



FEDERAL RESERVE BANK *of* NEW YORK

# Treasury Market Liquidity: An Overview

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13th International Monetary Fund Public Debt Management Forum  
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The views expressed in this presentation are those of the author and do not necessarily represent the views of the Federal Reserve Bank of New York of the Federal Reserve System

# Outline

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1. Treasury Market and Funding Liquidity Measures
2. Market Illiquidity Events
3. Pricing of Liquidity
4. Supply Effects
5. Trading Technology



# Treasury Market and Funding Liquidity

**Market liquidity** (see O'Hara 1997, Fleming EPR 2003)

1. Trading volume, trading frequency
2. Bid-ask spread, quote size, trade size
3. Depth, price impact

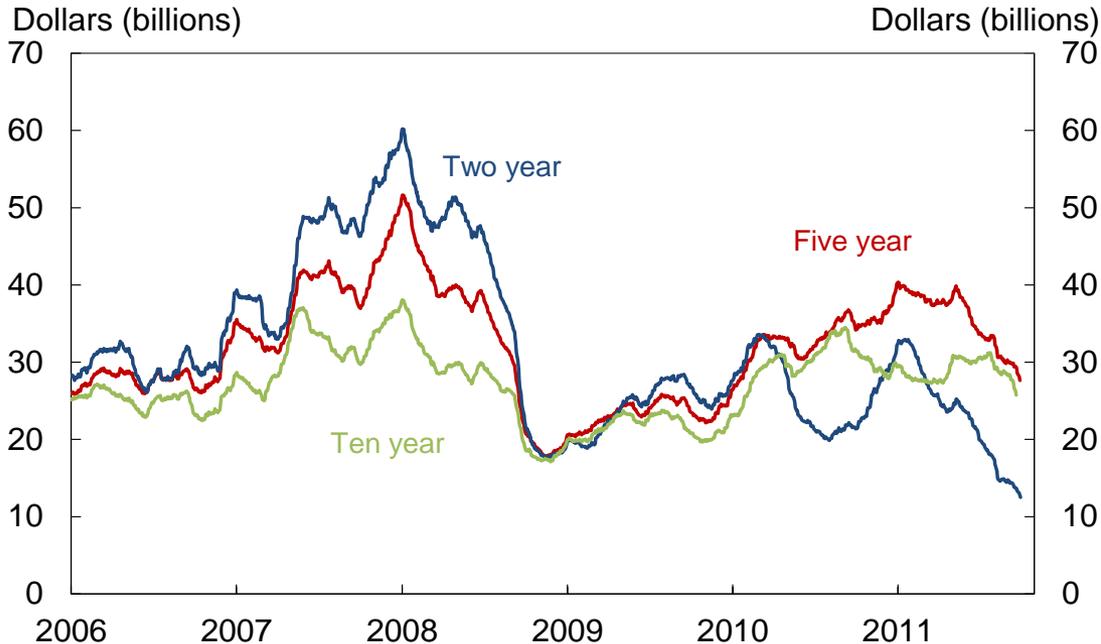
**Funding liquidity** (Brunnermeier Pedersen RFS 2009, Vayanos Vila 2009, Fleming Rosenberg 2008, Adrian Fleming 2005)

1. Balance sheet capacity of dealers
  2. Balance sheet capacity of arbitrageurs
- Market liquidity and funding liquidity are mutually reinforcing
  - Supply shocks affect both



# Trading Volume

## Daily Trading Volume



Source: Engle, Fleming, Ghysels, and Nguyen (2013)

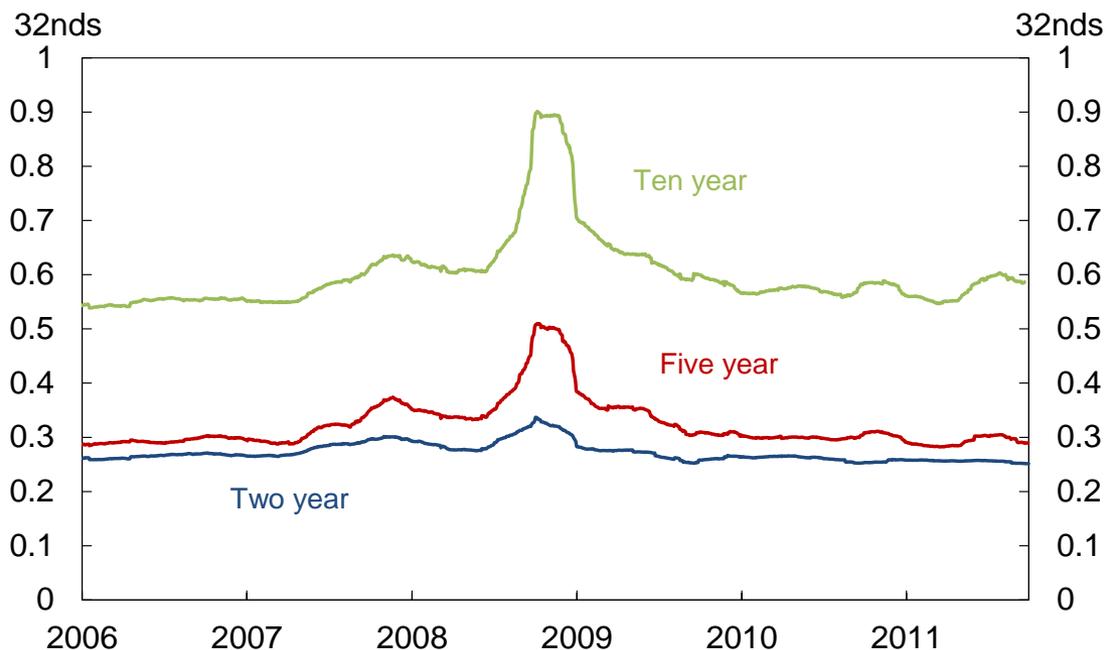
Note: 3-month moving average.

- Trading volume of Treasury securities increased sharply at the beginning of the crisis (August 2007-March 2008), and then declined sharply for the rest of 2008.
- While the five year and ten year bonds have seen an increase in volume since the beginning of 2009, the two year's trading volume has kept declining.
- The decline of trading in the two year maturity likely reflects the sustained low level of short-term interest rates.



