Some Lessons from the Financial Flows of the Great Recession

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Federal Reserve Board - June 2017

Introduction

- **Financial Crisis Narratives**
  - Demand channel: household wealth
  - Credit-Supply channel - two avenues
    - equity losses $\rightarrow$ banking frictions $\rightarrow$ credit crunch
    - absorption of shadow assets $\rightarrow$ banking frictions $\rightarrow$ credit crunch
- **This paper: contrast supply narrative with data**
  1. scale of shadow asset inflow & equity losses?
  2. frictions explain bank behavior?

Findings - Six Empirical Facts

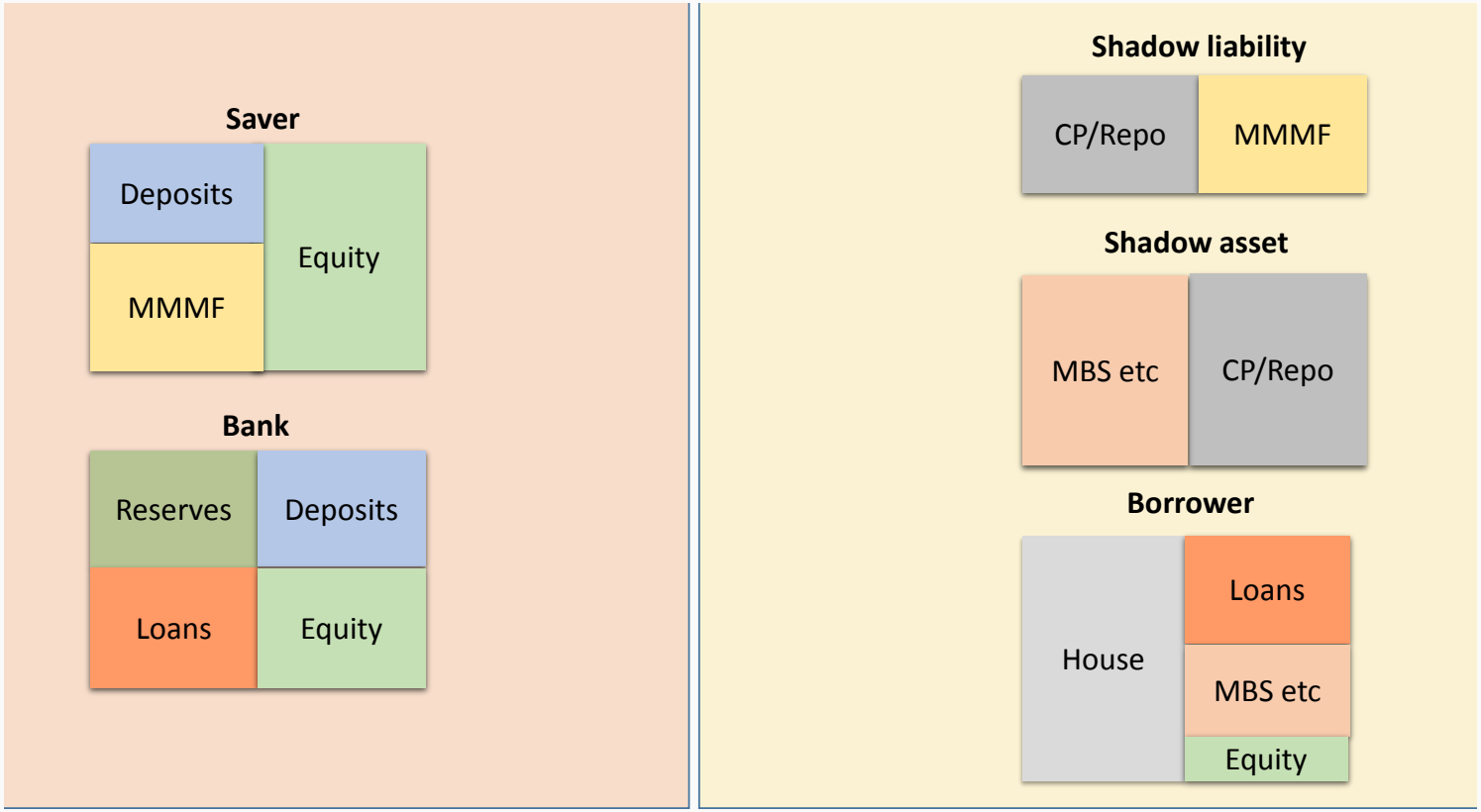
1. Between 2007Q1–2014Q4, shadow banks saw a net outflow of $4.2 trillion. However, Fed issued reserves to buy most of these assets.
2. Book values and market values diverged during the crisis. Market values capture information that book values do not.
3. Between 2007Q3–2014Q4, BHCs lost $710 billion in market capitalization. At same time, slowdown in lending.
4. Neither regulatory nor market constraints strictly bind for most banks. But, may influence bank's decisions indirectly.
5. Banks appear to operate with a target leverage; only slowly readjust after shocks. Suggests banks face adjustment costs.
6. Prior to crisis, banks reasjusted primarily by reducing assets. Post-crisis, banks also raised equity through retained earnings and issuances.

Findings - Lessons for Modeling

- Should move away from constraints used in literature
- Acknowledge distinction between book and market values
- Introduce frictions that prevent quick leverage adjustment, richer form of constraints

