Assessing and Pricing Liquidity Risk: An Economic Perspective of Asset and Liability Dynamics

Amnon Levy, Managing Director, Head of Portfolio Research
Yashan Wang, Senior Director, Portfolio Research
Bank Funding Costs Continue to be a Major Concern

Median Credit Spreads (bps) of 20 Largest US Banks

- Lehman Brothers Bankruptcy
- European Sovereign Debt Crisis
- Bear Stearns Hedge Funds’ Collapse

January 2000 to January 2012

Bond OAS
5yr CDS
Variation in Secured Lending

Investments in Repo by US MMFs and Securities Lenders ($billions)

For a complete description and interpretation of the data, please see Krishnamurthy, Arvind, Stefan Nagel and Dmitry Orlov. *Sizing up Repo*, working paper, 2011.
Regulatory Emphasis on Contingent Liquidity

Basel: “… the maintenance of a sufficient cushion of high quality liquid assets to meet contingent liquidity needs.”

FSA: “A Contingency Funding Plan should set out a firm’s strategy for addressing liquidity shortfalls in stressed conditions.”

Fed: “…a cushion of liquid assets, and a formal well-developed contingency funding plan (CFP) as primary tools for measuring and managing liquidity risk.”
Economic Guidance

Mostly in the form of motivating relationships:

» Banks’ assets and liabilities are often maturity-mismatched, with long-term assets funded through short-term liabilities

» In periods of distressed liquidity conditions, the bank may face elevated funding costs, and more stringent haircuts as it refines its short-term funding

» At the same time, the bank’s borrowers may increase their use of bank funds, forcing the bank to raise additional funds.

But a formal framework and quantitative guidance are limited:

» What amount of liquid assets should a financial institution hold in order to absorb potential losses due to adverse funding conditions?

» To which extent should more liquid/fungible assets receive liquidity offsets?

» How should a financial institution account for these dynamics when originating loans or when calculating a transfer price?
Some Funding Sources: Benefits, Drawbacks, and Risks

Long term borrowing – Typically costlier
  » Long term debt
  » Preferred stock
  » Equity
  » Demand deposits (can be uncertain)

Short Term Borrowing - Generally cheap but uncertain availability and cost
  » Collateralized borrowing (e.g., Repo, ABCP)
  » Money Market
  » Fed Funds
  » Discount window

Asset Sale
  » Often at a loss
  » Affects bank’s strategy
Measuring Contingent Liquidity Risk in a Stylized Economic Setting

Consider a simplified two-period setting:

» A bank invests in a variety of assets
  – Extends backup lines of credit to a pool of borrowers
    » Borrowers’ future demand for liquidity (line utilization) is uncertain
  – Fully funded instruments with varying degrees of liquidity
    » The degree to which assets can be collateralized is uncertain
    » The market price of the assets is uncertain

» The bank funds the credit lines using a combination of long-term funds (a liquidity buffer), short-term collateralized debt, and possibly asset sales

» The bank’s funding cost, in part due to the value of collateral, and the borrowers’ line usage are correlated

» Availability of short-term funds is limited in severe market conditions

What amount of liquid assets should the bank hold in order to absorb potential losses due to adverse funding conditions?
Basel III characterizes an acute short-term stress scenario for determining the resilience of the balance sheet:

» A significant downgrade of the institution’s public credit rating
» A partial loss of deposits
» A loss of unsecured wholesale funding
» A significant increase in secured funding haircuts
» Increases in derivative collateral calls and substantial calls on contractual and non-contractual off-balance sheet exposures, including committed credit and liquidity facilities
Case Study: Countrywide Taps Backup Lines as a Source of Funding Liquidity

Aug 16, 2007
Countrywide draws on $11.5bn syndicated credit facility

Jul 1, 2008
Bank of America completes acquisition of Countrywide
Characterization of the Funding Environment

Bank invests in assets of varying liquidity, and extends lines of credit. It funds operations with long-term borrowing.

Bank uses liquidity reserve to fund draw-downs.

Borrowers pay back lines and bank unwinds.

Bank uses a combination of reserve funds, short-term borrowing, and asset sales to fund draw-downs.

Markets shutdown or bank is not viable.

Markets are functioning and bank is viable.
Short Term Cost of Collateralized Funding

\[
\tilde{r}_{t_1}^{Bank} \approx -\frac{1}{t_2 - t_1} \log \left[ 1 - N \left( N^{-1}(PD_{t_1,t_2}^{Bank}) + \lambda_t \sqrt{RSQ_{Bank} \cdot (t_2 - t_1)} \right) \cdot LGD_{t_1} \right]
\]

- Probability of bank default between \( t_1 \) and \( t_2 \)
- Market risk premium

\[
\begin{align*}
\text{LGD}_{t_1} & \approx \frac{PD_{t_1,t_2}^{Colateral}}{\text{Bank Default}} \cdot \text{LGD}_{Colateral} \\
\end{align*}
\]

Access to capital markets may be limited

» A systemic event may result in access to funding to be severely hampered

\[
1_{\text{Markets Functioning}} = 1_{\lambda \leq \lambda_{\text{Shutdown}}}
\]
Modeling the Joint Dynamics