# Bid-Ask Spreads

Bid-Ask Spreads



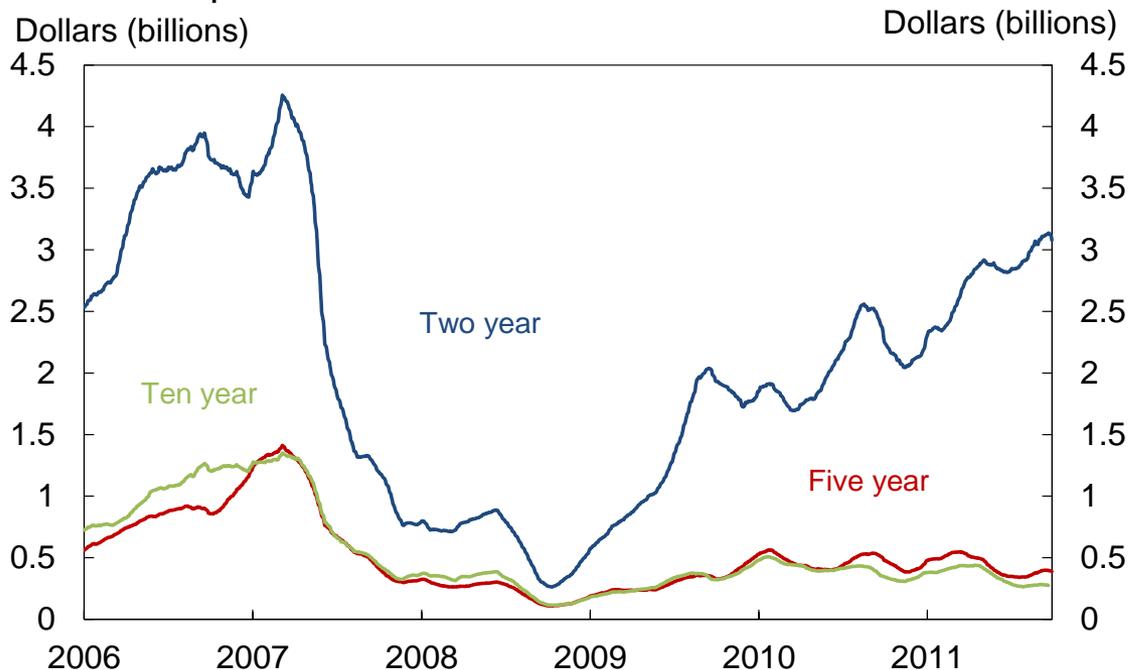
Source: Engle, Fleming, Ghysels, and Nguyen (2013)

Note: 3-month moving average.

- Bid-ask spreads are computed from the trading book as the difference between the best bid and ask.
- Bid-ask spreads increased dramatically during the financial crisis, despite the sharp increase in volume.
- The increase in bid-ask spreads reflect uncertainty at that time, as well as the reduced balance sheet capacity of dealers.
- Bid-ask spreads have reverted back to pre-crisis levels since then.

# Market Depth

Quoted Depth in the Book Across All Price Levels



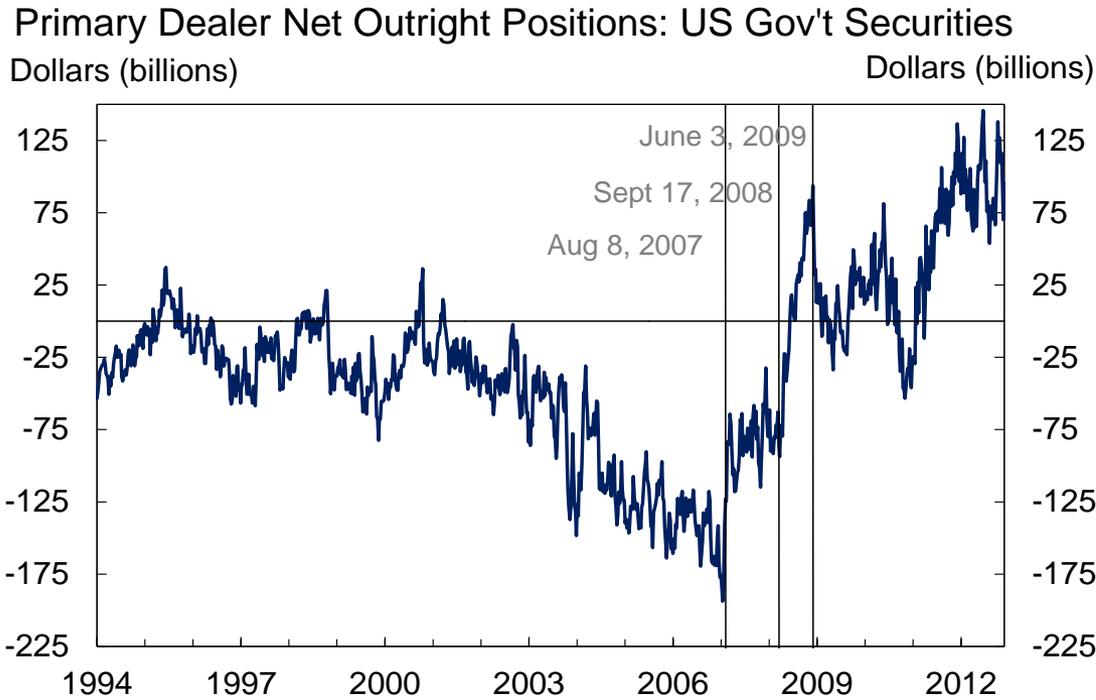
Source: Engle, Fleming, Ghysels, and Nguyen (2013)

Note: 3-month moving average.

- Market depth measures the amount that can be traded at a given moment in time as indicated by the trading book.
- The measure reported here aggregates the bid and the ask depth across the book and averages across the two.
- Market depth declined dramatically during the financial crisis, and has not fully recovered since.
- The decline of market depth might reflect dealers' diminished market making capacity since the crisis.