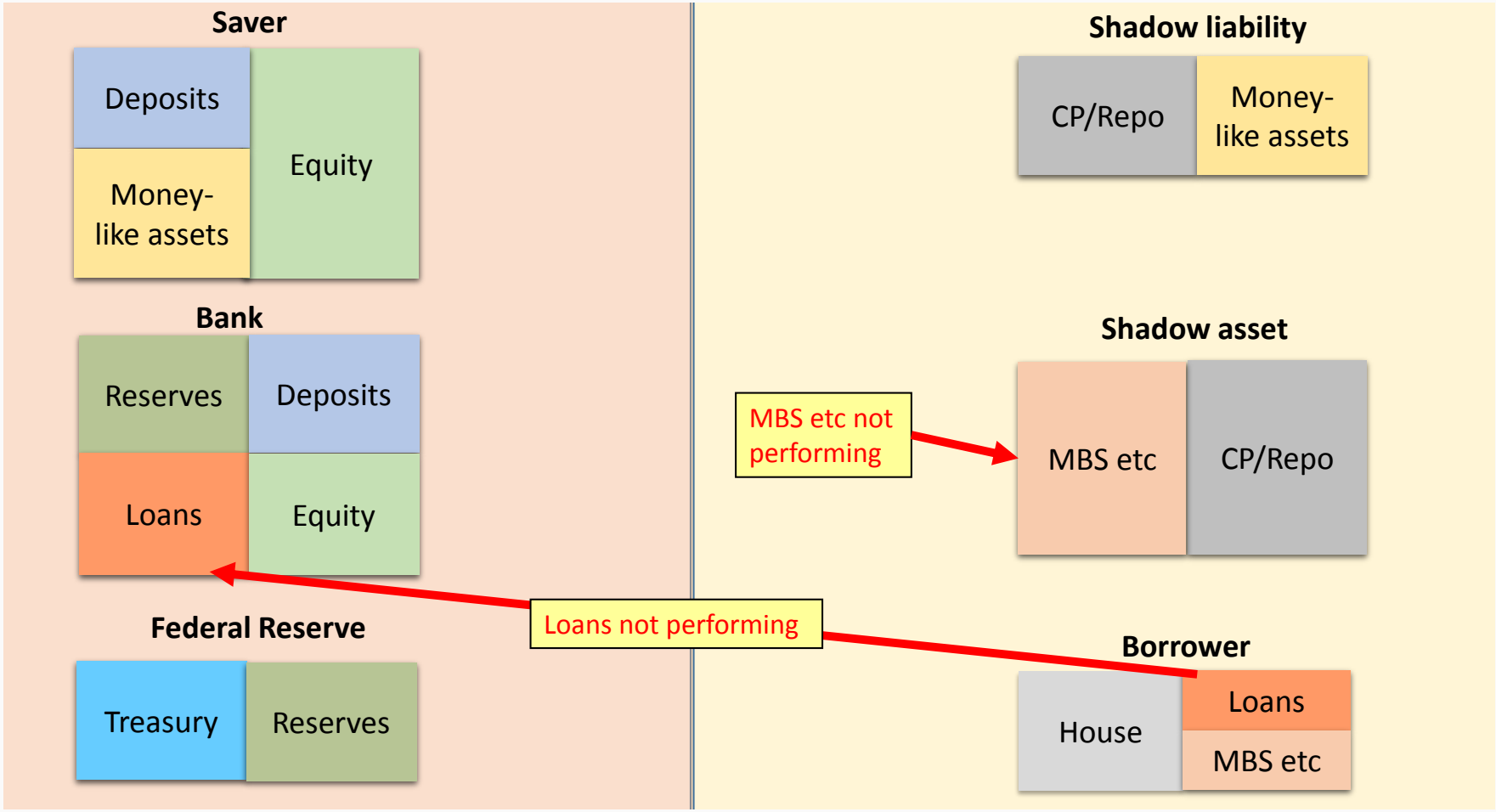
(1) Shadow asset flows and banks

Modern Financial System

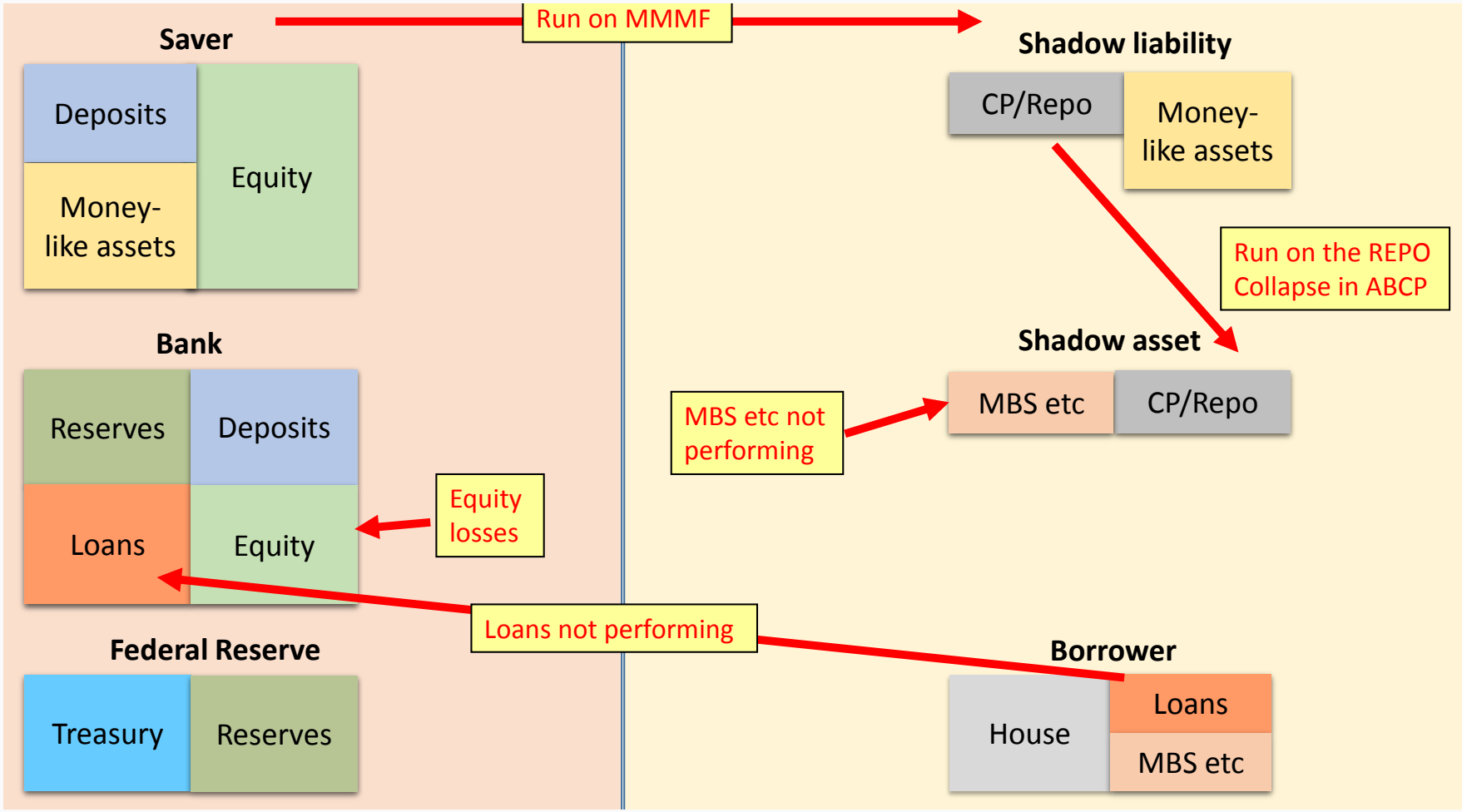


- **Traditional banks (TB):** Depository institutions
- **Shadow assets (SAB):** SBD, GSE, M-Pools, REITs, Fincos, ABSers
- **Shadow liabilities (SLB):** MMM funds + SBD Repo & Secloans + Pensions & Insurance & ROW (Repo)

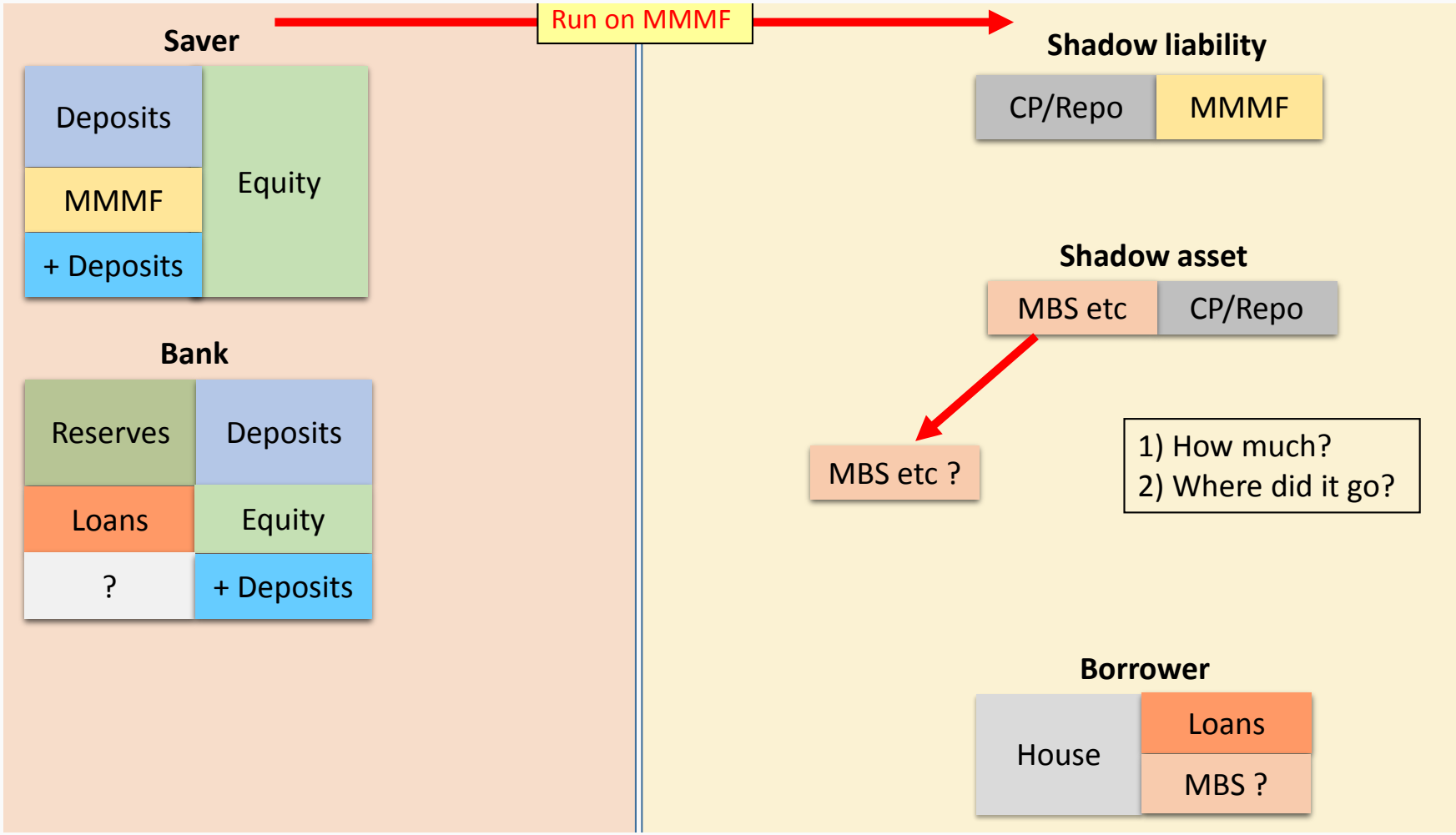
House price shock



Supply story



Asset Outflow: (a) Size? (b) Direction?



Data

- 2007q1-2015q1
- Financial Accounts (Flow of Funds)
- Bank level data on commercial banks
  - Call reports to adjust trad. banks' assets for GS & MS
- Security broker-dealer level (FOCUS) / SEC filings
  - adjust SAB series for GS & MS
- Money market mutual funds (ICI)
  - use ICI data to find share of prime MMMF
- 10-Q SEC filings
  - From quarterly filings get (lower bound) losses BS, ML,GS,MS, L $56 billion
- Morningstar Hedge Fund data
- Inflation adjusted (2009 $)

Fed Shadow-Asset Absorption Intermediated by Banks

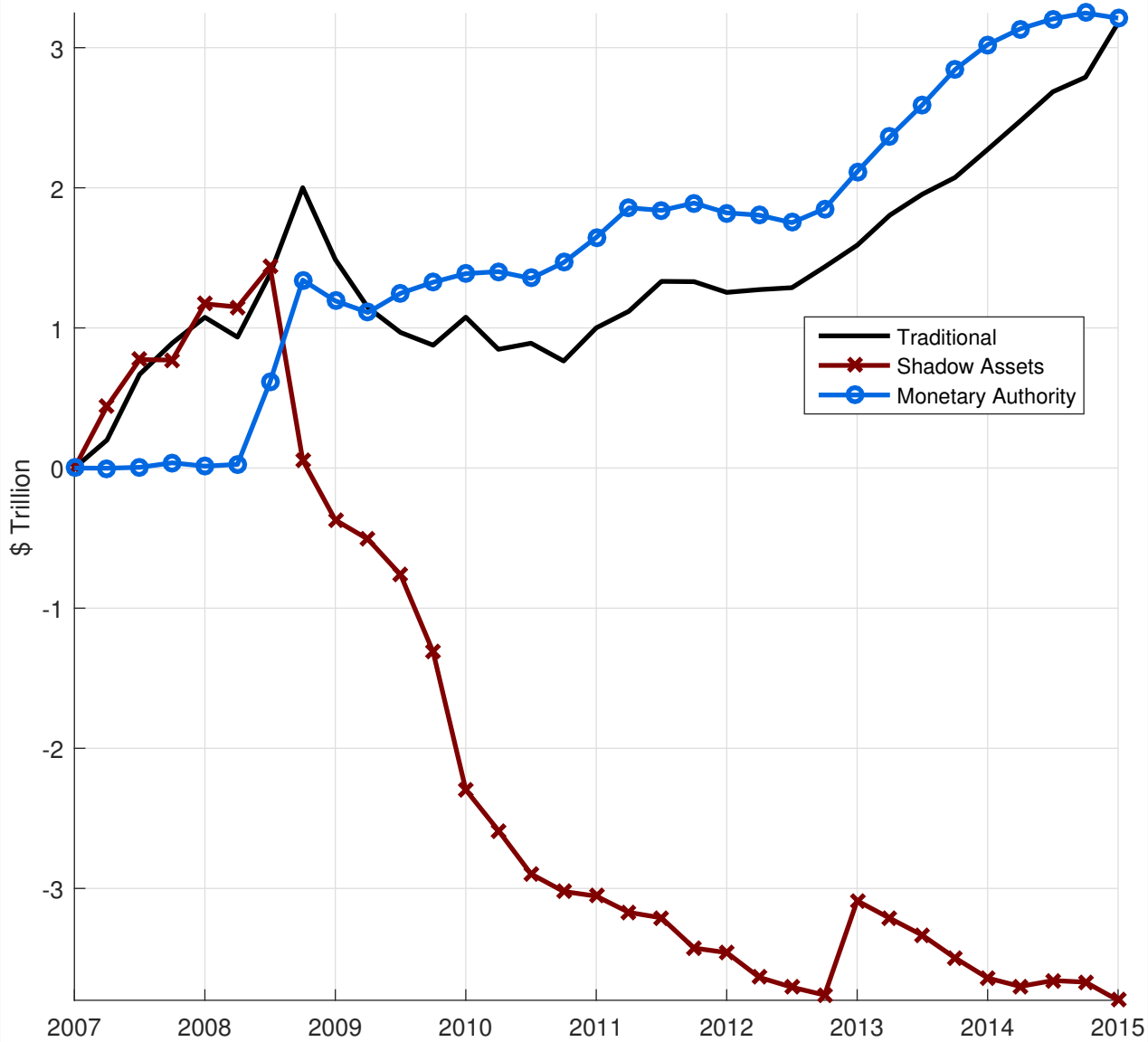


Figure 1:

