Capital and Liquidity Interaction in Banking

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Disclaimer: The views expressed here are solely those of the authors and do not represent those of the Bank of England or Moody’s Analytics.
Motivation

Questions
- How do capital and liquidity requirements interact?
- Where and when are they complement or substitute?
**Approach**

**Question:**
How does banks’ capital position affect their incentives to engage in liquidity transformation?

![Diagram showing the relationship between liquidity requirements, capital requirements, banks' liquidity resilience, and banks' credit risk resilience]

**Substitutability:** higher capital ratio $\Rightarrow$ less liquidity transformation

**Complementarity:** higher capital ratio $\Rightarrow$ more liquidity transformation
Roadmap and main results

• **Theoretical model to develop hypotheses**
  - The model analyses how banks’ choice of liquidity holdings depends on their capital ratio.

• **Empirical analysis**
  - Key dataset is a confidential Bank of England database of bank regulatory reporting requirements with semi-annual frequency, from 1989 to 2013.
  - Includes arguably exogenous changes in bank capital requirement

• **Main results**
  - Inverted U-shaped relationship between bank capital and liquid **asset** holdings
  - BUT **OVERALL** more capital leads banks to engage less in liquidity transformation
Related Literature

• Theory
  ▪ Gomez and Vo (2019)
  ▪ Miller and Sowerbutts (2017)
  ▪ Kara and Ozsoy (2019)

• Empirics
  ▪ Berger and Bouwman (2009)
  ▪ Distinguin et al. (2013)
  ▪ DeYoung et al (2018)
  ▪ Banerjee and Mio (2015)

• Identification strategy
  ▪ Aiyar et al. (2012); De-Ramon et al. (2017); Bahaj and Malherbe (2016)
Theoretical model – Set up

• Bank’s liabilities:
  ▪ The size of the bank’s balance sheet is normalized to 1
  ▪ The bank is funded at date 0 with
    • Equity of amount $k$
    • Retailed deposits of amount $1 - k$

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>$c$</td>
<td>$1 - k$</td>
</tr>
<tr>
<td>$1 - c$</td>
<td>$k$</td>
</tr>
</tbody>
</table>

• Two investment opportunities:
  ▪ Liquid assets: return per period equal to 1.
  ▪ Long-term assets: generate a cash flow of $R > 1$ at date 2.
Theoretical model - Timeline

Date 0

Given its liability structure \((k, 1 - k)\), bank chooses its cash holdings \(c\) and its investment \((1 - c)\) in the long-term assets.

Date 1

- Fraction \(\delta\) of depositors comes to withdraw.
- Bank repays their depositors by using its cash holdings and (possibly) selling long-term assets.
- If the bank cannot raise enough liquidity to repay its depositor, it is liquidated.

Date 2

- The long-term assets' cash flow is realised.
- Payments to remaining depositors are settled.
Theoretical model – Two main channels

- Banks’ capital ratio and their liquidity holdings: two competing effects
  - “Liquidity-demand effect”:
    Higher capital ratio $\rightarrow$ more stable liabilities $\rightarrow$ less demand for liquidity holdings $\rightarrow$ lower liquidity holdings
  - “Skin-in-the game effect”:
    Higher capital ratio $\rightarrow$ more skin in the game $\rightarrow$ costlier failure $\rightarrow$ less incentive to take liquidity risk $\rightarrow$ higher liquidity holdings.