# Dealer Inventories



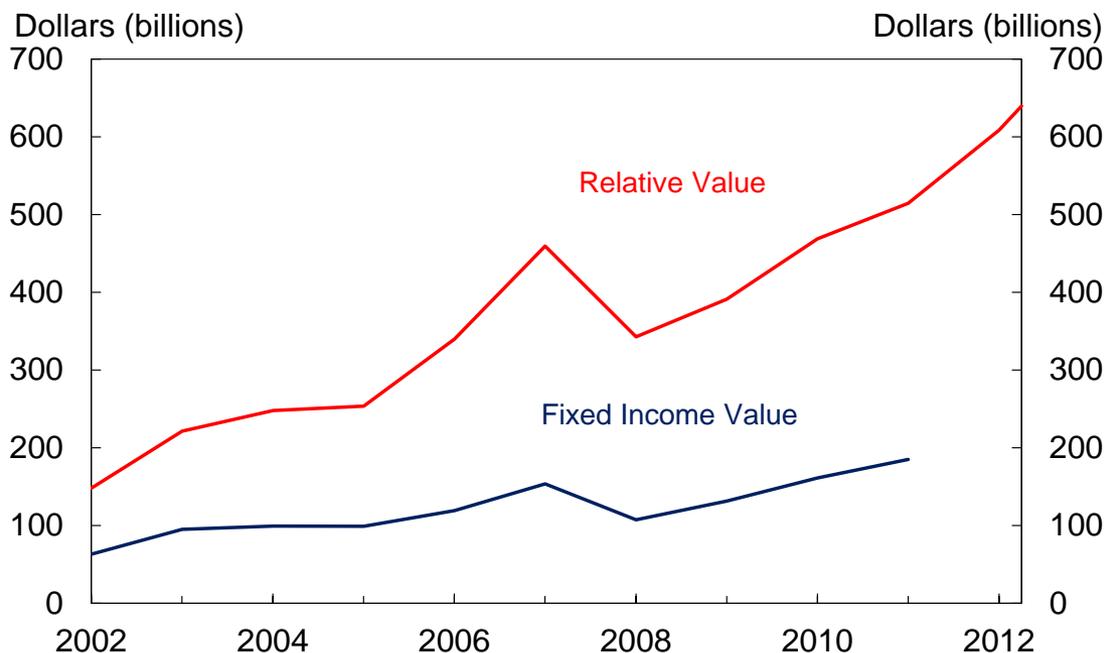
Source: Federal Reserve

- Primary dealer net outright positions in U.S. government securities exhibit a sharp reversal since the beginning of the crisis.
- Dealers used to be long corporates, agencies, MBS/ABS, and short Treasuries.
- This spread trade got unwound with the crisis.
- Since the end of the crisis, dealers have been long Treasuries.
- Overall size of dealers has declined markedly.



# Fixed Income Hedge Fund AUM

## Hedge Fund Assets Under Management



Source: Hedge Fund Research

- Fixed income arbitrage is a classic investment strategy that is a textbook case for the economics of “limits to arbitrage.”
- The most basic strategy is to bet that deviations from a Treasury valuation model are temporary, i.e. betting on convergence.
- In times of market turbulence, as some arbitrageurs are forced to unwind, temporary losses can spread across desks and funds, as was arguably the case in 1998 and 2008.
- Among relative value strategies, fixed income arbitrage has lost AUM recently.



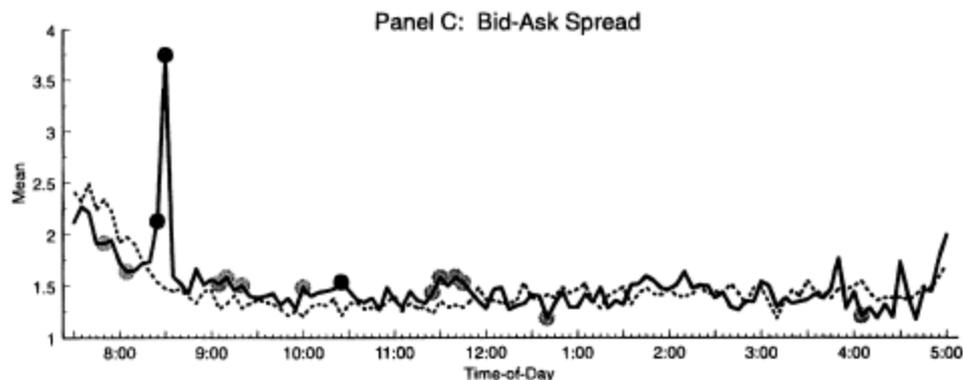
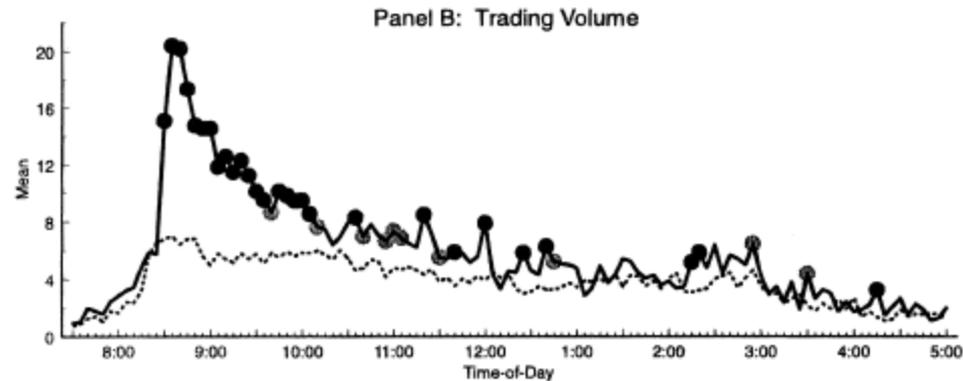
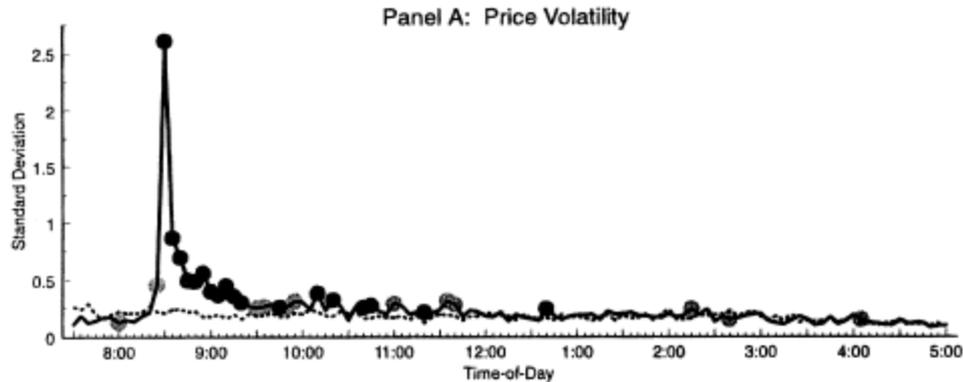
# Outline