Shadow Asset Absorption through Shadow Banks

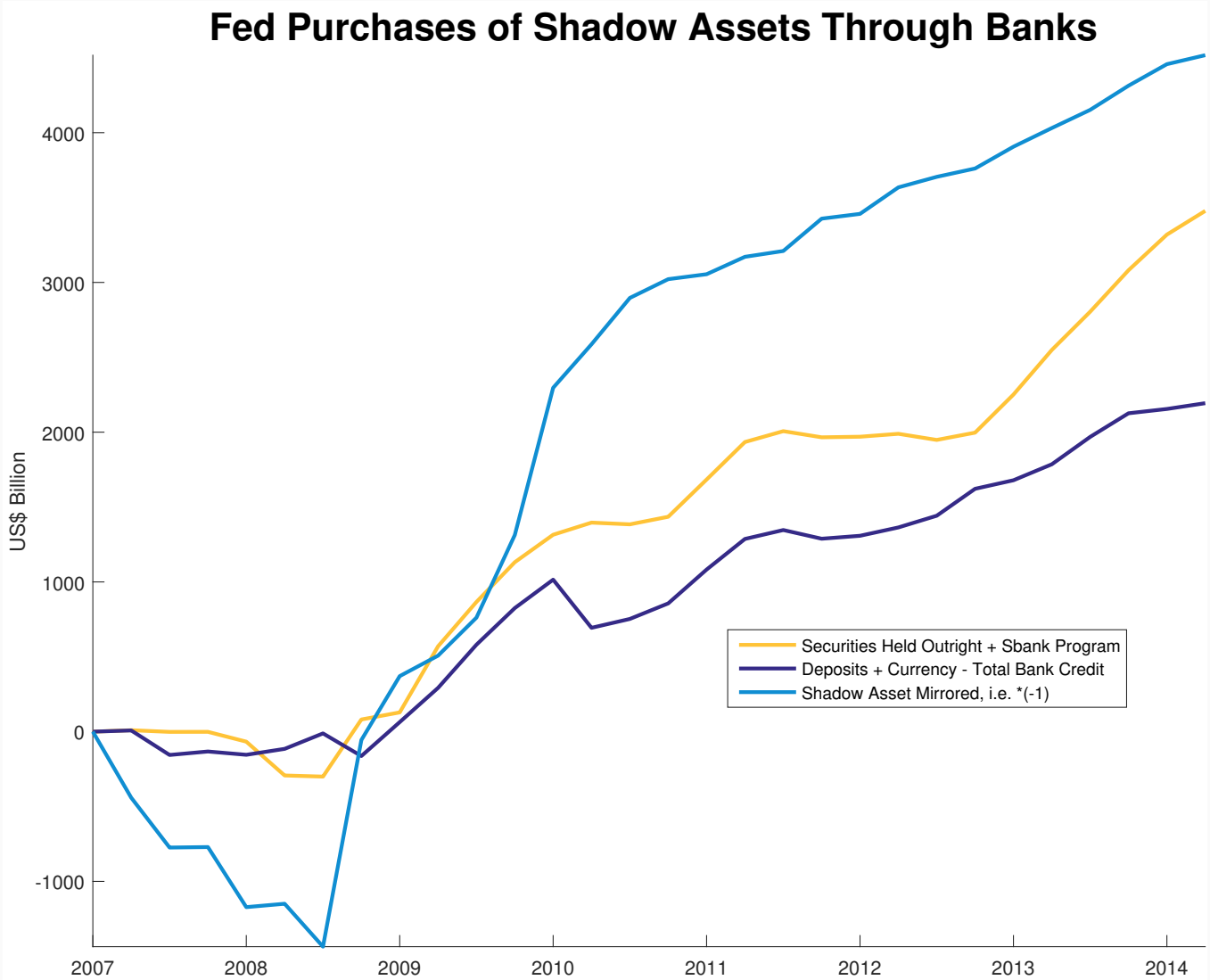


Figure 2: Assets in the Financial System

Takeaway (1)

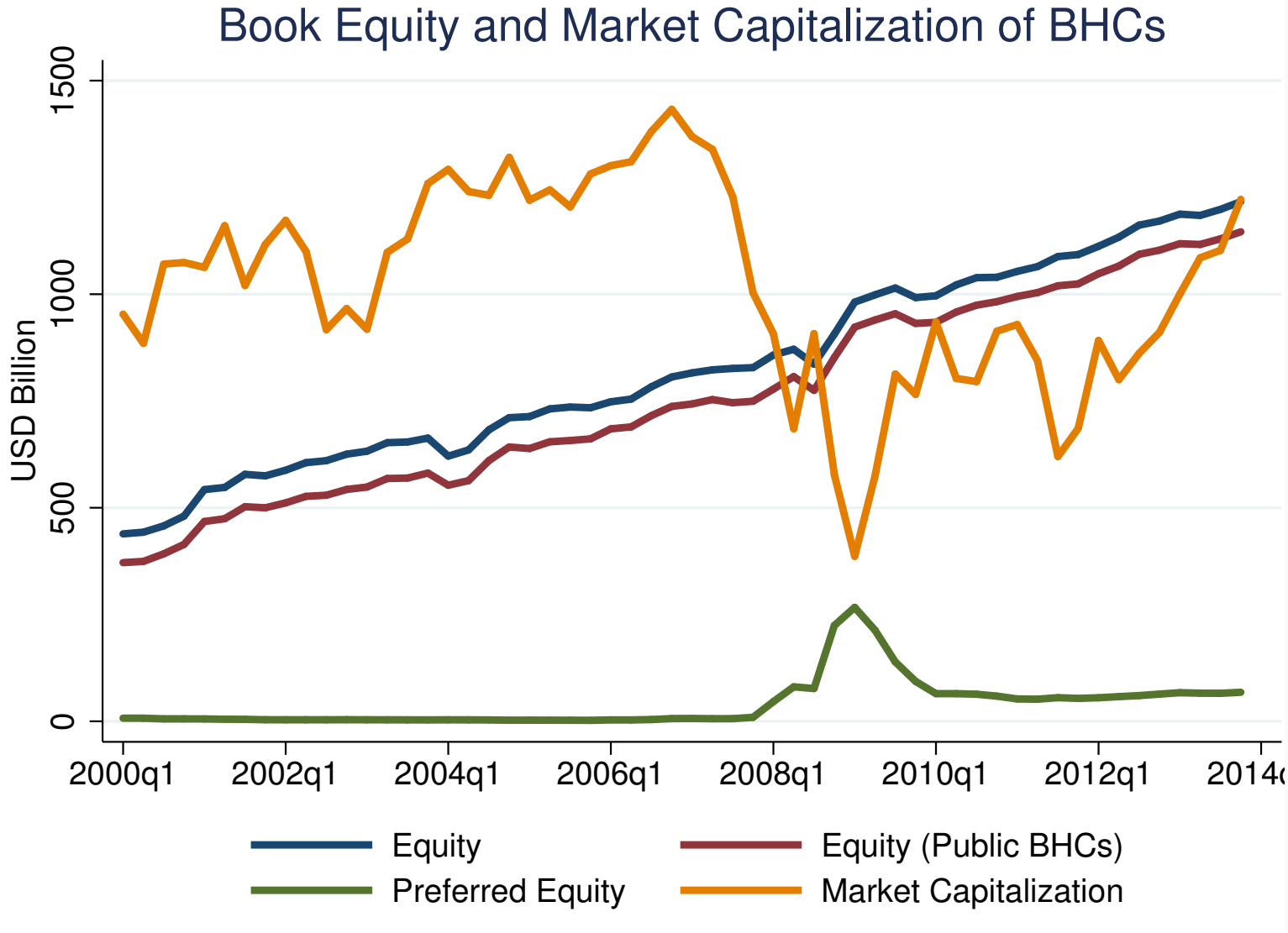
- Upper bound: FED absorbed most of shadow-asset outflow
  - increased reserves (liabilities) by \$1.7 trillion
  - increased MBS and treasuries (assets) by \$1.9 trillion
  - unobserved losses in shadows
- Traditional Banks
  - accumulated reserves (\$1.7 trillion) + increased deposits (\$2 trillion)
  - appear to have intermediated shadow asset purchase of FED
- **Lessons**
  - direct crowding-out story, unlikely
  - perhaps, indirect effects through decline in securitization and fire-sales

Part (2): Bank losses & leverage

Quantify shock to traditional banks

- Data:
  - FR Y-9C filings for BHC
    - BHC consolidates banks' position across different subdivisions
  - Exclude new entrants (e.g. GS, MS, ...)
  - Merge with CRSP data

Equity Evolution



- Flexibility to delay losses, raise equity to compensate book

Quantify shock to traditional banks

	Real Change Since 2007 Q3				
	2008 Q4	2009 Q4	2010 Q4	2011 Q4	2013 Q4
Market Cap.	-54%	-39%	-29%	-48%	-10%
Book Equity	-19%	7%	14%	19%	27%
S&P 500	-42%	-29%	-21%	-23%	10%

Predictability: (ME/E) correlated with future ROE

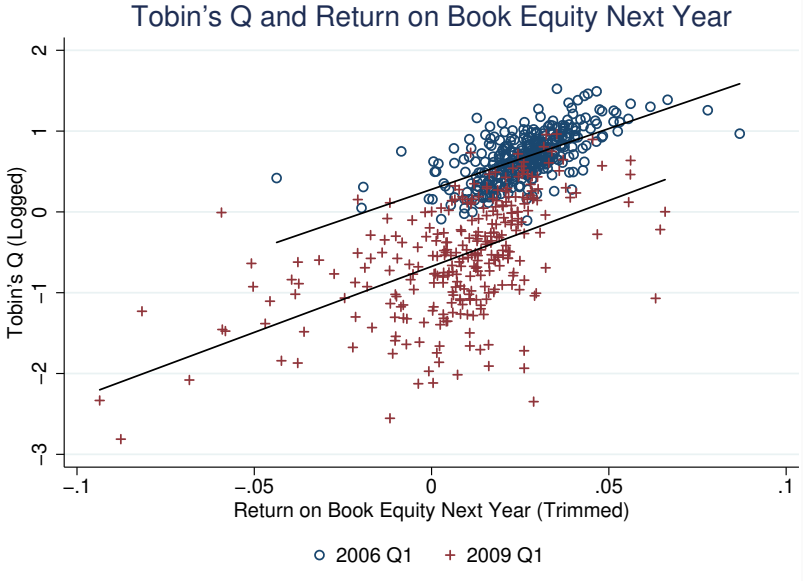


Figure 3: Logged Tobin's Q and Return on Book Equity

Takeaway (2)

- Book and market value discrepancy
- Modest book losses, offset by issuances
    - both TARP and private
- Book leverage constraints appear not strictly binding
    - avoidable by delaying to acknowledge losses