- Banks’ capital ratio and their overall liquidity transformation
  - Lower liquidity holdings per se do not mean higher liquidity transformation
  - Liquidity transformation depends on both asset and liability side
Numerical analysis

| Liquidity holdings as function of bank capital ratio | Survival probability as function of bank capital ratio |

![Liquidity ratio c vs Capital ratio k](image1)

![Survival probability vs Capital ratio k](image2)
How can we test – Empirical assessment

• Using *arguably exogenous changes* in capital requirements

  ⇒ *less concern for reverse causality* relative to earlier literature

• On top of Basel regulation: Individual capital guidance set by UK supervisors since 1989:

  ▪ *Not based on liquidity or credit risk*, lending volume or business model (Aiyar et al., 2014b,a and Aiyar et al., 2016)

  ▪ *Based on supervisory judgements* on organisational structures, systems and reporting procedures, quality of management (Turner, 2009 and Francis and Osborne, 2012)
Empirical assessment - Data

• Use detailed regulatory data on banks’ balance sheet, covering all UK banks for the period 1989-2013, with a semi-annual frequency (HBRD).

• We filter our data by removing outliers and banks with missing variables and winsorising at 1%.

• In total we have an unbalanced panel of 2514 observations for 154 banks and 516 changes in individual capital requirements.
Liquidity transformation measure - Berger and Bouwman (2009)

**Principle:**

One unit of unstable liabilities used to finance one unit of illiquid assets ⇒ one unit of liquidity transformation is created.

**BB Liquidity index** = \( \sum_i \text{notional value}_i \times \text{weight}_i / \text{Assets} + \text{Off BS commitments} & \text{Guarantees} \)
Econometric specifications

**Banks’ asset liquidity:**

\[ \text{LiquidAssetRatio}_{i,t} = \beta_1 + \beta_2 \text{CapMeasure}_{i,t} + \beta_3 \text{CapMeasure}_{i,t+1} + \beta_4 \text{Controls}_{i,t} + \nu_i + \text{time}_t + \epsilon_{i,t} \]

**Banks’ overall degree of liquidity transformation**

\[ \text{BB Liquidity index}_{i,t} = \gamma_1 + \gamma_2 \text{CapMeasure}_{i,t} + \gamma_4 \text{Controls}_{i,t} + \nu_i + \text{time}_t + \epsilon_{i,t} \]
# Capital and asset liquidity

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Liquid assets (BB)</th>
<th>(2) Broad</th>
<th>(3) Narrow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Req. capital to TA</td>
<td>2.343*</td>
<td>2.668**</td>
<td>1.212**</td>
</tr>
<tr>
<td></td>
<td>(1.210)</td>
<td>(1.172)</td>
<td>(0.474)</td>
</tr>
<tr>
<td>Req. capital to TA, square</td>
<td>-11.86**</td>
<td>-13.63**</td>
<td>-6.205**</td>
</tr>
<tr>
<td></td>
<td>(5.489)</td>
<td>(5.430)</td>
<td>(2.438)</td>
</tr>
</tbody>
</table>

Methodology: FE  
Controls: YES  
Observations: 1,984  
Adj. R2: 0.759  
Adj. R2 within: 0.0466  
Banks: 154  

Robust standard errors in parentheses  
*** p<0.01, ** p<0.05, * p<0.1
## Capital and OVERALL liquidity transformation

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Req. capital to RWA</td>
<td>-1.046*** (0.306)</td>
<td>-0.804** (0.336)</td>
<td></td>
</tr>
<tr>
<td>Req. capital to RWA (first lag)</td>
<td>-0.879** (0.378)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RWA density (lagged)</td>
<td>0.177*** (0.0509)</td>
<td>0.163*** (0.0510)</td>
<td></td>
</tr>
<tr>
<td>ROA (lagged)</td>
<td>-0.0446 (0.241)</td>
<td>-0.134 (0.253)</td>
<td>-0.219 (0.312)</td>
</tr>
<tr>
<td>Impairment scaled (lagged)</td>
<td>0.233** (0.0964)</td>
<td>0.198** (0.0900)</td>
<td>0.0814 (0.101)</td>
</tr>
<tr>
<td>Total assets (lagged and log)</td>
<td>0.00442 (0.0134)</td>
<td>0.0178 (0.0129)</td>
<td>0.0127 (0.0125)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.575*** (0.110)</td>
<td>0.345*** (0.116)</td>
<td>0.405*** (0.111)</td>
</tr>
<tr>
<td>Methodology</td>
<td>FE</td>
<td>FE</td>
<td>FE</td>
</tr>
<tr>
<td>Liquidity regimes</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>2,000</td>
<td>2,000</td>
<td>1,736</td>
</tr>
<tr>
<td>Adj. R2</td>
<td>0.860</td>
<td>0.869</td>
<td>0.875</td>
</tr>
<tr>
<td>Adj. R2 within</td>
<td>0.0701</td>
<td>0.130</td>
<td>0.121</td>
</tr>
<tr>
<td>Banks</td>
<td>154</td>
<td>154</td>
<td>134</td>
</tr>
</tbody>
</table>
## How banks adjust?