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1. Treasury Market and Funding Liquidity Measures
2. Market Illiquidity Events
3. Pricing of Liquidity
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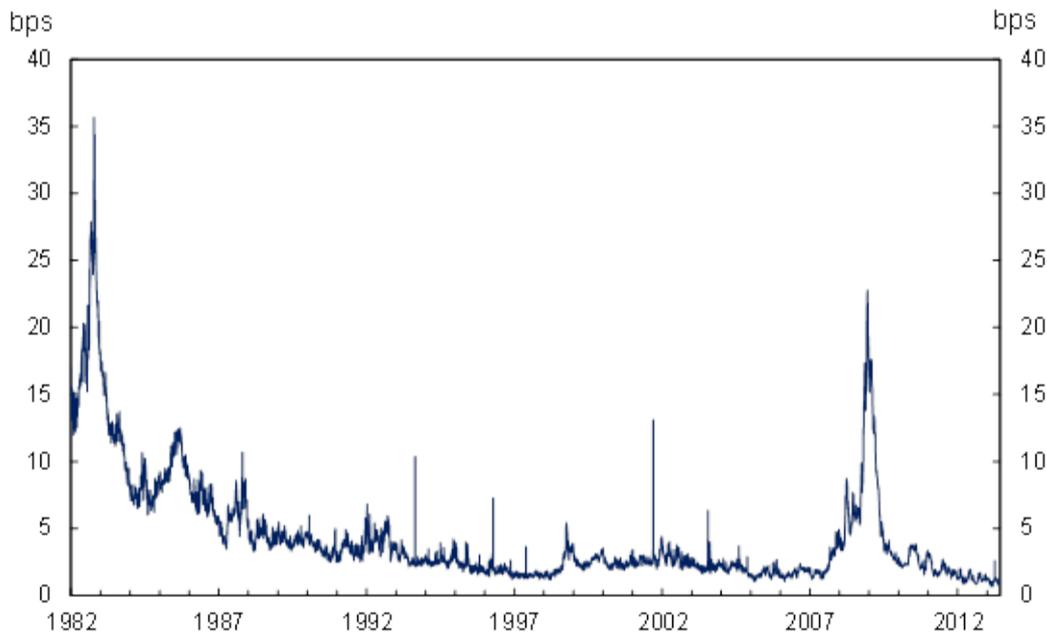
# Treasury Liquidity Around Macro Announcements



- Intraday liquidity patterns are from Fleming and Remolona (JF 1999).
- Price volatility spikes around announcement times.
- Trading volume higher throughout the day.
- Bid-ask spreads revert quickly.

# Treasury Yield Curve Fitting Errors

Treasury Yield Curve Average Absolute Fitting Errors

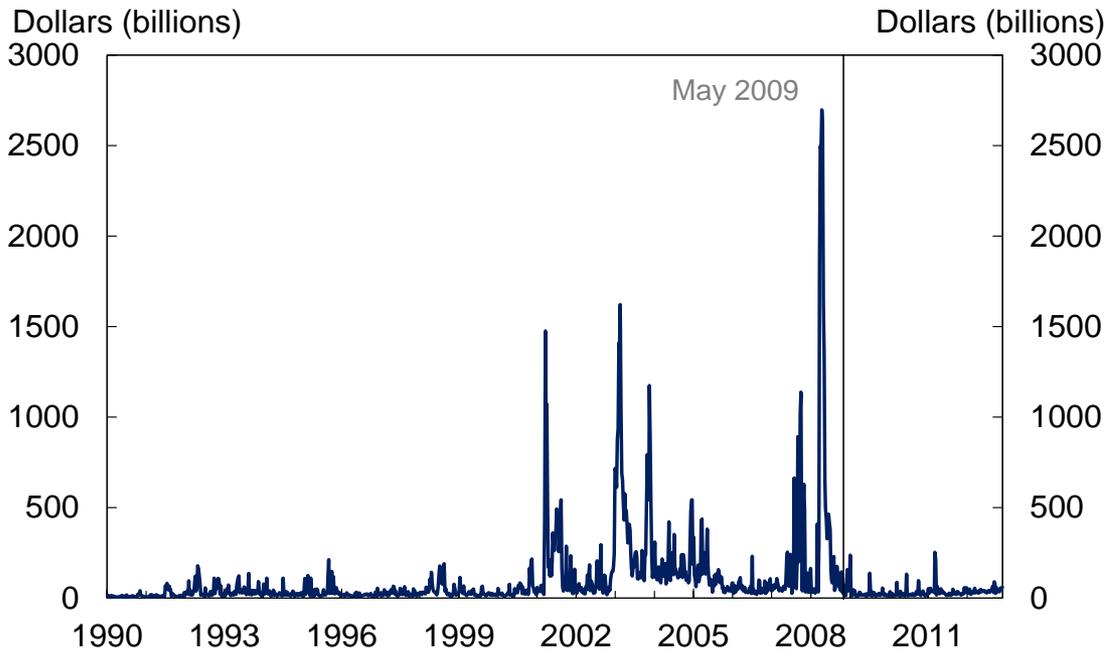


Source: Federal Reserve Board

- Treasury pricing is often modeled with a yield curve.
- Yield curve fitting errors are a proxy for limits to arbitrage due to limited balance sheet capacity of dealers and arbitrageurs.
- Hu, Pan, Wang (NBER 2010) show that shocks to the yield curve fitting errors constitute an asset pricing factor.
- Previous studies (see Fleming EPR 2000) plotted the yield curve fitting errors as a measure of Treasury market illiquidity.

# Primary Dealer Fails to Receive Treasury Securities

Primary Dealer Fails to Recieve: U.S. Treasury Securities



Source: FRBNY

- Failure to deliver specific collateral in outright, repo, and sec lending transactions was common until the introduction of the fails charge in 2009.
- In May 2009, a penalty for failing to deliver collateral in outright, repo, and securities lending transactions was introduced.
- The charge had been under consideration for many years, and the spike in fails following the Lehman crisis with rates near zero triggered the implementation of the charges.

# Specialness: Adoption of the Fails Charge

Special Rates of the On-the-run 2-, 5-, and 10-Year Notes

- The fails charge improved market functioning, as indicated by the negative specials rates.
- Negative specials rates have become common, indicating the scarcity of Treasuries on special.
- Garbade, Keane, Logan, Stokes, Wolgemuth (EPR 2010) explain the functioning, history, and impact of the fails charge in detail.