Part (3): Bank Portfolio Constraints

Possible bank constraints

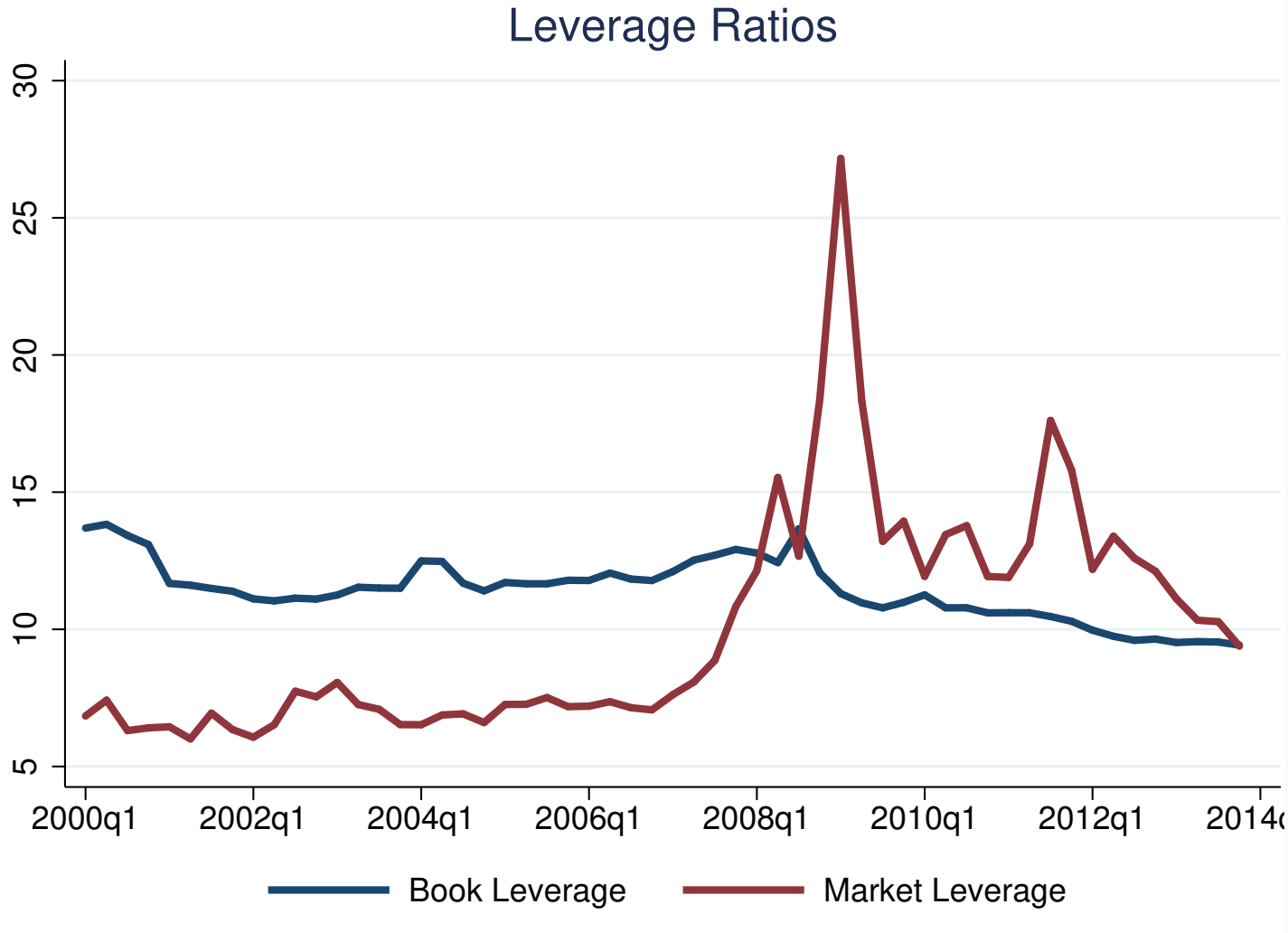
- Shocks matter only when TB face constraints

Possible bank constraints

- Shocks matter only when TB face constraints

1. Book capital requirements
2. Market-based constraints
3. Target Leverage (e.g. trade-off theory) with adjustment costs
    - Equity issuance costs + non-negative dividends
    - Sticky balance sheet (e.g. fire-sale costs, no early liquidation)

Book vs. Market Leverage



- Book leverage fell whereas market leverage rose
- Pro-cyclical (book) vs counter-cyclical (market) leverage

Adjustments to Target Leverage

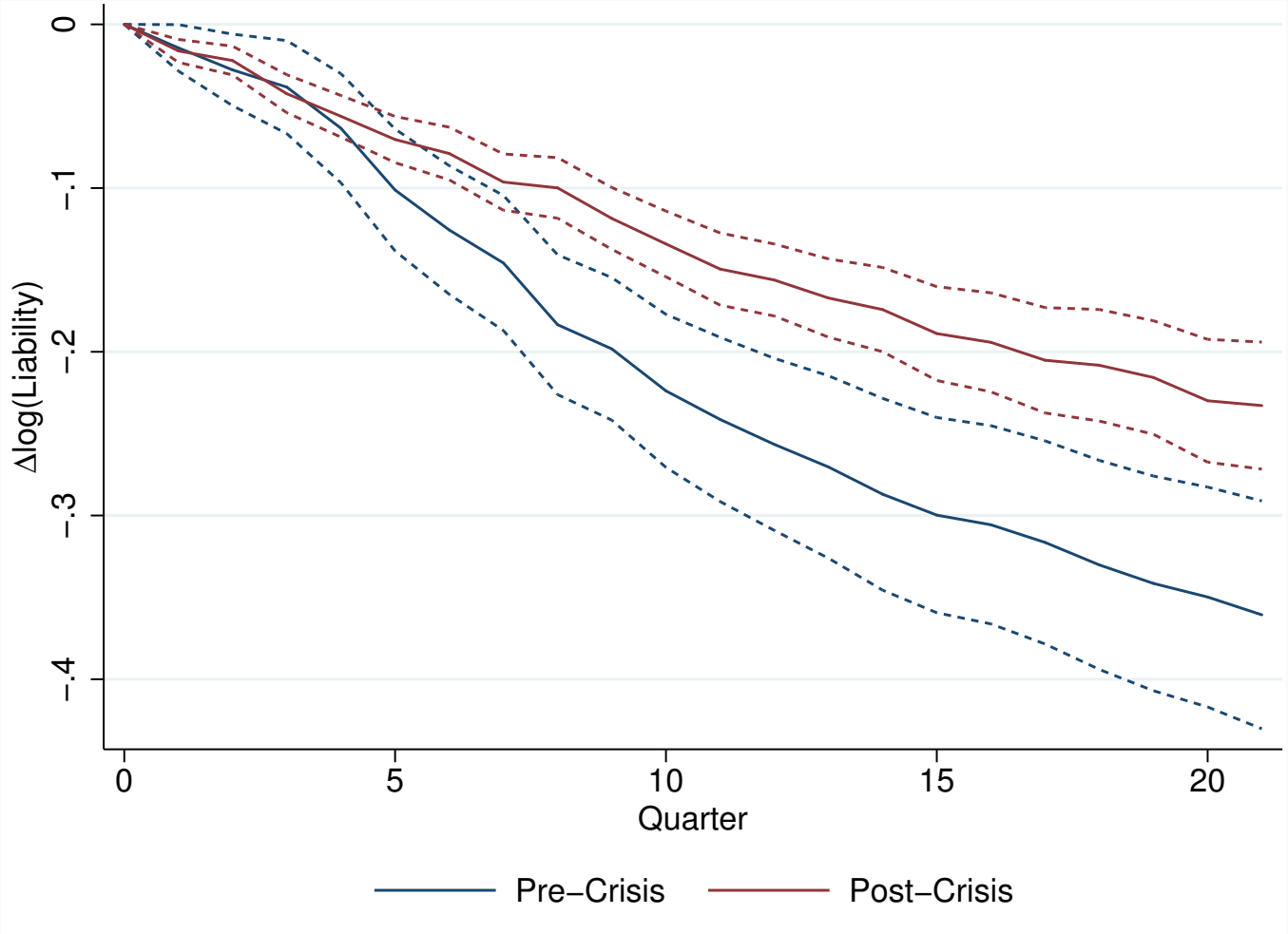
- Idea:
  - learn which constraints matter from IRF to return shocks
  - take advantage of fact that markets react faster

$$\Delta \log(y_{i,t}) = \alpha_t + \sum_{h=0}^{k} \beta_h \cdot \log(1 + r_{i,t-h}) + \gamma_h \cdot Post_t \ \log(1 + r_{i,t-h}) + \epsilon_{i,t}$$

- Time fixed effects control for aggregate shocks (e.g. demand)

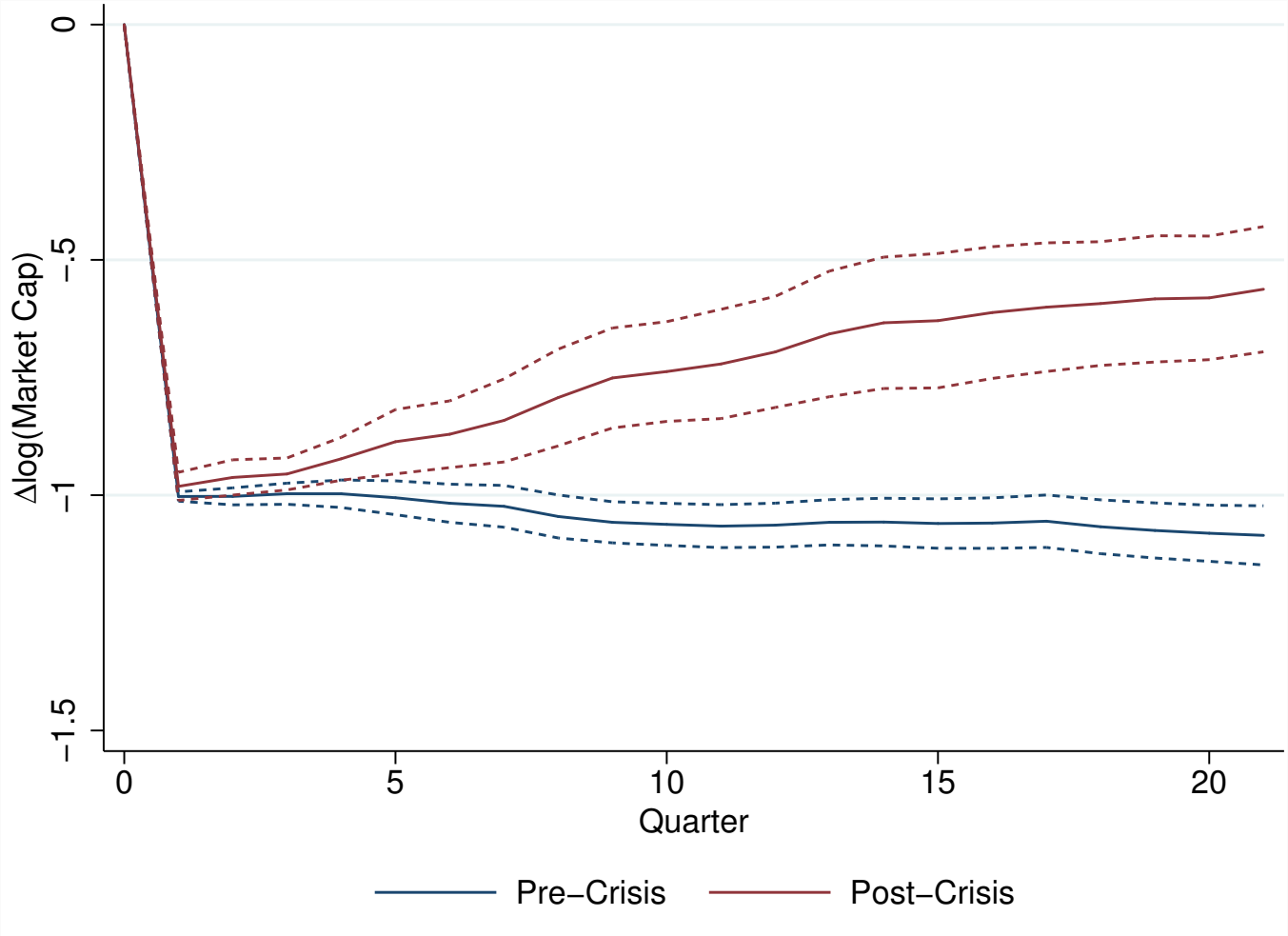
Bank liabilities and negative return shocks

- Liabilities adjusts slower post-crisis vs pre-crisis



Market Equity and Negative Return Shocks

- Market cap adjusts faster post crisi vs pre-crisis
- Large part of adjustment comes from new issuance



Banks are constrained on how they adjust leverage

1. Target leverage ratio (but not a tight constraint)
2. Pre and pre-crisis: change in how leverage was adjusted
   - 2.1 pre-crisis = asset sales
   - 2.2 post-crisis = equity issuance

Why?

