The Welfare Effects of Bank Liquidity and Capital Requirements

Skander Van den Heuvel*
Federal Reserve Board

FDIC/JFSR Bank Research Conference
September, 2018

* The views expressed here do not necessarily represent the views of the Federal Reserve Board or its staff.
Introduction

Financial crisis spurred crucial regulatory reforms, including Basel III.

- Stronger capital requirements
- New liquidity requirements

Goal: Make banks and the financial system safer, limiting negative externalities from bank failures.

Is it enough? Too much? There is an ongoing debate. E.g.

- Some favor much higher capital requirements (e.g. Admati and Hellwig)
- Others have argued for versions of “narrow banking” (e.g. Cochrane, Friedman)
  - Similar to a 100% liquidity requirement
Introduction

Debate in large part reflects disagreement about the existence and magnitude of social costs of capital and liquidity requirements.

Possible cost – reduced (net) liquidity creation.

Key idea: High-quality liquid assets are in limited supply and have important alternative uses.

Introduction

This paper –

- Examines the welfare costs and benefits of:
  - bank liquidity requirements and
  - bank capital requirements
- Quantifies their welfare costs through a sufficient statistics approach.

Quantitative general equilibrium analysis
- Extends previous work on capital requirements
  (Van den Heuvel, 2008)
1. Basic Model
Households
Fin. wealth = \( d + e + b \)

Banks

Firms

Non-bank Finance

Government

Bonds

Deposits

Bank equity
Households

Fin. wealth = $d + e + b$

Banks

Loans $L$
Equity $E$
Gov. Bonds $B$
Deposits $D$

Firms

Government

Households流向Banks的存款（Deposits）和银行股本（Bank equity）。

Banks流向Firms的贷款（Loans）。

Bonds由Government提供给Banks。
Households
Fin. wealth = d + e + b

Banks
Loans L
Gov. Bonds B
Equity E
Deposits D

Firms
Physical Capital K
Equity $E^f$
Loans L

Non-bank finance

Government
Households
Fin. wealth = \(d + e + b\)

Firms
Physical Equity \(E^f\)
Capital \(K\) Loans \(L\)

Banks
Loans \(L\)
Gov. Bonds \(B\)
Equity \(E\)
Deposits \(D\)

Government
Tot. debt = \(b + B\)
Households
Fin. wealth = d + e + b

Banks
Loans L
Equity E
Gov. Bonds B
Deposits D

Firms
Physical Equity \( E^F \)
Capital \( K \)
Loans L

Government
Tot. debt = b + B

Non-bank finance

Deposits
Bank equity

Loans
Bonds

Bonds
Households

Households value liquidity:

\[ u(c,d,b) \]

- Derived utility function; Feenstra (1985).
- Increasing and concave
- Flexibility will let the data speak
Households

Infinite horizon, no aggregate uncertainty → Perfect foresight problem.

\[
\max_{\{c_t,d_t,e_t,b_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t u(c_t,d_t,b_t)
\]

s.t. \[d_{t+1} + b_{t+1} + e_{t+1} + c_t = w_t 1 + R^D_t d_t + R^B_t b_t + R^E_t e_t - T_t\]

\[(c)\quad R^E_t = (\beta u_c(c_t,d_t,b_t)/u_c(c_{t-1},d_{t-1},b_{t-1}))^{-1}\]

\[(d)\quad R^E_t - R^D_t = \frac{u_d(c_t,d_t,b_t)}{u_c(c_t,d_t,b_t)}: \text{convenience yield on deposits}\]

\[(b)\quad R^E_t - R^B_t = \frac{u_b(c_t,d_t,b_t)}{u_c(c_t,d_t,b_t)}: \text{convenience yield on Treasuries}\]
### Banks

<table>
<thead>
<tr>
<th>$L_t$</th>
<th>Loans</th>
<th>$D_t$</th>
<th>Deposits</th>
</tr>
</thead>
<tbody>
<tr>
<td>$B_t$</td>
<td>Bonds</td>
<td>$E_t$</td>
<td>Equity</td>
</tr>
</tbody>
</table>

**Liquidity Requirement:**

$$B_t \geq \lambda D_t$$

**Capital Requirement:**

$$E_t \geq \gamma L_t \quad \text{(risk-based)}$$

Bank maximizes shareholder value.