Source: Fleming, Krishnan, Reed (2013)

# Outline

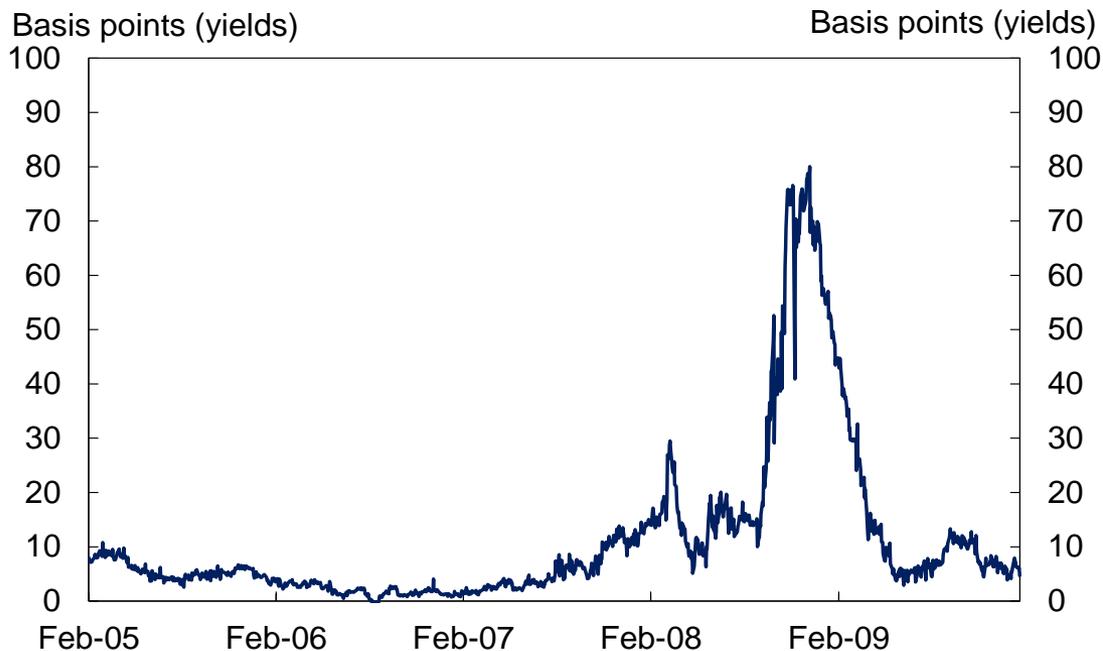
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# Pricing Impact of Liquidity

Pricing Impact of Liquidity



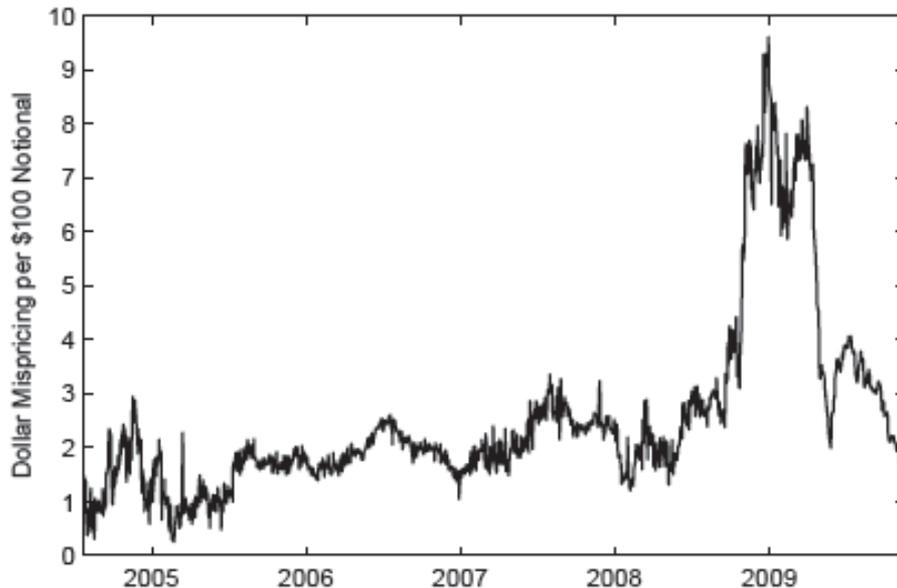
Source: CRSP

This figure presents the time series of the difference between the yields to maturity on two Treasury securities: an original-issue 30 year bond and an original-issue 10 year note. Both securities mature on February 15, 2015. The bond was, originally issued in 1985 with a coupon of 11.25 percent; the note was originally issued in 2005 with a coupon of 4 percent.

- Treasury securities with identical cash flows do not always cost the same.
- This was first shown by Amihud and Mendelson (JF 1991), and is most dramatically illustrated by Musto, Nini, Schwartz (2012) (see plot).
- Bonds traded for much less than notes due to the relative illiquidity [exact cash flow replication via STRIPS generates a similar plot].
- In 2008, the funding constraints of dealers and arbitrageurs meant that mispricing was not arbitrated away.

# Pricing TIPS Illiquidity

TIPS-Treasury Basis

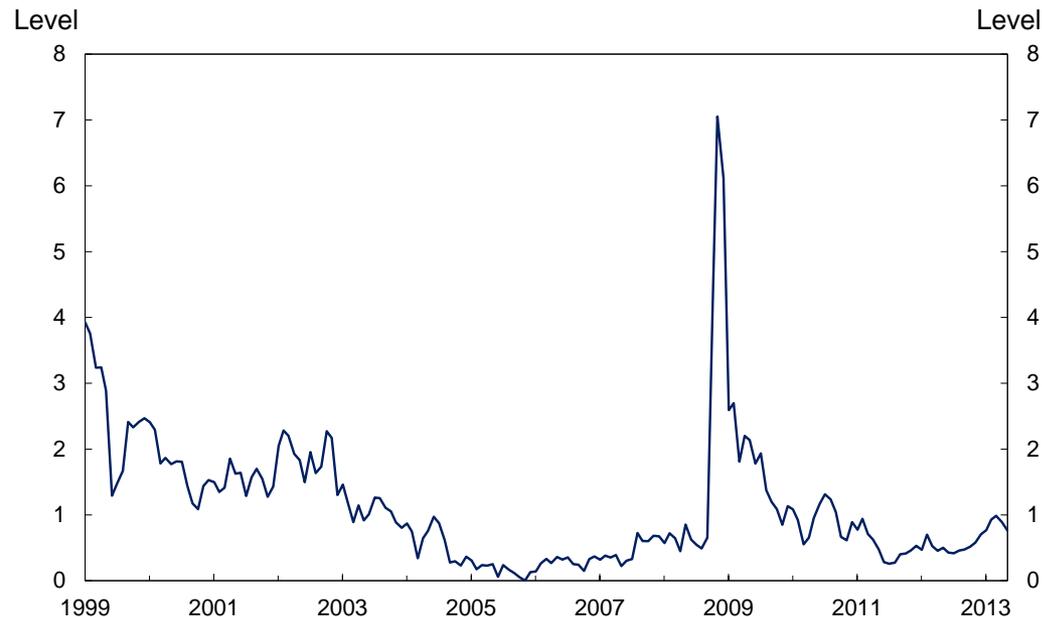


Source: Fleckenstein, Longstaff, Lustig (JF, forthcoming)

- Another example of the limits to arbitrage capacity during the crisis can be seen from the TIPS-Treasury basis.
- The basis is constructed by replicating the cash flows of Treasury securities using TIPS, inflation swaps, and STRIPS.
- The positive basis reflects the relative illiquidity of the replicating strategy and widens significantly in times of stress.
- Fleckenstein, Longstaff, Lustig (JF 2012) argue that the relatively higher funding cost of issuing TIPS should be taken into account in debt management strategy.