- Asymmetric information?
- Post-crisis resort to costly equity
- Deleveraging became harder
  - avoid regulation
  - lack of securitization

Model

Model Overview

Game, build simplest model to fit our six facts:

1. Fed purchase of shadow assets prevents crowding out
2. Discrepancies between books and market values
3. Traditional bank equity shock$\Rightarrow$Decline in lending
4. Bank leverage target with adjustment costs
5. Regulatory and market constraints do not bind, but influence bank behavior
6. Post-crisis use retained earnings and equity issuances more intensely to target leverage

Environment I

- Partial Equilibrium
- Inside and Outside Investors of banks:
  - Inside investors: risk-averse agents, run banks
  - Outside investors: price strip of dividends
- Perfectly elastic supply of deposits at rate r^d
- Fixed loan at rate r^l
  - maturity δ
  - bank specific loans $p(l, b, l, m)$

Environment II

- Bank state: $\left\{b, l, m, \bar{b}\right\}$ with real wealth: $W = b + m - l$
- Real leverage:

$$\lambda \equiv \frac{b}{W}$$

- Market Leverage Constraint: $\lambda > \bar{\lambda}$
- Regulatory constraint

$$x' > \kappa \left(\phi \bar{b}' - x'\right)$$

Violation of either constraint leads to bank liquidation

Bank's Problem

$$V\left(b, l, m, \bar{b}\right) = \max_{\{d,i,z\}} U\left(d\right) + \beta \mathbb{E}\left[\left(1-s\right) V\left(\varepsilon b', l', m', \bar{b}'\right) + \left(s\right) V\left(\varepsilon b', l', m', \varepsilon b'\right)\right]$$

subject to:

$$\begin{aligned}
\text{(loans) } b' &= \left(1+r^b\right)\left(1-\delta\right) b + l \\
\text{(book loans) } \bar{b}' &= \left(1+r^b\right)\left(1-\delta\right) \bar{b} + l \\
\text{(deposits) } l' &= \left(1+r^d\right) l - \delta b + p\left(l, b, l, m\right) l + d - z \\
\text{(reserves) } m' &= \left(1+r^d\right) m - z \\
\text{(regulation) } x' &\leq \kappa\left(\phi \bar{b}' - x'\right)
\end{aligned}$$

and

$$V\left(\varepsilon b', l', m', \bar{b}'\right) = V^o \text{ if } \left\{\varepsilon b', l', m', \bar{b}'\right\} \in \Gamma^{liquidation}.$$

Characterization

- Value function: homothetic in W
- Relevant state is: (λ, q) where $q = \bar{b}/b$.
- Main feature:

$$V\left(b, I, m, \bar{b}\right) = \bar{V}\left(\lambda, q\right) W^{1-\gamma}$$

where

$$\bar{V}\left(\lambda, q\right) = \max_{\{c,\iota\}} U\left(c\right) + \beta \mathbb{E}\left[\bar{V}\left(\lambda'\left(\varepsilon, \lambda\right), q\right) \Omega^{1-\gamma}\left(\varepsilon, c, \iota; \lambda\right)\right]$$

subject to: (a) law of motion for leverage, (b) law of motion for books, (c) portfolio returns:

$$\Omega\left(\varepsilon, c, \iota; \lambda\right) = \left[R^{a}\left(\varepsilon\right)\lambda - R^{d}\left(\lambda - 1\right) - c + \left(\varepsilon - \bar{p}\left(\iota, \lambda\right)\right)\iota\lambda\right].$$

(f) regulatory constraint, (g) liquidation

Outside Investor

- Value of representative outside investor:

$$S\left(b, I, m, \bar{b}\right) = d + \mu \mathbb{E}\left[S\left(\varepsilon b', I', m', \bar{b}'\right)\right].$$

- Recusively:

$$s\left(\lambda, q\right) W = c\left(\lambda, q\right) W + \mu \mathbb{E}\left[s\left(\lambda', q'\right) \Omega\left(\varepsilon', \lambda, q\right)\right] W.$$

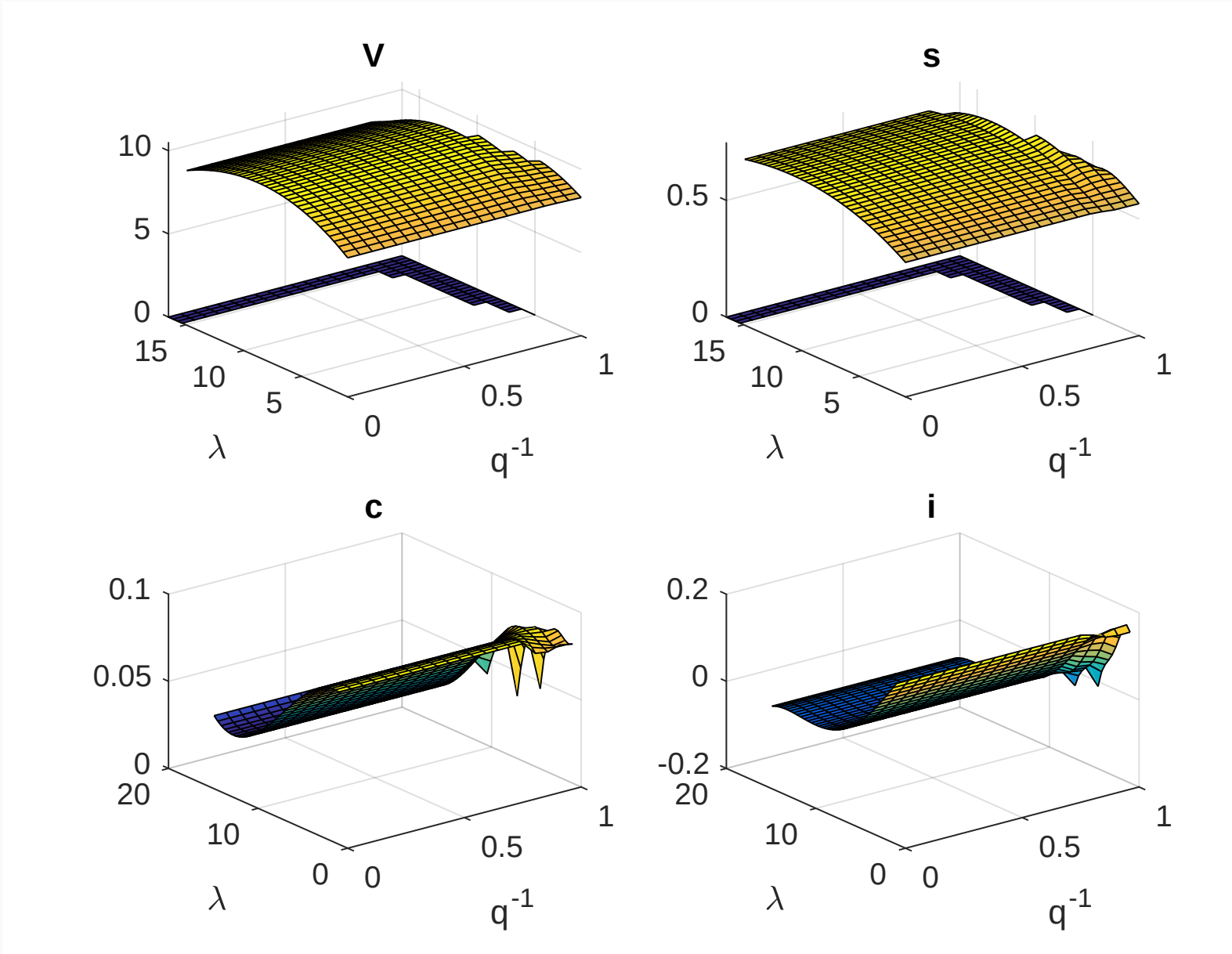
- Expected Return:

$$\bar{R} = \frac{c\left(\lambda, q\right) + \mathbb{E}\left[s\left(\lambda', q'\right) \Omega\left(\varepsilon', \lambda, q\right)\right]}{s\left(\lambda, q\right)}.$$

- Return shocks:

$$\Delta R\left(\varepsilon'\right) = R\left(\varepsilon'\right) - \bar{R} = \frac{s\left(\lambda', q'\right)}{s\left(\lambda, q\right)} \Omega\left(\varepsilon', \lambda, q\right) - \mathbb{E}\left[\frac{s\left(\lambda', q'\right)}{s\left(\lambda, q\right)} \Omega\left(\varepsilon', \lambda, q\right)\right].$$