- Competitive banking: $R^L, R^B, R^D, R^E$ given
Banks: Moral Hazard and Benefits of Regulation

Additional assumptions to generate benefits of regulation:

Deposit Insurance / government guarantees

→ Moral hazard of excessive risk taking. Two risk choices:

1. Credit risk: excessively risky lending practices

2. Liquidity risk: insufficient liquid assets
Banks: Moral Hazard and Benefits of Regulation

Deposit Insurance / government guarantees

→ Moral hazard of excessive risk taking. Two risk choices:

1. **Credit risk**: excessively risky lending practices
   
   *Capital requirement* solves this, together with bank supervision, through “skin-in-the-game”.

   \[
   \gamma \geq \phi \bar{\sigma} / R^E
   \]  
   (IC1)

   - \( \bar{\sigma} \): ability of banks to hide excessively risky loans from supervision
   - Liquidity regulation does not ameliorate this problem.
     - Bank size is not fixed so increase in \( B \) does not imply a decrease in \( L \).
Banks: Moral Hazard and Benefits of Regulation

Deposit Insurance / government guarantees

→ Moral hazard of excessive risk taking. Two risk choices:

2. **Liquidity risk**: insufficient liquid assets

   - Small probability $(1 - p)$ of liquidity stress: Fraction $w$ of depositors withdraws early.
   - Liquidity stress results in bank failure if $B < wD$.
     - Bank goes into resolution with social costs that may exceed the private loss
Banks: Moral Hazard and Benefits of Regulation

Bank will choose a prudent liquidity risk profile \( B \geq wD \) if

\[
\gamma \left( \frac{1-p}{p} \right) \geq (1-\gamma) \left( \frac{w}{1-w} - \frac{\lambda}{1-\lambda} \right) (R^D - R^B)
\]

(1C2)

A sufficient condition is: \( \lambda \geq w \).

Liquidity requirement and capital requirement can each mitigate the moral hazard of liquidity risk, but the liquidity requirement is more direct and efficient.

→ Division of Labor:

- Capital regulation for solvency risk
- Liquidity regulation for liquidity risk.
Banks: Illustration of welfare implications

The Welfare Effects of Bank Liquidity and Capital Requirements
Banks: Illustration of welfare implications

The Welfare Effects of Bank Liquidity and Capital Requirements
Summary of Bank’s Problem (no excessive risk)

<table>
<thead>
<tr>
<th>$L_t$</th>
<th>Loans</th>
<th>$D_t$</th>
<th>Deposits</th>
</tr>
</thead>
<tbody>
<tr>
<td>$B_t \geq \lambda D_t$</td>
<td>Bonds</td>
<td>$E_t \geq \gamma L_t$</td>
<td>Equity</td>
</tr>
</tbody>
</table>

All-in cost of funding loans with deposits:

$$\tilde{R}^D(\lambda) \equiv R^D + \frac{\lambda}{1-\lambda}(R^D - R^B)$$

With (IC1) and (IC2), solution’s zero-profit condition:

$$R^L = \gamma R^E + (1-\gamma)\tilde{R}^D(\lambda)$$

A finite solution requires: $R^B \leq R^D \leq R^L \leq R^E$.

1. Liquidity requirements binds if and only if $R^B < R^D$ *(will be relaxed)*

2. Capital requirement binds if and only if $R^E > \tilde{R}^D(\lambda)$
Equilibrium with capital and liquidity regulation

- **Investment** is affected by *both* the liquidity requirement and the capital requirement, if binding. \( R^L = \gamma R^E + (1 - \gamma) \tilde{R}^D (\lambda) \).

- With binding liquidity regulation, **government bonds** flow out of the nonbank sector, so their convenience yield \( R^E - R^B \) rises.

Adding a *larger* liquidity requirement →

- Can lead to **disintermediation** or **non-bank intermediation**: *Shadow banking*?
  - More likely if the demand for safe, liquid assets is high relative to the supply.
2. Gross Welfare Cost of the Policy Tools
Welfare Cost of the *Liquidity* Requirement

*If the economy is in steady state in the current period and IC1 and IC2 hold, then the marginal welfare cost of a permanent increase in $\lambda$ is:*

$$v_{LIQ} = \frac{d}{c} \left( R^D - R^B \right) (1 - \lambda)^{-1}$$

- As a first-order approximation, the welfare loss from $\Delta \lambda$ is equivalent to a permanent relative loss in consumption of $v_{LIQ}\Delta \lambda$.
- Takes into account gains and losses associated with move to a new steady state.
- Revealed preference logic + competitive banking.
Welfare Cost of the Capital Requirement

Under the same assumptions, the marginal welfare cost of a permanent increase in $\gamma$ is:

$$v_{CAP} = \frac{L}{c} \left( R^E - \tilde{R}^D (\lambda) \right)$$

Recall

$$\tilde{R}^D (\lambda) \equiv R^D + \frac{\lambda}{1 - \lambda} (R^D - R^B)$$
3. Costly Financial Intermediation

So far we have assumed that no resource costs are involved with financial intermediation.