- Bank borrowing cost
- Bank Funding Decision - Borrow or Sell
- Haircut/Asset Sale
- Market Risk Premium
- Collateral Asset Credit Migration
- Bank Gains/Losses
- Borrower Usage
- Borrower Credit Migration

Moody's

Assessing and Pricing Liquidity Risk October, 2011
Bank Asset Value and Credit Market Risk Premium

Correlation Between Banking Asset Return and Innovation in Market Price of Risk
Market Risk Premium Significantly Higher in Crisis Periods

Credit Market Risk Premium

The crisis period is characterized as the 95-percentile of the empirical density estimate:

\[ \lambda_{\text{Shutdown}} = 0.9 \]
**Other Empirical Specifications**

- **Asset Correlations**: Estimated using GCorr™ global correlation model
- **Credit Migration**: Obtained from the Moody’s Analytics Distance-to-Default Dynamics model
- **Credit Line Utilization**: A credit quality contingent PD-usage mapping is estimated using Moody’s Analytics Credit Research Database (CRD™)
- **Haircut data from European Central Bank**

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**Haircut on Collateral Assets, source ECB**

<table>
<thead>
<tr>
<th>Credit Rating</th>
<th>Haircut</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aaa to A3</td>
<td>3%</td>
</tr>
<tr>
<td>Baa1 to Baa3</td>
<td>18%</td>
</tr>
<tr>
<td>Below Baa3</td>
<td>Not eligible</td>
</tr>
</tbody>
</table>
### Case Study: Liquidity Provisioning for a Portfolio of Homogeneous Borrowers

#### Bank Characteristics
- Cost of long-term debt: 1.5%
- Maturity of short-term debt: 1 year
- 1 year default probability: 50 bps
- RSQ: 60%

#### Revolver Borrower Characteristics
- No. of Homogeneous Borrowers: 80
- Maturity of credit line: 2 years
- Contractual Usage Fee: 3%
- 1 year default probability: 2%
- RSQ: 25%

#### Collateral Asset Characteristics
- No. of Homogeneous assets: 40
- Maturity of assets: 2 years
- 1 year default probability: 80 bps
- Coupon rate: 3%
- RSQ: 40%
Quantifying the Value of Asset Liquidity

» Call collateralizable assets can be used as collateral in secured borrowing or asset sale (as well as being sold)
   » Banks often avoid asset sale under stressed market condition

» Liquid assets can be sold at market prices but not eligible as collateral in borrowing

» Illiquid assets are not eligible for borrowing or selling
   » Funding needs are met by liquidity buffer only

» Coupon Rate for Collateralizable Assets  = 3%

» To achieve the same solvency probability for the bank
   » Additional coupon required if assets are not collateralizable but liquid = 47 bps
   » Additional liquidity buffer cost if assets are not collateralizable and illiquid = 96 bps
Liquidity Buffer Size as a Fraction of Total Asset Value

- corr(bank, revolver) = 36%, assets collateralizable
- corr(bank, revolver) = 36%, assets liquid
- corr(bank, revolver) = 36%, assets illiquid
- corr(bank, revolver) = 56%, assets illiquid
Incorporating Contingent Liquidity Costs in Funds Transfer Pricing

Assumptions: Corr(Bank, Revolver) = 36%, w/ Collaterizable Assets

- Contractual Fee = 300bps
- Credit Spread 180 bps
- Contingent Liquidity Spread 94 bps
- Reference Rate
- FTP = 274 bps
A Practical Approach for FTP and Spread Decomposition

- Commercial Margin
  - Credit Spread: 135 bps
  - Option Spread: 23 bps
  - Funding Liquidity Spread: 78 bps
  - Contingent Liquidity Spread: 64 bps
  - Reference Rate

Valuation Lattice:
- Prepay
- Default

Median Credit Spreads (bps) of 20 Largest US Banks:

Moody’s Analytics
Assessing and Pricing Liquidity Risk  October, 2011
Summary

» Economic framework introduced that describes:
  » the level of liquid assets a financial institution should hold in order to absorb potential losses due to adverse funding conditions
  » how a financial institution should account for the cost of holding liquidity reserves when originating loans or when calculating a transfer price
  » how a financial institution should quantify the benefit of assets that provide liquidity offsets

» In understanding liquidity risks it is imperative to account for the correlation between
  » borrowers’ funding needs
  » the values of bank’s investment assets and their liquidity characteristics – to what extent they can be used in collateralized borrowing or selling
  » liability dynamics – in particular funding sources and costs
  » the market price for risk

» The economic framework is flexible and allows for integration with credit and other risks, calculation Funds Transfer Price, and decomposition of FTP into Credit Spread, Option Spread, Funding Liquidity Spread, and Contingent Liquidity Spread
Amnon Levy  
Managing Director  
Head of Portfolio Research  
Moody’s Analytics  
San Francisco  
Tel: +1 (415) 874 6279  
Email: Amnon.Levy@moodys.com

Yashan Wang  
Senior Director  
Portfolio Research  
Moody’s Analytics  
San Francisco  
Tel: +1 (415) 874 6238  
Email: Yashan.Wang@moodys.com