Solution


V
10
5
0
15
10
5
λ
0
0.5
1
q^-1
s
0.5
0
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10
5
λ
0
0.5
1
q^-1
c
0.1
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0
20
10
0
λ
0
0.5
1
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20
10
0
λ
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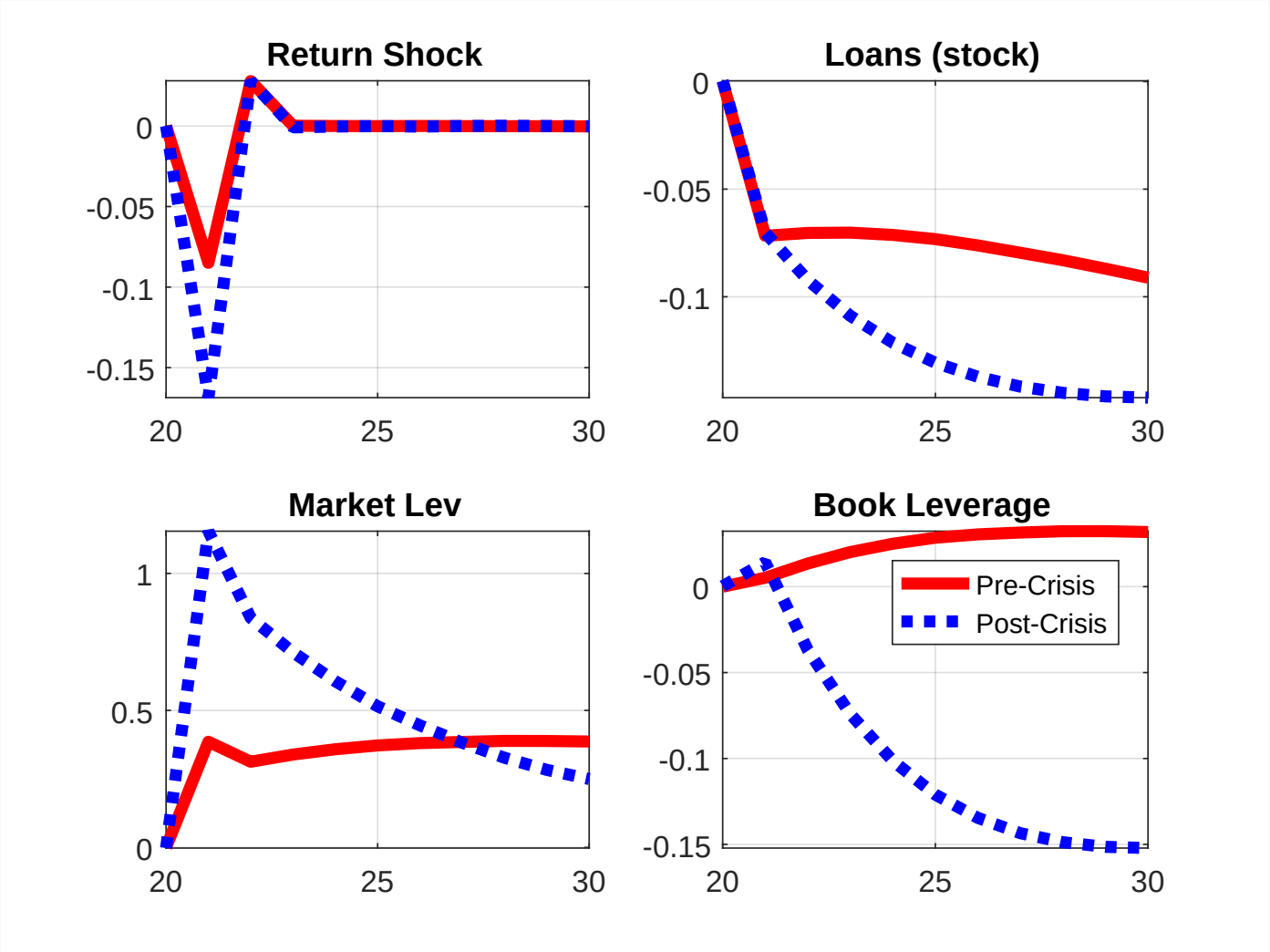
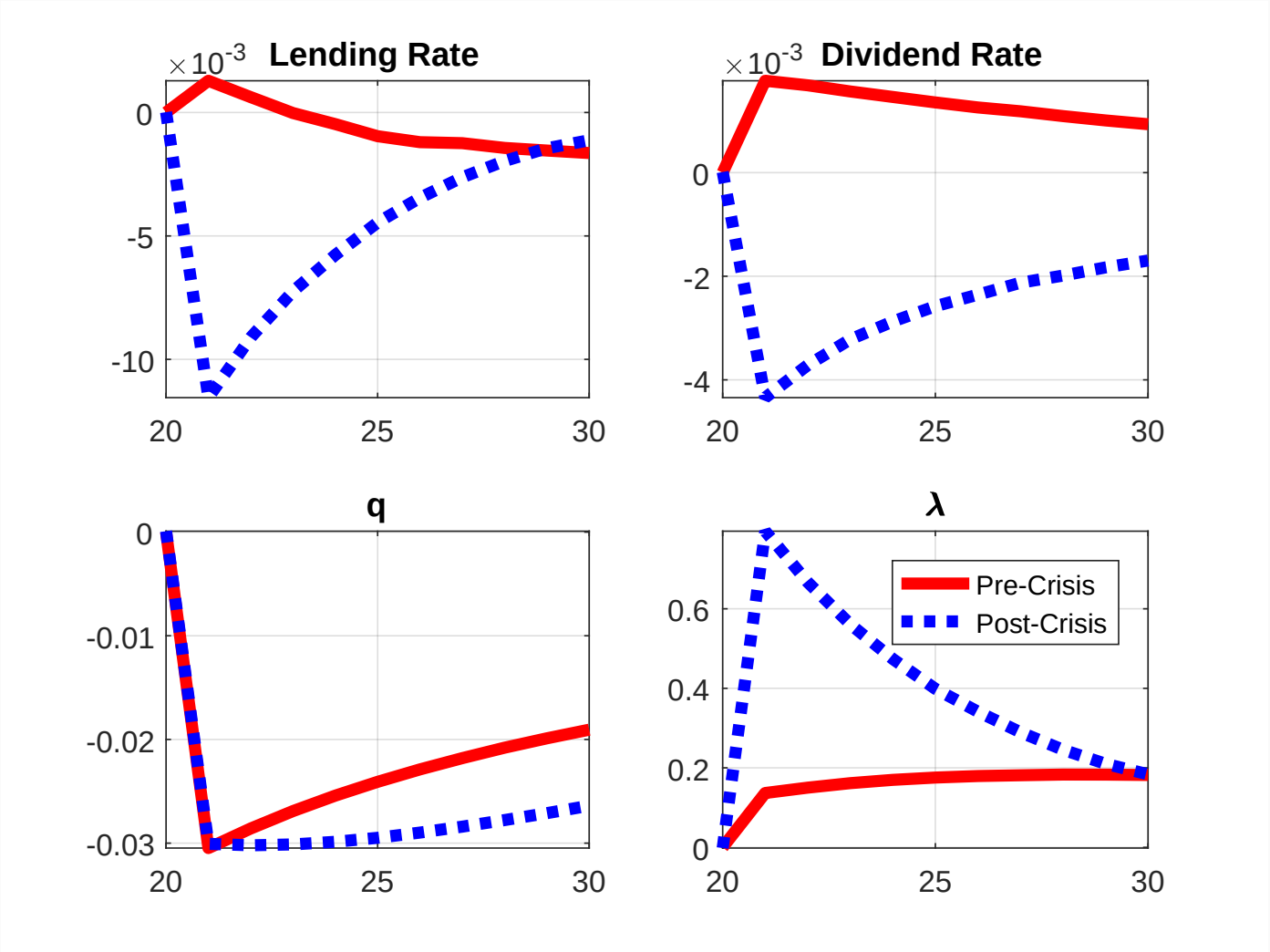
0.5
1
q^-1

Model Impulse Response I



Model Impulse Response II



Meets the facts?

- Facts 1 and 3
  - Even without crowding out from shadow outflows, traditional bank equity shock leads to a credit crunch
- Fact 2
  - Discrepancies between books and market values built into the model
  - Book vs. market have different impulse responses
  - Value function for market value captures info on λ and q

Meets the facts?

- Fact 4
  - Bank does have a target leverage
  - Impulse response shows slow response due to adjustment costs
- Fact 5
  - Regulatory and market constraints do not bind for most banks, but influence bank behavior
- Fact 6
  - Post-crisis impulse response use equity more to readjust leverage

Additional Lessons from the Model

- Amplification
  - Adjustment costs make losses even larger, worsening the crunch
- Contagion
  - In GE, we'd imagine that fire sales by one bank make the sale price worse for others
  - $\Rightarrow$Adjustment costs get worse
- Persistence
  - Adjustment costs slow down the return to target leverage
  - Prolongs credit crunch

Summary of findings

1. **Magnitudes**
   - Shadow industry flows:
   - \$3.8 trillion outflow vs. \$2.6 trillion inflow to traditional banks
     - traditional banks: purchase with deposits
     - Fed bought inflow with reserves
   - How big were direct losses of banks?
     - 7.5% book equity $\rightarrow$ \$160 billion losses but entirely recap
     - Market value losses $\rightarrow$ \$710 billion

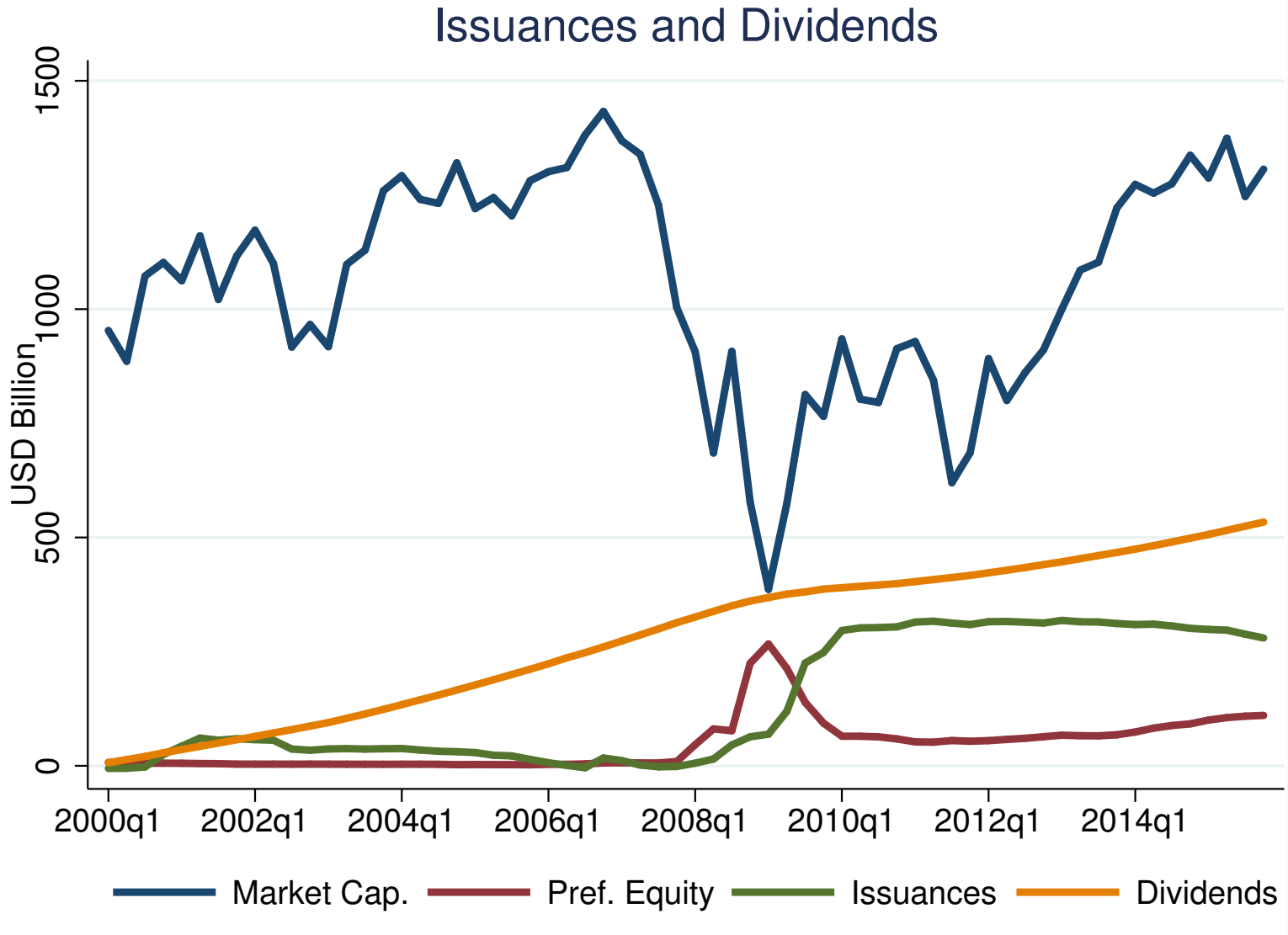
2. **Why do these flows matter?**
   - Possible frictions:
     - Book-equity constraints (NO - at least not in the short run)
     - Market-based constraints (unlikely)
     - Target leverage (YES)
     - Adjustment costs/ constraints needed (Equity and Assets)