# TIPS Illiquidity in a Term Structure Model

AACM Illiquidity Factor



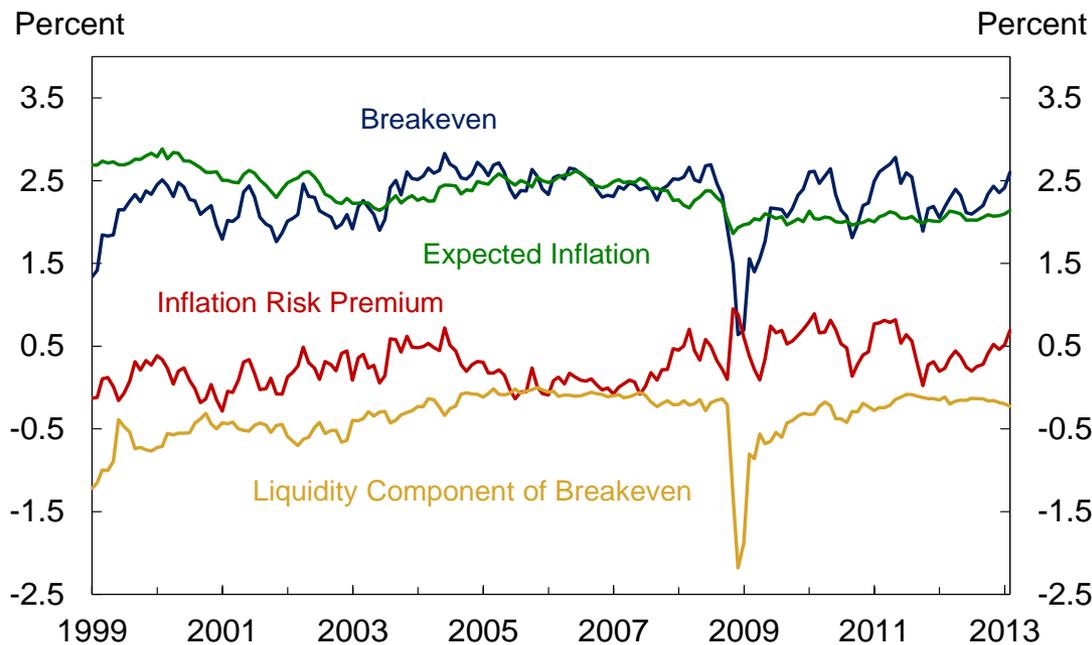
Source: FRBNY Calculations

- When modeling the joint dynamics of the TIPS and Treasury yield curves, the relative illiquidity of TIPS must be taken into account explicitly.
- Abrahams, Adrian, Crump, Moench (2012) derive an illiquidity factor from the relative yield curve fitting error, and the relative volume of the TIPS and Treasuries.
- The illiquidity factor helps to explain the joint real and nominal yield curve dynamics.



# Liquidity and Risk Premia for Breakevens

AACM 10-Year Yield Decomposition

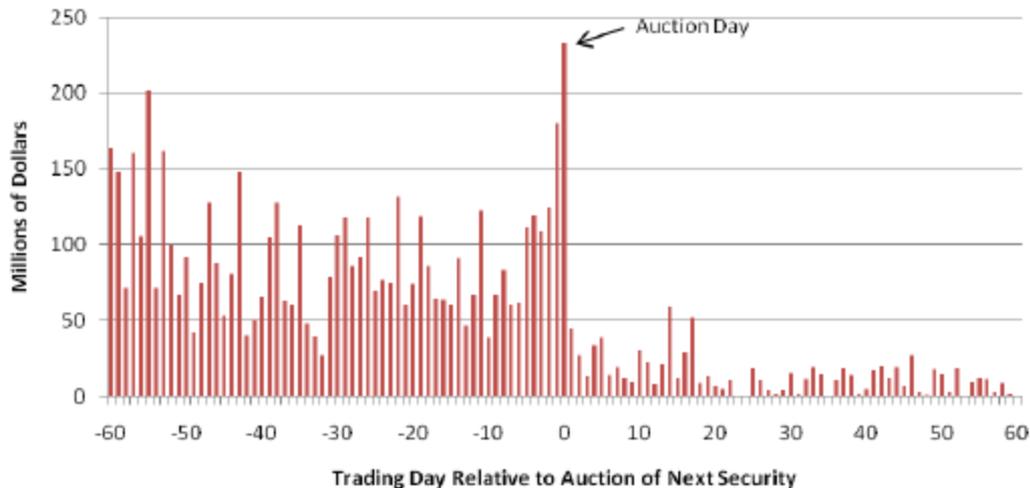


Source: FRBNY Calculations

- Breakevens experienced a sharp drop in the aftermath of the Lehman bankruptcy, reflecting fire sales of TIPS.
- Breakevens are thus driven by liquidity events, as well as inflation risk premia and inflation expectations.
- By adjusting for the illiquidity premium within the AACM term structure model, the inflation expectations implied by the TIPS and Treasury yield curves are stable through the 2008 crisis.

