

LIQUIDITY MISMATCH

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Objective

- Measuring and regulating liquidity is widely understood to be an important part of macro-prudential policies
 - ▣ Liquidity requirements
 - ▣ Liquidity stress-testing
- But ... there is no clear consensus on how to best measure liquidity and liquidity risks.
- Many ideas that are around:
 - ▣ “Cash is king;” Treasuries have good liquidity risk
 - ▣ Basel 3: Net stable funding ratio
 - ▣ Liquidity and leverage
 - ▣ Maturity transformation and liquidity

Outline

1. Motivating examples
 - ▣ What are we trying to measure?
2. Proposal: Liquidity Mismatch Index (LMI)
3. Applications

Example 1: Liquidity Mismatch

- Bank with \$20 of equity and \$80 of debt
- Debt: \$50 of overnight repo financing; rest is 5-year debt.
- The bank buys one Agency mortgage-backed security for \$50 (which is financed via repo at a 0% haircut)
- Loans \$50 to a firm for one year.

Example 1: Liquidity Mismatch

Assets	Liabilities
\$50 1-Year Loan	\$20 Equity
\$50 Agency-MBS	\$50 Repo debt
	\$30 5-Year debt

- *Liquidity risk: What if the firm cannot renew financing?*
- *Leverage is a crude measure...*

Example 1: Liquidity Mismatch

Assets	Liabilities
\$50 1-Year Loan	\$20 Equity
\$50 Agency-MBS	\$50 Repo debt
\$50 Private-Label-MBS	\$30 5-Year debt

- *The asset-side is less liquid*
- *More liquidity mismatch in this example*

Example 2: Rehypothecation

- Dealer starts with \$10 of equity, invested in \$10 of Treasuries
 - ▣ Initially no leverage
- Dealer lends \$90 to a hedge fund against \$90 of MBS collateral in an overnight repo
- Dealer posts \$90 of MBS collateral to money market fund and borrows \$90 in an overnight repo

Assets	Liabilities
\$10 Treasuries	\$10 Equity
\$90 Loan to Hedge Fund	\$90 of Repo Debt

Example 2: Leverage Error

- Dealer lends \$90 to a hedge fund against \$90 of MBS collateral in an overnight repo
- Dealer posts \$90 of MBS collateral to money market fund and borrows \$90 in an overnight repo

Assets	Liabilities
\$10 Treasuries	\$10 Equity
\$90 Loan to Hedge Fund	\$90 of Repo Debt

- *Leverage = 9X, but little liquidity risk*
- *What if hedge fund loan was 10 days? Liquidity falls...*

Example 3: Credit Lines

- Bank with \$20 of equity and \$80 of debt
- The bank buys \$100 of U.S. Treasuries
- Offers a credit line to a firm to access upto \$100.
- *Bank has made a contingent commitment of liquidity.*

Example 4: Derivatives

- Bank with \$20 of equity and \$80 of debt
- The bank buys \$100 of U.S. Treasuries
- Writes protection on a diversified portfolio of 100 investment-grade U.S. corporates, each with a notional amount of \$10; so there is a total notional of \$1,000.
- *Liquidity measurement problem 1: Dynamic collateral calls are a liquidity drain.*
- *Liquidity measurement problem 2: Downgrade will trigger a liquidity event.*

Example 5: Spillovers

- Many identical banks: \$20 equity, \$80 debt
- Debt is \$40 overnight repo, \$50 of 5-year debt.
- Each bank owns \$40 of private-MBS, \$40 of repo loans (at 0% haircut) to other banks
- Liquidity management: Bank has liquidity to cover losses if MBS prices fall by 5%, but if they fall by more, the bank will not renew its repo loans/raise repo haircuts.
- *Issue: Liquidity management in general equilibrium*

Measurement

- Date 0: measurement date
- Date 1: Possible crisis. State $\omega \in \Omega$
- Firm i
 - **(A)ssets**: Securities/loans, derivatives, repo loans, cash
 - **(L)iabilitys**: short-term debt, long-term debt, equity
- Measure **liquidity mismatch index** of each firm in each possible state

Liquidity Mismatch Index (LMI)

A

L

Market liquidity

- Can only sell assets at **fire-sale prices**

Ease with which one can raise money by **selling** the asset

Funding liquidity

- Can't **roll over** short term debt
- **Margin**-funding is recalled

Ease with which one can raise money by **borrowing** using the asset as collateral

Liquidity Mismatch Index = liquidity of assets minus
liquidity promised through liabilities

Liquidity Mismatch Index (LMI)

