Liquidity Regulation and the Implementation of Monetary Policy

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The views expressed herein are those of the authors and do not reflect the views of the Bank for International Settlements.
Background

- Basel III introduces a framework for liquidity regulation
  - objective: ensure banks hold a more liquid portfolio of assets, limit maturity mismatch

- Two components:
  - Liquidity Coverage Ratio (LCR)
    - establishes minimum holding of high-quality liquid assets
  - Net Stable Funding Ratio (NSFR)
    - establishes minimum amount of funding from “stable” sources

- Implementation:
  - LCR: 3-year phase-in began in Jan 2015
  - NSFR: begins in Jan 2018
Definition

\[ LCR = \frac{\text{Stock of unencumbered high-quality liquid assets}}{\text{Net cash outflows in a 30-day stress scenario}} = \frac{HQLA}{NCOF} \]

- **HQLA**: cash, reserves, govt. bonds, certain other securities

- **NCOF Scenario**: partial loss of retail deposits, significant loss of wholesale funding, contractual outflows from a 3-notch ratings downgrade, and substantial calls on off-balance sheet exposures

- Requirement:

\[ HQLA \geq NCOF \]

or

\[ LCR \geq 100\% \]
Question

- How might the LCR affect monetary policy *implementation*?
  - that is, the process by which a central bank steers market interest rate(s) toward some target

- Many central banks target the interest rate on interbank loans...
  - of reserve balances (a high-quality liquid asset)

- If the LCR changes the demand for such loans,
  - it seems likely to change the structure of market interest rates

- Want to understand:
  - how the LCR is likely to affect interbank interest rates
  - whether these effects could, in some circumstances, impair a CB’s ability to move the interest rate to target
What we do

- Develop a simple model to analyze this issue
  - goal is to identify *possible side effects* of the LCR

- Begin with a standard model of interbank lending
  - introduce an LCR requirement
  - ask: how does it change equilibrium interest rates?

- Results:
  - tends to push the overnight rate **down** and term rates **up**
  - effect depends critically on the **form** of central bank operations
    - bonds vs. other assets; counterparties; purchases vs. repos

- Conclusion:
  - LCR may make implementing monetary policy more challenging
The Model
A baseline model (no LCR)

- Three stages: $t = 0,1,2$
- Continuum of banks ($i \in [0,1]$), a central bank, and others
  - each begins with a balance sheet

### Bank $i$

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans $L_i^0$</td>
<td>Deposits $D_i^0$</td>
</tr>
<tr>
<td>Bonds $B_i^0$</td>
<td>Equity $E_i^0$</td>
</tr>
<tr>
<td>Reserves $R_i^0$</td>
<td></td>
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</tbody>
</table>

### Central Bank

<table>
<thead>
<tr>
<th>Assets</th>
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<tbody>
<tr>
<td>Loans $L_{0CB}$</td>
<td>Reserves $R_0$</td>
</tr>
<tr>
<td>Bonds $B_{0CB}$</td>
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</tbody>
</table>

### Other investors

<table>
<thead>
<tr>
<th>Assets</th>
<th>Liabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loans $L_0^h$</td>
<td>Equity $E_0^h$</td>
</tr>
<tr>
<td>Bonds $B_0^h$</td>
<td></td>
</tr>
<tr>
<td>Deposits $D_0$</td>
<td></td>
</tr>
</tbody>
</table>
Timeline:

\[ t = 0 \]
\[ t = 1 \]
\[ t = 2 \]

- Open market operations
- Interbank market
- Payment shocks
- Standing facilities open

Bank \( i \)

<table>
<thead>
<tr>
<th>Assets</th>
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</thead>
<tbody>
<tr>
<td>Loans ( L^i_1 )</td>
<td>Deposits ( D^i_1 - \varepsilon^i )</td>
</tr>
<tr>
<td>Bonds ( B^i_1 )</td>
<td>Borrowing ( \Delta^i + X^i )</td>
</tr>
<tr>
<td>Reserves ( R^i_1 + \Delta^i - \varepsilon^i + X^i )</td>
<td>Equity ( E^i_0 )</td>
</tr>
</tbody>
</table>
- Banks are risk neutral
- Must satisfy a reserve requirement:

\[ R_1^i + \Delta^i - \varepsilon^i + X^i \geq K^i \]

- Profit:

\[
\pi^i(\varepsilon^i) = r_L L_2^i + r_B B_2^i - r_D D_2^i + r_K K_i^i \\
- r\Delta^i + r_R (R_1^i + \Delta^i - \varepsilon^i + X^i - K_i) - r_X X^i
\]

where
- \( r_R \) = interest rate at CB’s deposit facility (excess reserves)
- \( r_X > r_R \) is the rate at the CB’s lending facility
Demand for interbank loans