- For 86-13, net noninterest costs are 1.3% of total assets.

Before measuring costs, extend model:

\[
\text{Bank pays noninterest cost: } g(D, L)
\]

\(g\) is increasing, convex, constant returns to scale.

\[
\text{Dividends} = \max(0, (R_t^L + \sigma_t \varepsilon)L_t + R_t^B B_t - R_t^D D_t - g(D_t, L_t))
\]

The Welfare Effects of Bank Liquidity and Capital Requirements
Gross Welfare Costs with Costly Intermediation

Marginal welfare costs of increasing $\lambda$ and $\gamma$ with costly financial intermediation:

\[ \nu_{LIQ} = \frac{d}{c} \left( R^D + g_D(d, L) - R^B \right) (1 - \lambda)^{-1} \]

\[ \nu_{CAP} = \frac{L}{c} \left( R^E - \tilde{R}^D(\lambda) - (1 - \lambda)^{-1} g_D(d, L) \right) \]


- From 1986-2000, Treasuries/Assets exceed 1 percent → Use this period to estimate $g_D$ through the condition: $R^B = R^D + g_D \rightarrow g_D = 1.22\%$

- Alternative estimate based Hanson, Schleifer, Stein, Vishny (2015): $g_D = 0.81\%$

- Use 2001-2007 to estimate average returns and ratios.
  - Treasuries < 1% of assets
  - Provides an estimate of the cost of a liquidity requirement for a period when it would likely have been binding.
  - Current environment: high level of reserves could reflect phase-in of LCR, or could mean that a modest liquidity requirement entails little immediate economic costs.
U.S. Treasuries and excess reserves held by U.S. depository institutions

Measurement of the Welfare Cost: Liquidity

\[ d = \text{Total Deposits} \quad d/c = 0.67 \]
\[ c = \text{Personal Consumption Expenditures} \]
\[ R^D = \frac{\text{(Interest on Total Deposits)}}{\text{(Total Deposits)}} = 2.04\% \]
Including marginal noninterest cost: \[ R^D + g_D = 3.26\% \]
\[ R^B = \text{3-month Treasury yield} \quad = 2.80\% \]
\[ \lambda = \text{liquidity requirement} \quad = 0 \]

\[
\nu_{LIQ} = \frac{d}{c} \left( R^D + g_D - R^B \right) (1 - \lambda)^{-1} \\
= 0.67 \times (0.0326 - 0.0280) \times 1 = 0.0031
\]
Measurement of the Welfare Cost: Liquidity

Interpretation of $\nu_{LIQ} = 0.003$.

- The gross welfare cost of imposing a 10 percent liquidity requirement is equivalent to a **permanent loss in consumption of** $\nu_{LIQ} \times 0.1 \times 100\% = 0.031\%$.

- About $3.5$ billion per year.

- With HSSV-based estimate ($g_D = 0.81\%$): welfare cost = **0.003\%**.
Measurement of the Welfare Cost: Capital

A risk-adjusted measure of the required return on equity is needed.

I use the required return on subordinated bank debt.

- Sub-debt counts towards regulatory capital, within certain limits.
- Defaults on bank sub-debt have been rare.

Limits:
- Part of tier 2 capital
- Until recently, limited to at most 50% of tier 1 capital.
- Same tax treatment as deposits

The required return on sub-debt may be less than the risk-adjusted pre-tax required return on regular bank equity.

→ conservative measure.
Measurement of the Welfare Cost: Capital

Sample: 1993-2010

\[ L = \text{Total Assets} - (\text{Treasuries} + \text{Ex. Reserves}) \quad L/c = 0.96 \]

\[ c = \text{Personal Consumption Expenditures} \]

\[ R^E = (\text{Interest on Subordinated debt}) / (\text{Sub-debt}) \quad = 5.45\% \]

\[ R^D = (\text{Interest on Total Deposits}) / (\text{Total Deposits}) \quad = 2.43\% \]

Including marginal noninterest cost: \[ R^D + g_D = 3.65\% \]

\[ \nu_{CAP} = \frac{L}{c} \left( R^E - (R^D + g_D) \right) \left( 1 - \lambda \right)^{-1} \]

\[ = 0.96 \times 0.0180 \times (1 - 0)^{-1} = 0.017 \]
Measurement of the Welfare Cost: Capital

Interpretation of $\nu_{CAP} = 0.017$.

