}_1 \end{cases}$

- if $j = 2, ..., J-1$, then $\begin{cases} \delta_j = \frac{\bar{r}_{j-1}+\bar{r}_j}{2} \\ p_j^{\delta} = \bar{p}_j - \bar{p}_{j-1} \end{cases}$

- if $j = J$, then $\begin{cases} \delta_J = \frac{\bar{r}_J+\bar{r}_{max}}{2} \\ p_J^{\delta} = 1 - \bar{p}_J \end{cases}$

Return

Deposit Capacity Constraint Process $\bar{d}$

- Model: banks choose deposits d
  - Choice bounded above by $\bar{d}$ (i.e. $d \leq \bar{d}$)
  - $\bar{d}$ is individual, exogenous first-order process $\left(\bar{D}, P_d\right)$
- **Intuition**: banks prefer deposits to wholesale funds (it's cheaper) but...
  - face uninsurable deposit inflow/outflow
  - rely on wholesale funding to optimally finance assets
    - i.e. $a > 0 \Rightarrow d = \bar{d}$
- Empirical Method: estimate AR(1) process at the bank-level for deposits
  - Discretize with Tauchen method

Deposit Capacity Constraint Process $\bar{d}$

(1) Create bank groups 1,2 and 3 (as in loan cost estimation)

(2) Deflate series

(3) For each bank
   (a) normalize deposits with average
   (b) de-trend with hp filter
   (c) estimate AR(1) process

(4) For each bank group
   (i) Take average of estimates $(\hat{\rho}, \hat{\sigma}_\epsilon)$
   (ii) Discretize with Tauchen

Deposit Capacity Constraint Process $\bar{d}$

Bank Group	**Bank Size ($ Billion)**	$\hat{\rho}$	$\hat{\sigma}_{\epsilon}$	$\hat{\sigma}_{d}$
		persistence	error vol	deposit vol
1	≤ 10	0.62	0.18	0.23
2	$(10, 50)$	0.67	0.15	0.21
3	≥ 50	0.60	0.09	0.11

Table: Deposit Process Estimation

Return

Cross-Section Correlations

TABLE 10
Bank Cross-Section Correlation matrix

	Size	RWE	Lev	Liq	Ins Def	Liq Def	ROE
Size	1	–	–	–	–	–	–
RWE	**-0.29**	1	–	–	–	–	–
Lev	0.21	-0.09	1	–	–	–	–
Liq	**0.21**	-0.05	-0.05	1	–	–	–
Ins Def	**-0.26**	-0.08	-0.15	-0.08	1	–	–
Liq Def	**0.27**	-0.07	0.01	-0.06	**-0.12**	1	–
ROE	-0.01	**-0.57**	-0.19	-0.03	**0.69**	**-0.21**	1

Return

Regulation and Household Consumption

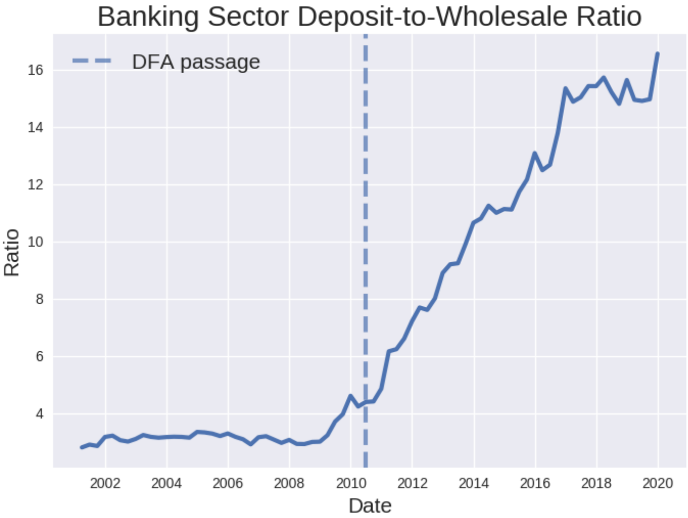
- Household consumption:

$$C = \underbrace{(R^d - 1)d}_{\text{Net Deposit Return}} + \underbrace{Div}_{\text{Money Market, Bank Dividends}} - \underbrace{T}_{\text{Gov.'t Tax}}$$