- Using the reserve requirement:

\[ R^i_1 + \Delta^i - \varepsilon^i + X^i \geq K^i \]

- where

\[ \varepsilon_K^i \equiv R^i + \Delta^i - K^i \]

- Bank \( i \) will choose \( \Delta^i \) so that:

\[ r = r_R \left( \text{prob}[\varepsilon^i < \varepsilon_K^i] \right) + r_X \left( \text{prob}[\varepsilon^i > \varepsilon_K^i] \right) \]
Equilibrium

- Net interbank lending = 0 \Rightarrow \varepsilon_K^* = R_1 - K

\[ r^* = r_R(\text{prob}[\varepsilon < \varepsilon_K^*]) + r_X(\text{prob}[\varepsilon > \varepsilon_K^*]) \]

Notes:

- \( r^* \) depends only on aggregate excess reserves
- distribution of \( R_1^i \) and other balance sheet items is irrelevant
- implication: effect of an OMO depends only on size of the operation
Liquidity Requirements
Expand the model to include two interbank markets

- interpret as overnight vs. term loans
- both markets open at the same time

Bank $i$

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<td>Loans $L_1^i$</td>
<td>Deposits $D_1^i - \varepsilon^i$</td>
</tr>
<tr>
<td>Bonds $B_1^i$</td>
<td>Borrowing $\Delta^i + \Delta_T^i + X^i$</td>
</tr>
<tr>
<td>Reserves $R_1^i + \Delta^i + \Delta_T^i - \varepsilon^i + X^i$</td>
<td>Equity $E_0^i$</td>
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</table>
Introducing the LCR requirement

- In the model:
  - bonds and reserves are high-quality liquid assets
  - loans = all other assets

- Requirement:

  \[ LCR = \frac{B^i + R^i + \Delta^i + \Delta_T^i - \varepsilon^i + X^i}{\theta_D(D^i_1 - \varepsilon^i) + \Delta^i} \geq 1 \quad \left\{ = \frac{HQLA}{NCOF} \right\} \]

- Runoff rates for different types of liabilities:
  - deposits: \( \theta_D \) (3%, 5%, or 10%)
  - overnight borrowing: 100%  
    (paper: two markets with \( \theta_a \neq \theta_b \))
  - term borrowing: 0%
  - borrowing from central bank: 0%  
    (see paper for \( \theta_X > 0 \))
Repeating:

\[
\frac{B^i + R^i + \Delta^i + \Delta^i_T - \varepsilon^i + X^i}{\theta_D (D^i - \varepsilon^i) + \Delta^i} \geq 1
\]

DW borrowing for LCR purposes:

where

\[
\varepsilon_C^i \equiv \frac{B^i + R^i + \Delta^i_T - \theta_D D^i}{1-\theta_D} \\
\text{to meet LCR (slope }= 1 - \theta_D) \\
\text{notice: the two } \Delta^i \text{ terms cancel out}
In equilibrium:

$$r^* = r_R \left( \text{prob}[\varepsilon < \hat{\varepsilon}^*] \right) + r_X \text{prob}[\varepsilon > \hat{\varepsilon}^*]$$

$$r_T^* = r^* + (r_X - r_R) \text{prob}[\varepsilon^*_C < \varepsilon < \hat{\varepsilon}^*]$$

\(\hat{\varepsilon}^* > \varepsilon^*_K \Rightarrow\) overnight rate lower

\(\hat{\varepsilon}^* > \varepsilon^*_K \Rightarrow\) a premium emerges
Results

- If the LCR is a binding concern in some states of nature (that is, if $\varepsilon_C^* < \varepsilon_K^*$):
  1. the overnight rate $r^*$ is **lower** than in the standard model
  2. the term rate $r_T^*$ is **higher** than in the standard model
     \[ \Rightarrow \text{difference is a regulatory premium} \]

- In addition, open market operations change banks’ LCR position (that is, change $B_1, R_1, D_1 \Rightarrow \text{change} \, \varepsilon_C^*$)
  - direction, size of change depend on how operation is structured
     \[ \Rightarrow \text{effect of an operation on } (r^*, r_T^*) \text{ depends on how it is structured} \]
  - next: examine OMOs in detail
Open Market Operations
Balance sheet effects of an OMO

- Central bank chooses size of purchases $z_L, z_B$

**Central Bank**

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<tr>
<td>Loans $L_0^{CB} + z_L$</td>
<td>Reserves $R_0 + z$</td>
</tr>
<tr>
<td>Bonds $B_0^{CB} + z_B$</td>
<td></td>
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- Effect on bank balance sheets depends on counterparites $(\alpha_L, \alpha_B)$