- The gross welfare cost of increasing capital requirements by 10 percentage points is equivalent to a **permanent loss in consumption of** $\nu \times 0.1 \times 100\% = 0.17\%$.

- About $20$ billion per year.

- With HSSV-based estimate ($g_D = 0.81\%$): welfare cost = **0.21\%**.
Measurement of the Welfare Cost: Summary

<table>
<thead>
<tr>
<th>10% Liquidity requirement</th>
<th>10% Capital requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>gD = 0.81%</td>
<td>gD = 1.22%</td>
</tr>
<tr>
<td>0.003</td>
<td>0.031</td>
</tr>
<tr>
<td>0.213</td>
<td>0.173</td>
</tr>
</tbody>
</table>
Conclusions

Liquidity and capital requirements reduce the ability of banks to create net liquidity in equilibrium and impact investment and economic activity.

• Cost of *capital* requirement scales with the *convenience yield on bank deposits*

• Cost of *liquidity* requirement scales with the *difference in the convenience yields on HQLA assets and on bank deposits* (adjusted for noninterest costs)

Quantitative result: Welfare cost of liquidity requirement is modest and much lower than the welfare cost of similarly-sized capital requirements.

Financial stability benefits of liquidity requirements are narrower than capital, yet liquidity regulation is part of the optimal policy mix → division of labor:

• Capital regulation addresses credit risk;
• Liquidity regulation addresses liquidity risk.
Extra Slides
The Demand for Treasuries

Corporate Bond Spread and Government Debt

Source: Krishnamurthy and Vissing-Jorgenson, JPE
Banks: Introducing Moral Hazard

Credit risk: Banks can make risky loans to firms with a stochastic technology

- Return to the bank’s loan portfolio is $R_t^L + \sigma_t \varepsilon_t$
- $\sigma_t$ corresponds to fraction of lending to a risky firm
- $\varepsilon_t$ has negative mean → Excessive risk taking
  - Consistent with assumptions on technology of risky firms
- Supervision can detect excessive risk taking if $\sigma_t > \bar{\sigma}$
Bank’s Problem

Bank maximizes of shareholder value:

$$\max_{\sigma, B, L, D, E} \mathbb{E} \left[ (1 - \eta \mathbb{1}_{B < wD}) \right] \max \left( 0, (R^L + \sigma \varepsilon) L + R^B B - R^D D \right) / R^E - E$$

s.t.  \[ L + B = E + D \]
\[ B \geq \lambda D \]
\[ E \geq \gamma L \]
\[ \sigma \in [0, \bar{\sigma}] \]

Result: Expected dividends are convex in $\sigma$
- Decreasing when $\sigma \approx 0$;
- Increasing when $\sigma$ is sufficiently large
Choice of $\sigma$: illustration for a 2-point distribution of $\varepsilon$

Dividends

$R^L L + R^B B - R^D D$

Expected Dividends

$\varepsilon > 0$

$\varepsilon < 0$

Excessive risk taking, $\sigma$
Bank’s Risk-Taking Choice

- Excessive lending risk
- No liquidity risk
- No excessive lending risk
- No liquidity risk

Optimal Policy to deter excessive risk

The Welfare Effects of Bank Liquidity and Capital Requirements
## Neoclassical Firms

<table>
<thead>
<tr>
<th>$K_t$</th>
<th>Physical Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_t$</td>
<td>Loans</td>
</tr>
<tr>
<td>$E^F_t$</td>
<td>Firm Equity</td>
</tr>
</tbody>
</table>

Safe technology: $F(K, H)$, constant returns to scale

\[
F_H(K, H) = w
\]

\[
F_K(K, H) + (1 - \delta) = R^L
\]

Firms raise non-bank finance (firm equity) only if $R^E = R^L$.