- Tax T includes costs of deposit insurance/bank default
- Increasing regulation trades off
  - Lower deposit insurance, lower tax (+)
  - Lower dividends (–)

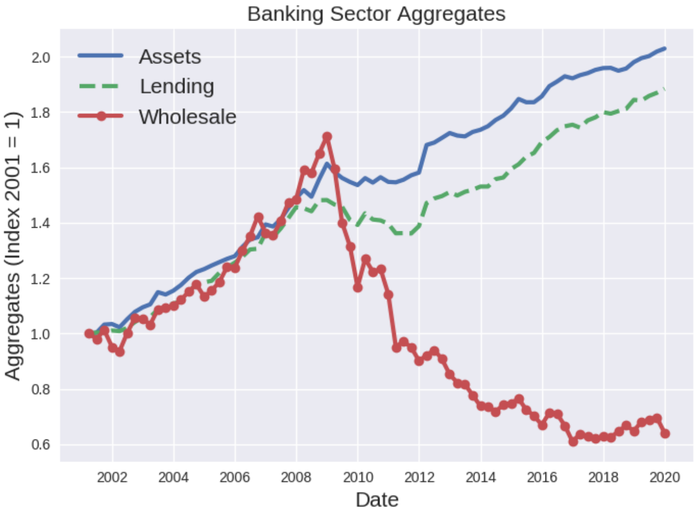
Return

Wholesale Funding Use Declined

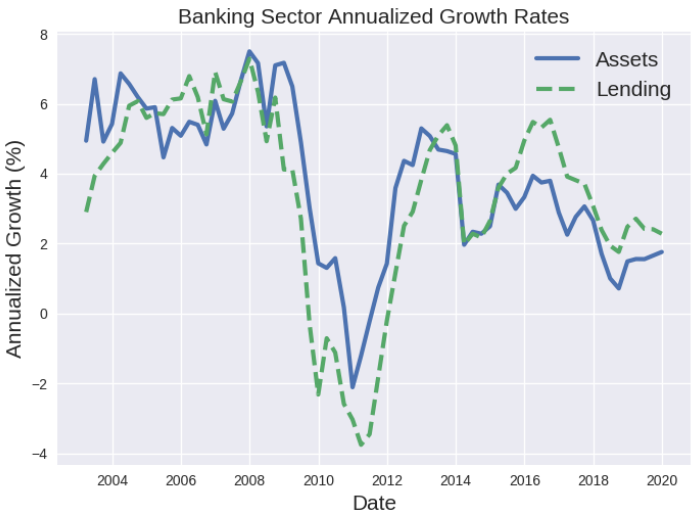


Return

Banking Sector Aggregates



Balance Sheet Growth



Return

The *Cost* of Liquidity Regulation

Case: High Wholesale Debt Usage

Assets		Liabilities	
loans	55	deposits	45
liq assets	45	wholesale	45
		equity	10

The *Cost* of Liquidity Regulation

Case: High Wholesale Debt Usage

Assets		Liabilities	
loans	55	deposits	45
liq assets	45	wholesale	45
		equity	10

100% liquidity ratio

The *Cost* of Liquidity Regulation

Case: High Wholesale Debt Usage

Assets		Liabilities	
loans	55	deposits	45
liq assets	45	wholesale	45
		equity	10

100% liquidity requirement restricts bank's ability to generate returns from loan origination

The *Cost* of Liquidity Regulation

Case: Low Wholesale Debt Usage

Assets		Liabilities	
loans	90	deposits	80
liq assets	10	wholesale	10
		equity	10

Return

The *Cost* of Liquidity Regulation

Case: Low Wholesale Debt Usage

Assets		Liabilities	
loans	90	deposits	80
liq assets	10	wholesale	10
		equity	10

100% liquidity ratio on smaller stock of wholesale debt; less costly to maintain

Return

The *Cost* of Liquidity Regulation

Case: Low Wholesale Debt Usage

Assets		Liabilities	
loans	90	deposits	80
liq assets	10	wholesale	10
		equity	10

Capital requirements indirectly reduce wholesale debt;
less costly to set high liquidity requirement