**Banking system**

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<tbody>
<tr>
<td>Loans $L_0 - \alpha_L z_L$</td>
<td>Deposits $D_0 + (1 - \alpha_L)z_L + (1 - \alpha_B)z_B$</td>
</tr>
<tr>
<td>Bonds $B_0 - \alpha_B z_B$</td>
<td>Equity $E_0$</td>
</tr>
<tr>
<td>Reserves $R_0 + z$</td>
<td></td>
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\[= R_1\]
OMOs (1): Purchases of HQLA from banks

- Suppose $z_B > 0 = z_L$ and $\alpha_B = 1$

- Operation leaves the LCR of the banking system unchanged:

\[
\begin{align*}
\text{Assets} & \quad \text{Liabilities} \\
\text{Loans} & \quad L_0 & \text{Deposits} & \quad D_0 \\
\text{Bonds} & \quad B_0 - z & \text{Equity} & \quad E_0 \\
\text{Reserves} & \quad R_0 + z
\end{align*}
\]

\[
\Rightarrow LCR_1 = \frac{B_0 - z + R_0 + z}{\theta_D D} = LCR_0
\]

- the likelihood of a bank violating its LCR constraint is unchanged
- but the likelihood of violating its reserve requirement falls
  - $\Rightarrow$ regulatory premium must increase
Start from a situation where the LCR is never a binding concern:

When central bank buys bonds:

- same $r^*$ as with no LCR
- no premium

- $r^*$ falls more than in the standard model
  - a premium arises
Effect of open market operations on equilibrium interest rates

assuming initial LCR of the banking system is well above 100%

As reserves increase, eventually LCR is a binding concern in some states
If the initial LCR of the banking system is lower:

- Results:
  - adding reserves tends to create a term premium
  - overnight rate becomes highly responsive to $z$
  - term rate becomes unresponsive to $z$
OMOs (2): Purchases of non-HQLA from banks

- Suppose $z_L > 0 = z_B$ and $\alpha_L = 1$

- This operation raises the LCR of the banking system:

\[
\begin{array}{c|c}
\text{Assets} & \text{Liabilities} \\
\hline
\text{Loans} & L_0 - z \\
\text{Bonds} & B_0 \\
\text{Reserves} & R_0 + z \\
\end{array}
\begin{array}{c}
\text{Deposits} & D_0 \\
\text{Equity} & E_0 \\
\end{array}
\Rightarrow LCR_1 = \frac{B_0 + R_0 + z}{\theta_D D_0} > LCR_0
\]

- likelihood of a bank violating its reserve requirement falls (as before)

- likelihood of violating its LCR requirement falls by more
  - $\Rightarrow$ regulatory premium tends to decrease
Effect of open market operations on equilibrium interest rates:

Results:
- Draining reserves tends to create a term premium.
- Overnight rate becomes less responsive to $z$.
- Term rate becomes (slightly) more responsive to $z$.

Exactly opposite to previous case.
OMOs (3): Purchases from non-banks

- Now suppose $\alpha_B = \alpha_L = 0$

- Operation raises the LCR of the banking system:

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<td>Equity $E_0$</td>
</tr>
<tr>
<td>Reserves $R_0 + z$</td>
<td>Deposits $D_0 + z$</td>
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</table>

⇒ $LCR_1 = \frac{B_0 + R_0 + z}{\theta_D(D_0 + z)} > LCR_0$

- likelihood of a bank violating both requirements falls at the same rate

- relative importance depends on distribution of payment shock

⇒ equilibrium term premium may increase or decrease
Effects of OMOs are a hybrid of the two previous cases:

- Higher initial LCR
- Lower initial LCR
Summarizing the results

- An LCR pushes the overnight rate down and term rates up
  - a regulatory premium emerges on loans that improve bank’s LCR

- The effects of an open market operation depend on the details (which were irrelevant in the standard model)
  - some of these details \((\alpha_L, \alpha_C)\) are outside of central bank’s control

- Effects are stronger:
  - with repos/collateralized loans than with outright purchases/sales
  - if runoff rate on CB loans \(\theta_X\) is positive

⇒ Implementing monetary policy may become significantly more difficult when LCR is fully in effect
Possible adjustments

- Should a CB adjust its framework? If so, how?
  - no definitive answers here
  - but the model highlights some considerations and tradeoffs

- Target rate: overnight rate vs. term (say, 3 month)
  - if regulatory premium is variable, choice becomes more important
  - and makes a stronger argument for a term target?