A

- Asset “liquidity weight”: λ
 - ▣ Treasuries/cash: $\lambda = 1$
 - ▣ Overnight repo: $\lambda = 1$ (or close to one)
 - ▣ Agency MBS: $\lambda = 0.95$
 - ▣ Private-label MBS: $\lambda = 0.90$

L

- Liability “liquidity weight”: λ
 - Overnight debt: $\lambda = 1$
 - Long-term Debt: $\lambda = 0.5$
 - Equity: $\lambda = 0.20$

LMI = liquidity of assets minus
liquidity promised through liabilities

Basel 3: Net Stable Funding Ratio, Liquidity Coverage Ratios implicitly assign some λ weights

Monetary Aggregation

- Barnett Divisia indices
 - Weight money quantities by “moneyness/medium-of-exchange” to form money aggregates
- We are doing the same, but that at the firm level and with weights that reflection financial liquidity

How to choose $\{\lambda\}$

1. Interest rate spreads on bonds
 - ▣ Krishnamurthy-Vissing Jorgenson: Measure the “liquidity convenience” of the asset
2. Repo haircuts
3. Micro-structure measures:
 - ▣ Bid-ask spreads
 - ▣ Price impact
 - ▣ Trading volume or turnover
- ▣ Large empirical finance literature can be used.

We need both $\{\lambda\}$ as well as $\{\lambda^\omega\}$

- Empirical finance work has documented time-series variation in aggregate liquidity measures
 - Bond market liquidity spreads
 - Stock market measures of liquidity
 - Covariances with aggregate risk factors
- Example for setting $\{\lambda^\omega\}$
 - Take a baseline set of $\{\lambda\}$
 - Consider an ω macro state; We know covariance with aggregate liquidity measure
 - Consider percentage deviations in $\{\lambda^\omega\}$ based on moves of aggregate liquidity measure.

Data collected from firms

1. Current liquidity
2. Liquidity in each future scenario (state ω)
 - ▣ Liquidity risk

Liquidity Risk

- Consider for a given firm (or sector) the vector $\{LMI^\omega\}$
 - ▣ The LMI for each state ω
- $\{LMI^\omega\}$ is the *liquidity risk* taken by the firm
 - ▣ Portfolio decision at date 0 is over assets/liabilities
 - ▣ Asset/liability choices + realization of uncertainty result in $\{LMI^\omega\}$
- How much liquidity risk are firms taking?
 - ▣ Example: a firm holding an illiquid asset financed by overnight debt is also taking on a lot of liquidity risk.

Example 1: Liquidity Mismatch

Assets	Liabilities
\$50 1-Year Loan	\$20 Equity
\$50 Agency-MBS	\$50 Repo debt
	\$30 5-Year debt

- *LMI places a larger weight on repo debt than Agency MBS*
- *This bank's $LMI < 0$*

Example 1: Liquidity Mismatch

Assets	Liabilities
\$50 1-Year Loan	\$20 Equity
\$50 Agency-MBS	\$50 Repo debt
\$50 Private-Label-MBS	\$30 5-Year debt

- *The asset-side is less liquid (lower liquidity weight)*
- *LMI is more negative*

Example 2: Rehypothecation

- Dealer lends \$90 to a hedge fund against \$90 of MBS collateral in an overnight repo
- Dealer posts \$90 of MBS collateral to money market fund and borrows \$90 in an overnight repo

Assets	Liabilities
\$10 Treasuries	\$10 Equity
\$90 Loan to Hedge Fund	\$90 of Repo Debt

- $LMI > 0$ because of Treasury holdings
- What if hedge fund loan was 10 days? LMI falls...

Example 3: Credit Lines

- Bank with \$20 of equity and \$80 of debt
- The bank buys \$100 of U.S. Treasuries
- Offers a credit line to a firm to access upto \$100.
- $LMI < 0$ in state(s) $\omega \in \Omega$ where credit line is accessed.

Example 4: Derivatives

- Bank with \$20 of equity and \$80 of debt
- The bank buys \$100 of U.S. Treasuries
- Writes protection on a diversified portfolio of 100 investment-grade U.S. corporates, each with a notional amount of \$10; so there is a total notional of \$1,000.
- $LMI < 0$ in state(s) $\omega \in \Omega$ where CDS causes a mark-to-market

How can you use the LMI?