# On-the-run Liquidity

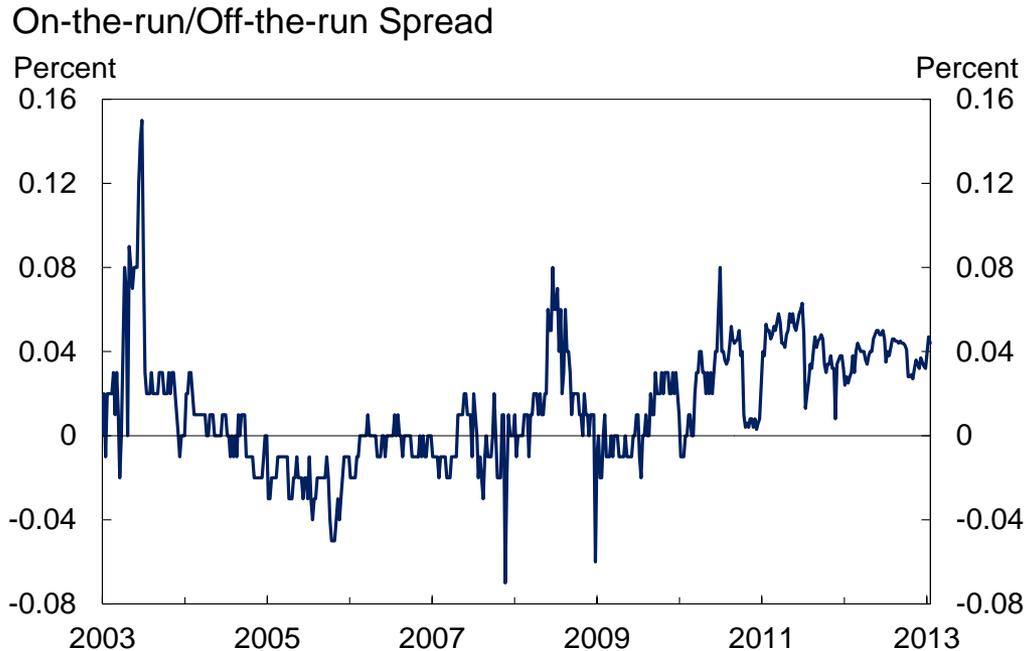
Trading Volume around off-the-run dates



Source: Fleming and Krishnan (2012)

- Liquidity of most recently issued “on-the-run” securities is much larger than the liquidity of off-the-run securities.
- As a new security gets issued, volume drops off sharply, a phenomenon specific to the US which ensures low trading costs for on-the-run 2, 5, 10 years.
- In Germany, liquidity is determined by futures contract deliverability while in Japan there are arbitrary “benchmark” securities.
- Barclay Hendershott Kotz (JF 2006) show that the share of trading on electronic trading platforms drops from 81% to 12% when securities go off the run.

# On-the-run/Off-the-run Spread



Source: Haver Analytics

- Krishnamurthy (JFE 2002) argues that the spread between the on-the-run and the off-the-run is a liquidity measure.
- This spread is sometimes used as a proxy for illiquidity, as cash flows of the on the run and closest off the run security are very similar.
- Repo rates also differ between on the run and off the run securities.
- However, the spread is difficult to estimate, and does not correspond closely to other liquidity measures.

# Outline

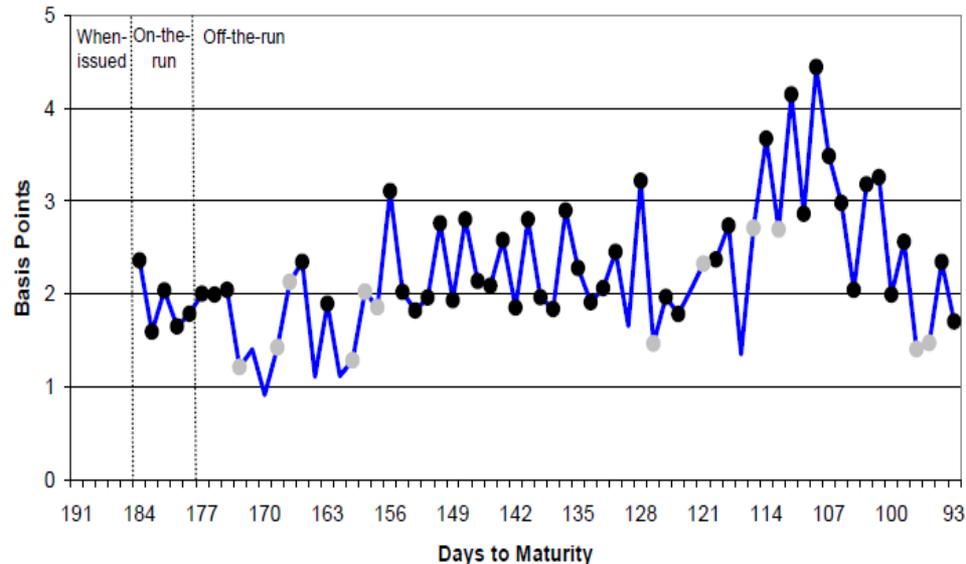
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# Pricing Effects of Bill Re-openings

Pricing Differences due to Bill Re-openings

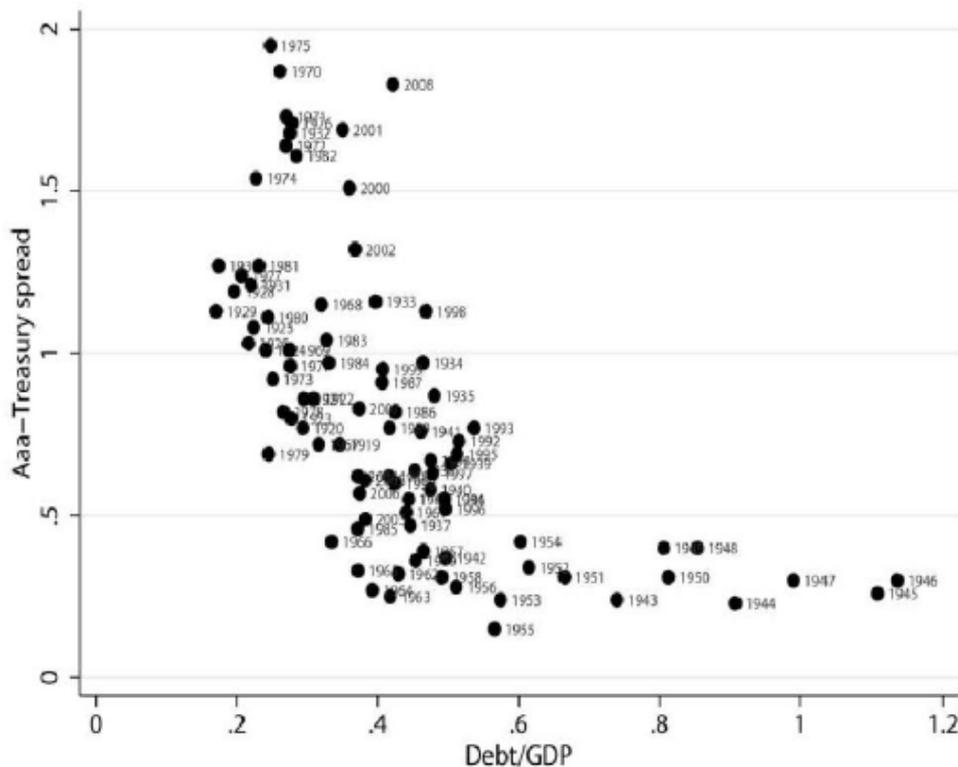


Source: Fleming (JM CB 2004)

- The figure plots differences in butterfly spreads between bills originally issued as 52-week bills and those originally issued as 26-week bills by days to maturity for both 26- and 13-week bills.
- Shaded and solid circles indicate differences significant at the 5% and 1% levels, respectively.
- The re-openings show that larger issues are significantly cheaper, despite being more liquid.