- Type of operation
  - If targeting the overnight rate, HQLA with banks may work best
  - If targeting a term rate, non-HQLA or with non-banks may be more effective
Could take steps to mitigate monetary policy effects of LCR

- set runoff rate for CB loans ($\theta_X$) to zero
- introduce a bond-lending facility
  - aim to provide “LCR liquidity” separately from “reserve liquidity”
- create a committed liquidity facility (CLF)
  - sell committed CB credit lines that count as HQLA (Australia)

Note: each of these may undermine objectives of the regulation

- want to incentive banks to hold more HQLA
- but also want to ease any HQLA shortages that arise

⇒ possible tension between financial stability and monetary policy
Determining the best approach requires a broader model

- need to integrate our analysis with the objectives of the regulation

General message:

- Central banks will likely need to pay attention to the LCR when implementing monetary policy
  - need to monitor LCR conditions in same way as reserve conditions
  - and design their operations and facilities with the LCR in mind

More work is needed:

- tailoring the analysis to different environments, operating regimes
- including benefits as well as costs of liquidity regulation
- studying how other new regulations interact with the effects here
Extra Materials
OMOs (4): Repos of HQLA with banks

- Next, return to first case: $z_B > 0 = z_L$ and $\alpha_B = 1$
  - but now CB does repo transaction rather than outright purchase

- Operation decreases the LCR of the banking system:

<table>
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<td>Loans $L_0$</td>
<td>Deposits $D_0$</td>
</tr>
<tr>
<td>Bonds $B_0$</td>
<td>CB repo $z$</td>
</tr>
<tr>
<td>- encumb. $\frac{z}{1-h}$</td>
<td></td>
</tr>
<tr>
<td>Reserves $R_0 + z$</td>
<td>Equity $E_0$</td>
</tr>
</tbody>
</table>

$\Rightarrow LCR_1 = \frac{B_0 + R_0 - \frac{h}{1-h} z}{\theta_D D_0} < LCR_0$

- If haircut ($h$) is zero, effect is same as outright purchases
  - but with a positive haircut ...
Effect of open market operations via repos (using HQLA)

Term premium is larger with repos than with outright purchases

- difference is increasing in the size of the haircut
Alternate case: $\theta_X > \theta_D$

- Recall
\[
LCR = \frac{B + R + \Delta + \Delta_T - \varepsilon + X}{\theta_D(D - \varepsilon) + \Delta + \theta_X X} \geq 1
\]

- LCR rules allow local supervisors to set $\theta_X = 0$ (our baseline case) ...
  - ... or higher
    - the original LCR rules (in 2010) required $\theta_X \geq 25$

- Analysis above applies to any $\theta_X < \theta_D$

- For $\theta_X < \theta_D$ ...
When $\theta_X > \theta_D$

In equilibrium:

$$r^* = r_R \left( \text{prob}[\varepsilon < \varepsilon_K] + \text{prob}[\varepsilon > \hat{\varepsilon}] \right) + r_X \text{prob}[\varepsilon_K < \varepsilon < \hat{\varepsilon}]$$

$$r_T = r^* + \frac{r_X - r_R}{1 - \theta_X} \text{prob}[\varepsilon > \hat{\varepsilon}]$$

same basic pattern ...
When $\theta_X > \theta_D$

- Effect of open market operations on equilibrium interest rates
- assuming initial LCR of the banking system is 100%

Effects highlighted above become stronger as $\theta_X$ increases

... but effects are magnified
When $\theta_X > \theta_D$

- If $\theta_X$ is large enough, the term interest rate can rise above $r_X$:

- because $1$ of term funding can save a bank from borrowing

\[
\frac{1}{1 - \theta_X} > 1
\]

from the discount window
Shadow banks

- The LCR requirement applies only to (some) commercial banks

- If $r_T^* > r^*$, profit opportunity for anyone not subject to the LCR:
  - lend at the term rate,
  - borrow at the overnight rate and roll over the loan each day

- Doing so may be costly
  - it raises institution’s leverage, funding costs

- Let $F = \text{net activity by non-banks in these markets}$
  - assume balance sheet cost $\phi(F)$ is weakly increasing

- No arbitrage $\Rightarrow \phi(F^*) = r_T^* - r^*$
Market clearing conditions become:

\[ \int_0^1 \Delta^i di = F \quad \text{and} \quad \int_0^1 \Delta_T^i di = -F \]

Analysis above was based on \( F = 0 \)
Lending by shadow banks:

- Mitigates the term premium ...
  - by moving maturity transformation outside of commercial banks
- OMOs have less impact on term premium, but ... will change $F^*$

![Graph showing $r_T^* - r^*$ vs. $F$ with $F^*$ indicating the point where $\phi(F)$ intersects the vertical axis.]

 Raises financial stability concerns?