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>liquid assets</th>
<th>semi-liquid assets</th>
<th>illiquid assets</th>
<th>deposits</th>
<th>wholesale funding</th>
<th>off-balance sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Req. capital to RWA</td>
<td>0.587*</td>
<td>0.291</td>
<td>-0.835*</td>
<td>-0.455</td>
<td>0.400</td>
<td>-0.0472</td>
</tr>
<tr>
<td></td>
<td>(0.308)</td>
<td>(0.412)</td>
<td>(0.443)</td>
<td>(0.700)</td>
<td>(0.638)</td>
<td>(0.252)</td>
</tr>
<tr>
<td>Methodology</td>
<td>FE</td>
<td>FE</td>
<td>FE</td>
<td>FE</td>
<td>FE</td>
<td>FE</td>
</tr>
<tr>
<td>Controls</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Observations</td>
<td>2,000</td>
<td>2,000</td>
<td>2,000</td>
<td>2,000</td>
<td>2,000</td>
<td>2,000</td>
</tr>
<tr>
<td>Adj. R2</td>
<td>0.751</td>
<td>0.928</td>
<td>0.933</td>
<td>0.891</td>
<td>0.879</td>
<td>0.836</td>
</tr>
<tr>
<td>Adj. R2 within</td>
<td>0.0456</td>
<td>0.256</td>
<td>0.291</td>
<td>0.0419</td>
<td>0.0220</td>
<td>0.0242</td>
</tr>
<tr>
<td>Banks</td>
<td>154</td>
<td>154</td>
<td>154</td>
<td>154</td>
<td>154</td>
<td>154</td>
</tr>
</tbody>
</table>

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
## Heterogeneity

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) Crisis</th>
<th>(2) 10 largest banks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Req. capital to RWA</td>
<td>-0.767*** (0.274)</td>
<td>-0.956*** (0.354)</td>
</tr>
<tr>
<td>Req. capital to RWA * $I_{\text{year}&lt;2007}$</td>
<td>-0.0799 (0.395)</td>
<td></td>
</tr>
<tr>
<td>Req. capital to RWA * $I_{\text{top 10 banks}}$</td>
<td></td>
<td>1.853** (0.880)</td>
</tr>
</tbody>
</table>

| Methodology | FE | FE |
| Controls | YES | YES |
| Observations | 2,000 | 2,000 |
| Adj. R2 | 0.869 | 0.871 |
| Adj. R2 within | 0.130 | 0.140 |
| Banks | 154 | 154 |

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
Conclusion

• We find empirically that the relationship between the bank’s capital requirement and their liquidity transformation is negative.

• We find both theoretically and empirically that the relationship between banks’ asset liquidity and leverage ratio has a form of an inverted U-shape, with a turning point around 10% leverage ratio.

• Policy implications:
  ▪ Capital and liquidity requirements are, at least to some extent, substitutes.
  ▪ This substitution is mainly driven by small banks ⇒ insight for the debate on the proportionality of the regulatory requirements for small banks.
Thank you for your attention
APPENDIX
Stylised facts

Liquidity index

Changes in Individual Capital Guidance