Back-up slides

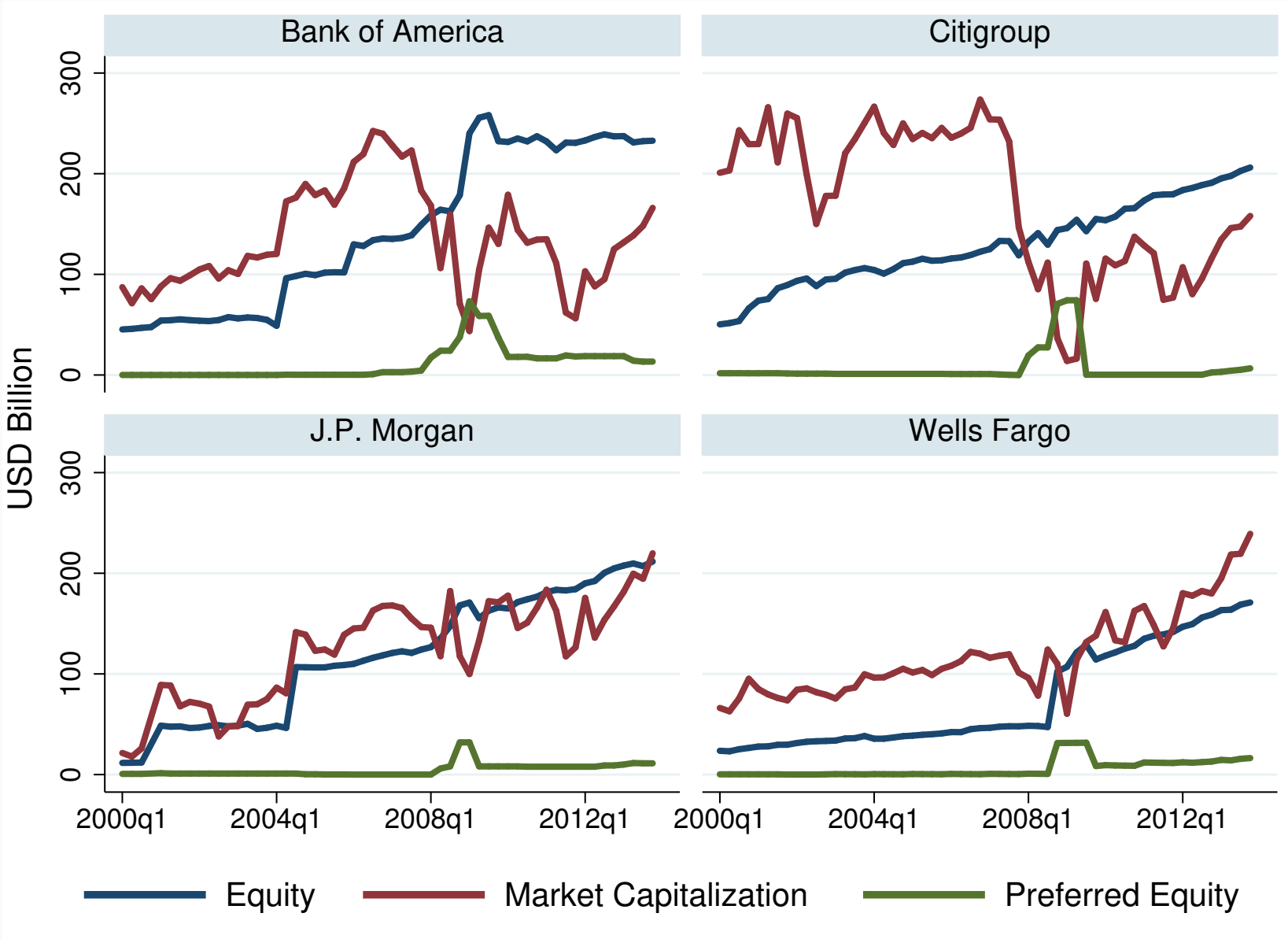
Quantify upper bound of asset flow to traditional banks

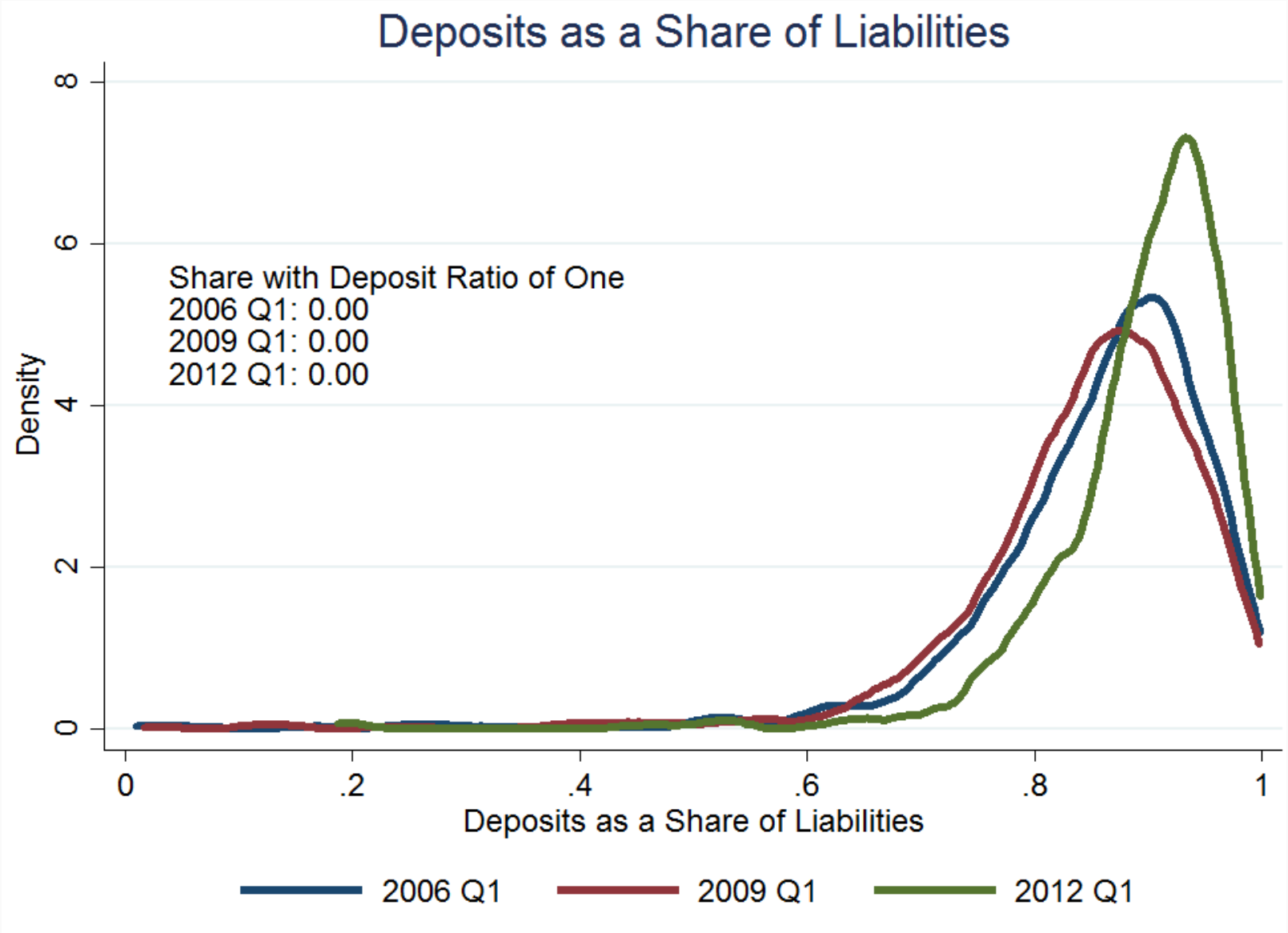
$ Inflow Billion		$ Outflow Billion	
TB	$3,177	SBA	$5,049
- MS & GS	$2,970	- MS & GS	$3,855
		Losses	−$57
Inflow	$2,970	Outflow	$3,798