1. Liquidity aggregation
2. Scenario analysis and liquidity risks
3. Gauging feedbacks and spillovers

Liquidity Map

- Liquidity measures aggregate
 - ▣ If bank A holds o/n repo on Bank B
 - Bank A is long liquidity, Bank B is short liquidity
 - More generally, there is netting of asset and liability liquidity
 - ▣ If bank A holds \$100 of Treasuries and Bank B holds \$100 of Treasuries
 - Total liquidity reflects total holding of \$200
- Aggregate LMI equals a “liquidity aggregate”
 - ▣ Analogy to (old days) monetary aggregates
 - ▣ Monetary aggregation with weights $\{\lambda\}$ along the lines of Barnett
- *Note: Measures designed to allow for some cross-checking, like Flow of Funds.*

Liquidity Pockets

- Sectoral LMI
 - ▣ Guess: Banking sector is net short liquidity
 - But, to whom, how much, etc.
 - ▣ Guess: Corporate, household sectors are long liquidity
- 2000 to 2008 build up
 - ▣ Guess: Aggregate liquidity rises (good), but LMI for financial sector is more negative (bad)
- Identify systemically important institutions
 - ▣ $LMI < 0$ identifies “financial intermediary”
 - ▣ Lowest LMIs are the systemically important ones

Liquidity Chains

- Baseline case: Symmetric weights $\{\lambda\}$
 - i.e. Asset weights $\{\lambda\}$ match liability weights $\{\lambda\}$
- Consider asymmetric case:
 - Bank A owns \$100 short-term repo issued by bank B:
 - Asset weight = 0.95
 - Bank B issues \$100 short-term repo:
 - Liability weight = 1
- Measurement: liquidity chains (A owes to B owes to C...) causes a contraction in aggregate liquidity

Stress Testing

- Define $\Lambda = \{\lambda\}$
- Consider stress scenarios as specifying Λ^ω
 - ▣ Move all $\{\lambda\}$ in a percentage shift
 - ▣ Move all λ s of MBS in a percentage shift
 - ▣ Move all λ s of long-term assets in a percentage shift
- Measurement: Identify states of the world where imbalances are high

Liquidity Risk

- $\{LMI^\omega\}$ is the *liquidity risk* taken by the firm
 - Portfolio decision at date 0 is over assets/liabilities
 - Asset/liability choices result in $\{LMI^\omega\}$
- Research: Given a time series of $\{LMI^\omega\}$, we can build empirical models of firm liquidity choices.
 - Analogy: We use the CEX to model household spending behavior and test asset pricing models.

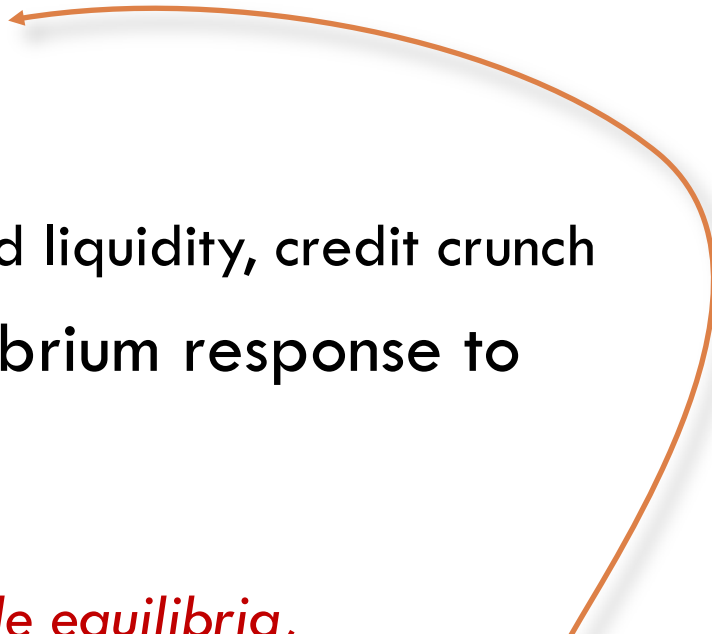
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Calibrating Response Function

- In addition, to liquidity, let us measure value (equity or enterprise value) of firm(s) in each state.
- Data presents a history of “date 0”s in varying conditions
 - Each date is a portfolio choice, Δ , as a function of current firm value/liquidity and current state of economy
 - Panel data
 - Estimate/model the portfolio choice of firms.

General equilibrium modeling

- In each state we know **direct** responses to 5%, 10%, 15%,... drop in MBS in terms
 - ▣ Value, Liquidity index
 - Predict response function
 - ▣ Try to “fire” sell assets, hoard liquidity, credit crunch
 - Derive likely **indirect** equilibrium response to
 - ▣ this stress factor
 - ▣ other factors
- 

*Externalities, multiple equilibria,
amplification, mutually inconsistent plans,...*

Summary

- Benchmark proposal for measuring liquidity
 - Liquidity Mismatch Index
- Measures capture relevant exposures
- Measures are useful to diagnose systemic liquidity risk