Risky firms: $F(K, H) + \sigma_R \varepsilon K \rightarrow \text{risky loans}$
Government - Regulator

Sets

\( \gamma \): Capital adequacy regulation

\( \lambda \): Liquidity regulation

\( \bar{B} \): Fixed supply of government debt

Balanced budget, including any resolution costs:

- Excess losses covered by deposit insurance fund
- Direct resolution costs
Equilibrium

Market Clearing:

\[ d_t = D_t \]
\[ e_t = E_t + E_t^F \]
\[ \bar{B} = B_t + b_t \]
\[ L_t = K_t - E_t^F \]
\[ H_t = 1 \]
\[ F(K_t,1) - \xi \sigma_t L_t + (1 - \delta)K_t = c_t + K_{t+1} + \psi_t + T \]

Given a government policy \( \gamma, \lambda, \bar{B}, \) and \( T, \) an equilibrium is defined as a path of consumption, capital, deposits, equity, and bond holdings, bank loans and financial returns, for \( t = 0,1,2,\ldots \) such that:

1. Households, banks, and nonfinancial firms all solve their maximization problems, described above, with taxes set according to the balanced budget constraint; and
2. All markets clear.
2. Gross Welfare Cost of the Policy Tools

Methodology:

1. Guess a *constrained social planner’s* problem with the liquidity and capital requirements.

2. Verify that it *replicates* the decentralized equilibrium.

3. Differentiate the value of the problem (= *welfare*) with respect to $\lambda$ or $\gamma$.

4. Use optimality conditions of the decentralized equilibrium to express the marginal welfare cost in terms of *observable sufficient statistics*. 
Gross Welfare Cost of the Policy Tools

Replicating constrained social planner’s problem

\[ V_0(K_0, \gamma, \lambda, \overline{B}) = \max_{\{c_t, d_t, b_t, K_{t+1}\}_{t=0}^\infty} \sum_{t=0}^\infty \beta^t u(c_t, d_t, b_t) \]

\[ \text{s.t.} \quad F(K_t, 1) + (1-\delta)K_t = c_t + K_{t+1} \]
\[ d_t \leq (1-\gamma)L_t + \overline{B} - b_t \]
\[ \overline{B} - b_t \geq \lambda d_t \]
\[ L_t \leq K_t \]
## Welfare Cost of Bank Capital Requirements


\[ \nu_{CAP} \times 0.1 \text{ in } \% \]

<table>
<thead>
<tr>
<th></th>
<th>( g_D = 0 )</th>
<th>( g_D = g / D )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Debt (93-04)</td>
<td>0.22</td>
<td>0.10</td>
</tr>
<tr>
<td>Total Assets (86-04)</td>
<td>1.09</td>
<td>0.94</td>
</tr>
<tr>
<td>Risk adjusted</td>
<td>0.85</td>
<td>0.71</td>
</tr>
<tr>
<td>Total Loans (86-04)</td>
<td>1.36</td>
<td>1.22</td>
</tr>
<tr>
<td>Risk adjusted</td>
<td>1.02</td>
<td>0.88</td>
</tr>
</tbody>
</table>
Effect of the Capital Requirement on Steady State Income

Capital requirement affects capital stock even in steady state, in contrast to inflation in the Sidrauski model.

Example:

\[ g \equiv 0 \]

\[ u(c,d) = \tilde{u}\left( \frac{c^{(\eta-1)/\eta} + a d^{(\eta-1)/\eta}}{\eta/(\eta-1)} \right) \]

\[ \Rightarrow d_t = a^n c_t (R_t^E - R_t^D)^{-\eta} \]

\( K^* \) is increasing (decreasing) in \( \gamma \) if \( 0 < \eta < 1 \) \( (\eta > 1) \)

Intuition: \( MPK = R^L = \frac{R^E}{\beta^{-1}} - (1 - \gamma)(R^E - R^D) \)
Distribution of Tier 1 risk-based capital ratio

Percent of assets

- 2013:Q1
- 2014:Q1

Black line: well-cap threshold (1/1/15)
Blue line: Basel III minimum (incl. capital conservation buffer). Note: CCAR may require a higher buffer.
The Optimal Capital Requirement

Suppose the costs of excessive risk taking ($\xi$ and $\psi$) are sufficiently large so that preventing excessive risk taking ($\sigma = 0$) is socially desirable $\rightarrow$

Welfare maximization in steady state, conditional on $\sigma = 0$:

$$\max_{T,\gamma} V_0(\theta) \text{ s.t. } \gamma \beta^{-1} \geq S(T)$$

$\rightarrow$ Set $\gamma$, $T$ such that

$$cv^{ci} = -\left. \frac{dT}{d\gamma} \right|_{S(T) = \gamma \beta^{-1}} = -1 \frac{1}{\beta S'(T)}$$

Assuming $S'' > 0$, larger welfare cost implies a larger $T$ and a smaller $\gamma$. 