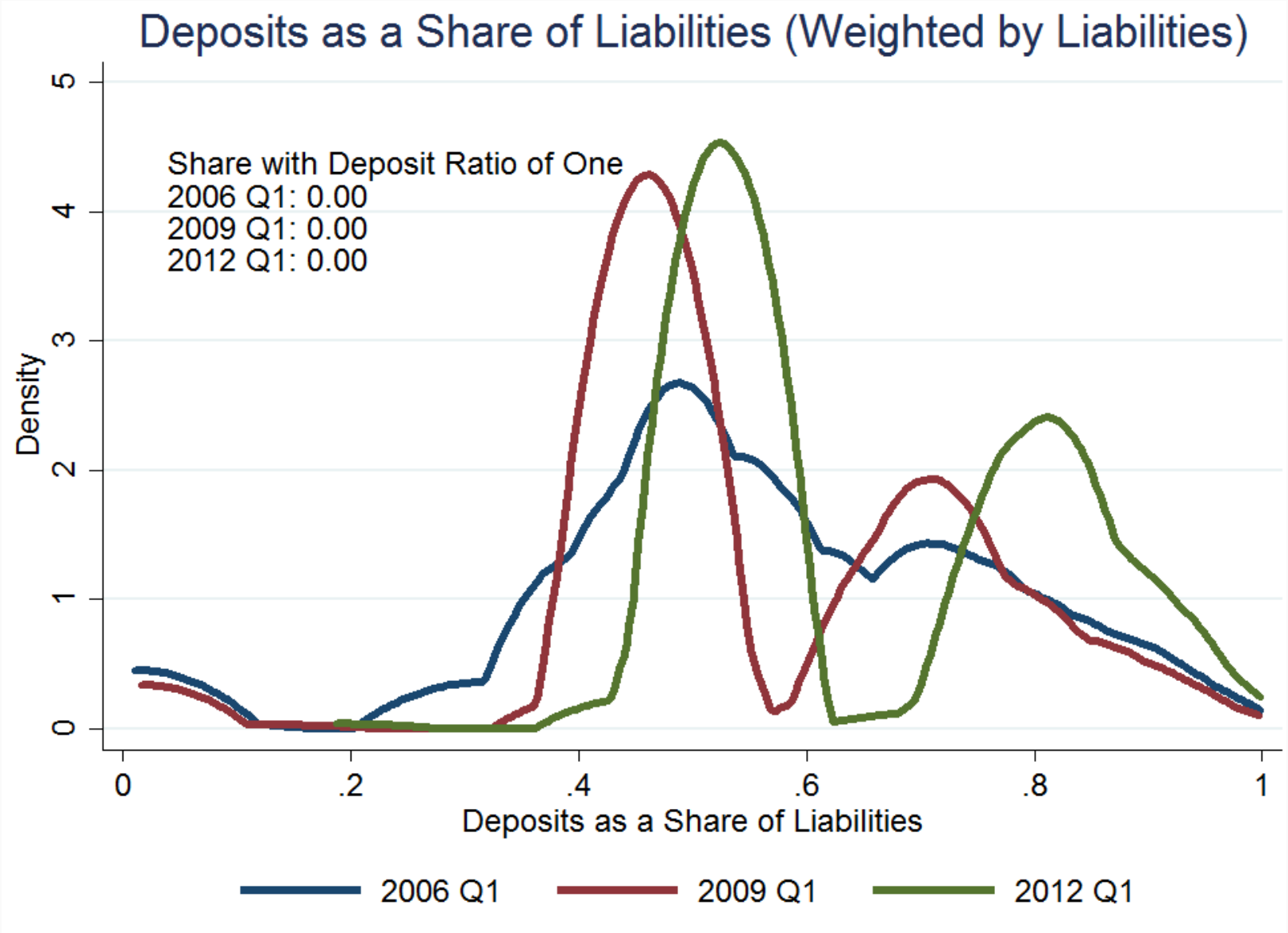
Issuances and Dividends

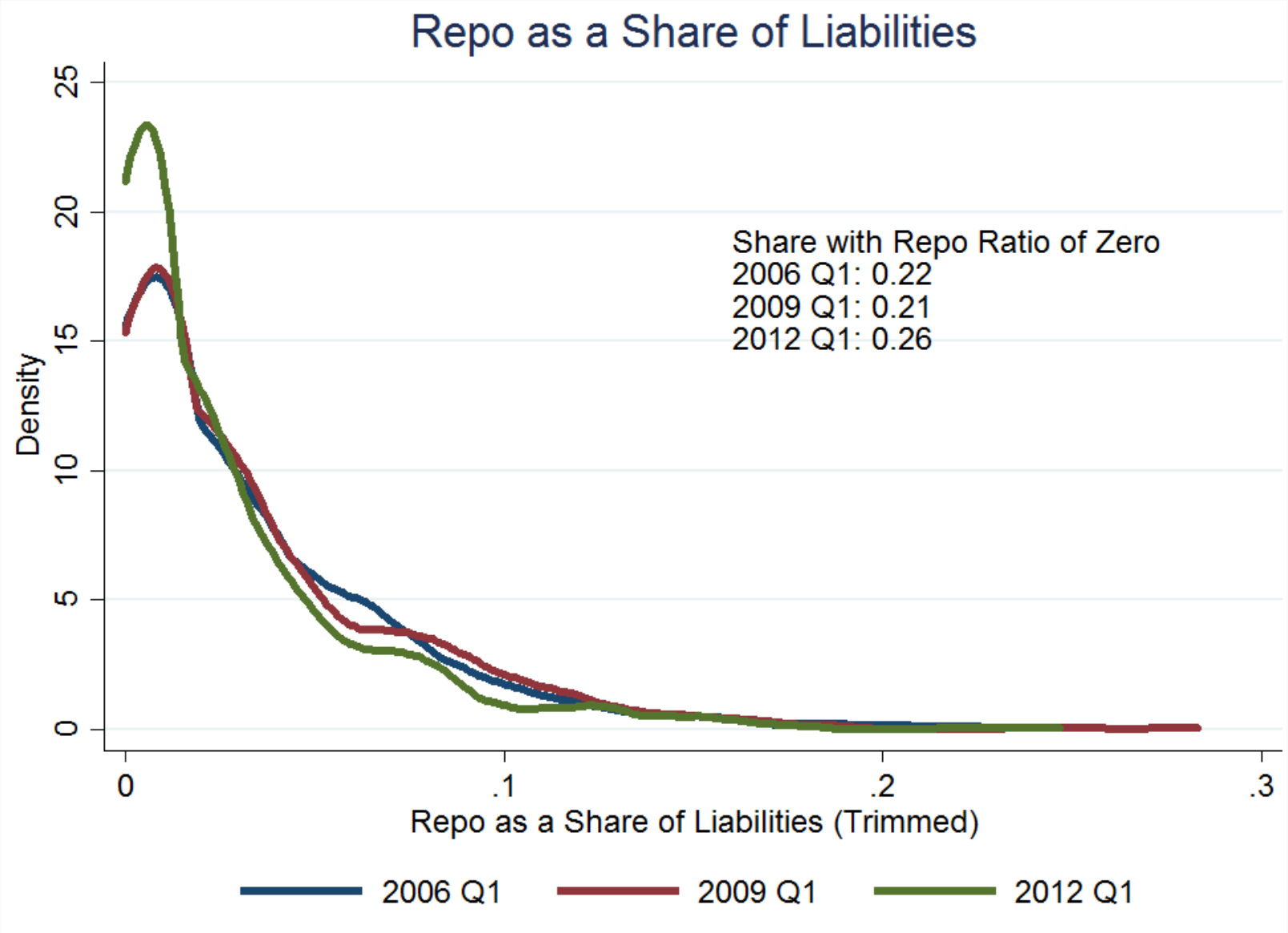


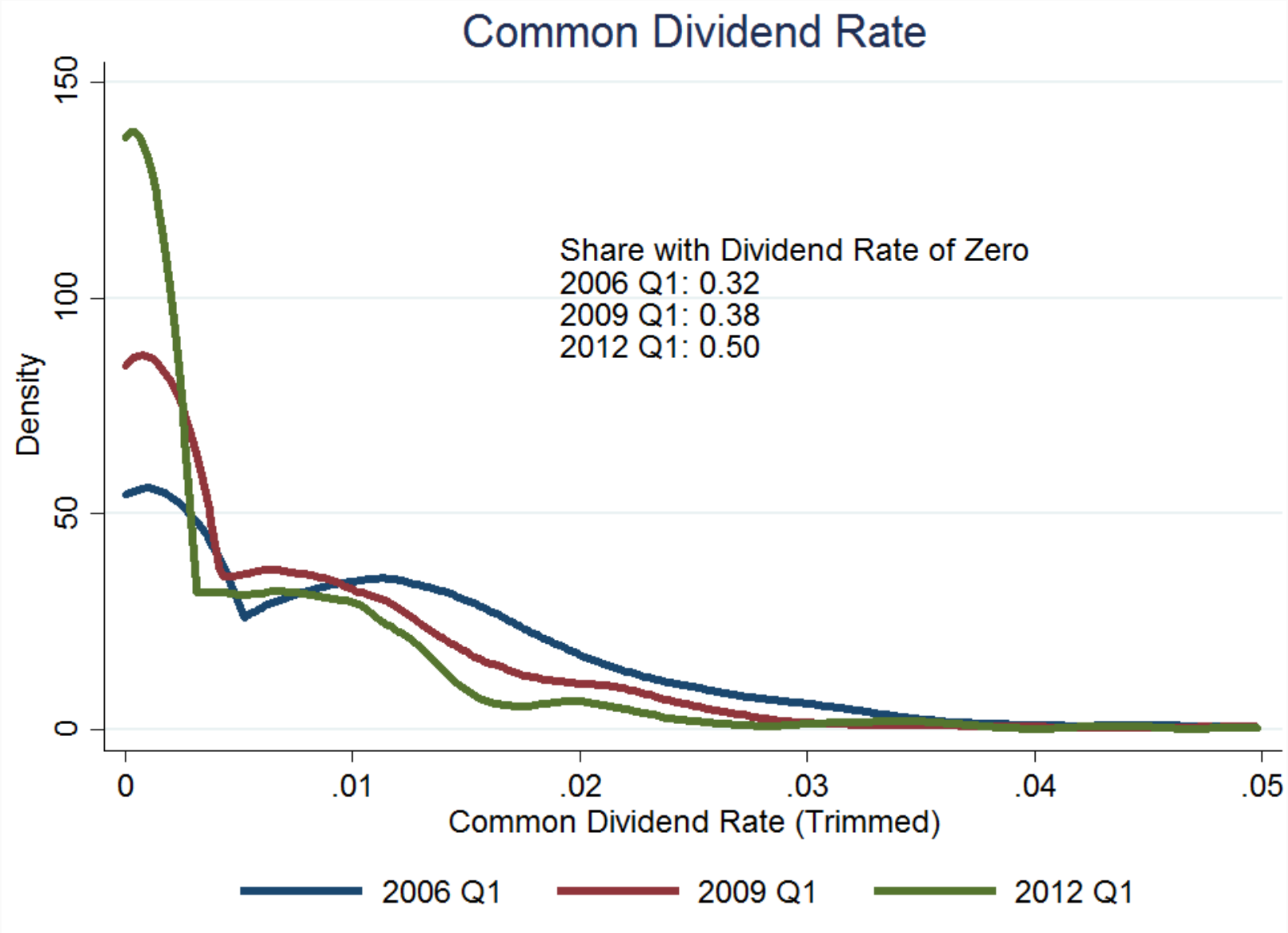
Book equity & market cap. of Top 4




Deposits as a Share of Liabilities
Share with Deposit Ratio of One
2006 Q1: 0.00
2009 Q1: 0.00
2012 Q1: 0.00
Density
0
2
4
6
8
0
.2
.4
.6
.8
1
Deposits as a Share of Liabilities
2006 Q1
2009 Q1
2012 Q1


Deposits as a Share of Liabilities (Weighted by Liabilities)
Share with Deposit Ratio of One
2006 Q1: 0.00
2009 Q1: 0.00
2012 Q1: 0.00
Density
0
1
2
3
4
5
0
.2
.4
.6
.8
1
Deposits as a Share of Liabilities
2006 Q1
2009 Q1
2012 Q1


Repo as a Share of Liabilities
Share with Repo Ratio of Zero
2006 Q1: 0.22
2009 Q1: 0.21
2012 Q1: 0.26
Density
0
5
10
15
20
25
0
.1
.2
.3
Repo as a Share of Liabilities (Trimmed)
2006 Q1
2009 Q1
2012 Q1


Common Dividend Rate
Share with Dividend Rate of Zero
2006 Q1: 0.32
2009 Q1: 0.38
2012 Q1: 0.50
Density
0
50
100
150
0
.01
.02
.03
.04
.05
Common Dividend Rate (Trimmed)
2006 Q1
2009 Q1
2012 Q1

Additional Findings on Frictions

- Equity frictions
  - External finance - used more frequently
  - Internal finance - many banks had zero dividends
- Balance-sheet frictions
  - Probably not illiquid liabilities (banks had plenty of liquid liabilities like REPO)
  - Could be illiquid assets