# Convenience Yield and Treasury Supply

Aaa-Treasury spread versus Government Debt-to-GDP

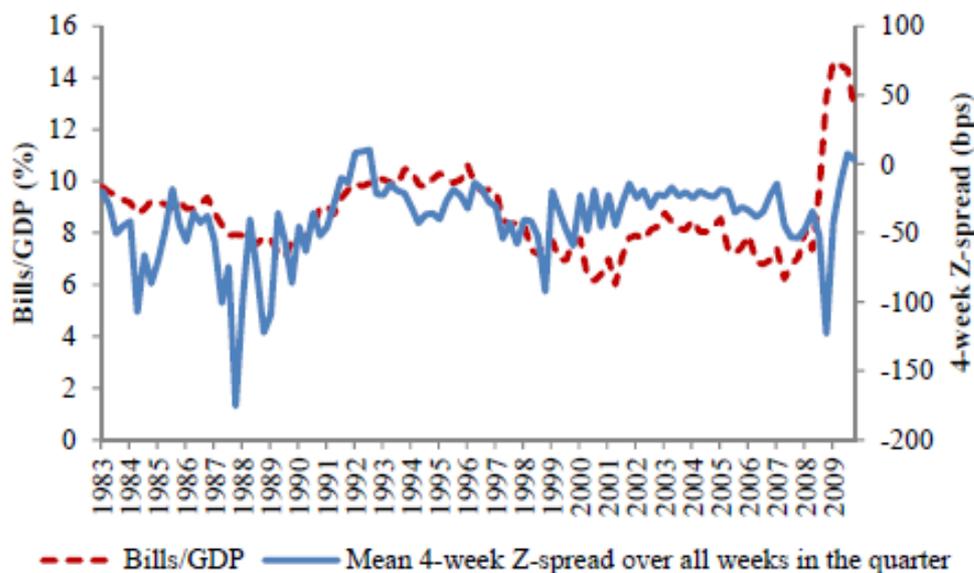


Source: Krishnamurthy and Vissing-Jorgensen (JPE 2012)

- Treasuries tend to be expensive when the government debt to GDP ratio is low.
- Treasuries are expensive as they offer liquidity service to households and firms.
- When the amount of liquid assets supplied by the government is limited, the private sector supplies substitutes.
- Hanson, Greenwood, Stein (JF 2010) show that corporations issue long term debt when Treasury does not (“gap filling theory”).

# Comparative Advantage Approach to Government Debt Maturity

The Money Premium on Short-term Treasury Bills, 1983-2009

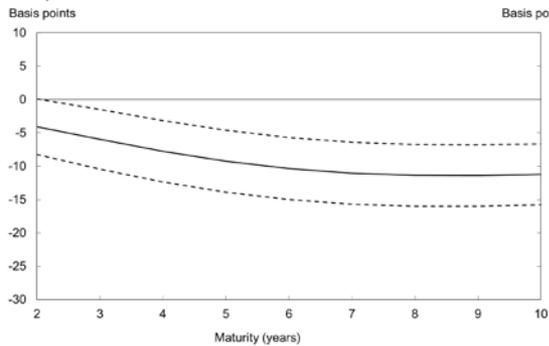


Source: Hanson, Greenwood, Stein (2012)

- The liquidity discount of bills (“Z-spread”) correlates with the bill/GDP supply.
- This reflects the liquidity value of Treasury bills.
- Hanson, Greenwood, Stein (2012) argue that the government has a comparative advantage relative to the private sector in bearing refinancing risk, and hence should aim to (partially) crowd out the private sector’s use of short-term debt.
- Sunderam (2012) is linking the bill supply to incentives for shadow banking activities.

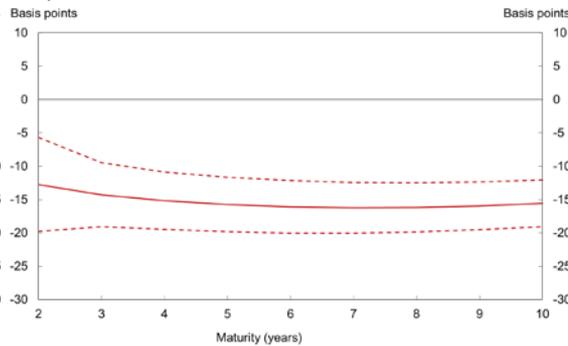
# LSAP Announcement Effects on Treasury Yields

Response of Nominal Yields



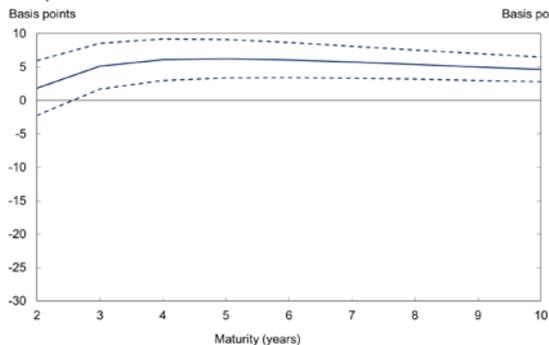
Source: FRBNY Calculations

Response of Real Yields



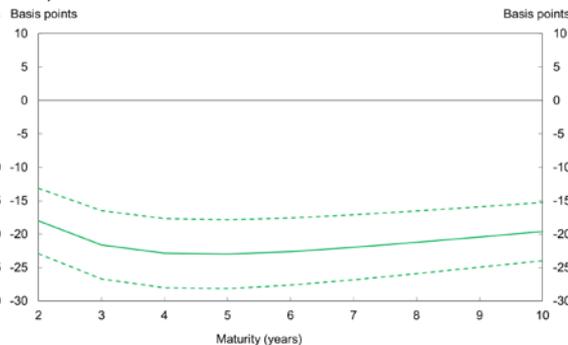
Source: FRBNY Calculations

Response of Risk Neutral Real Yields



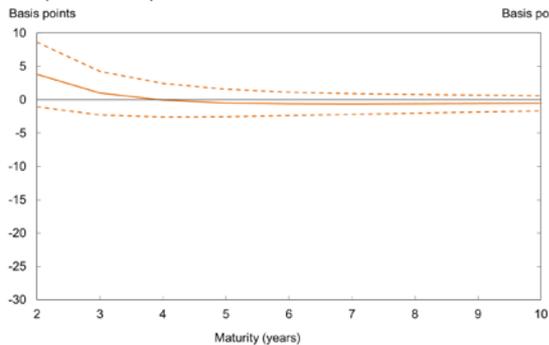
Source: FRBNY Calculations

Response of Real Term Premium



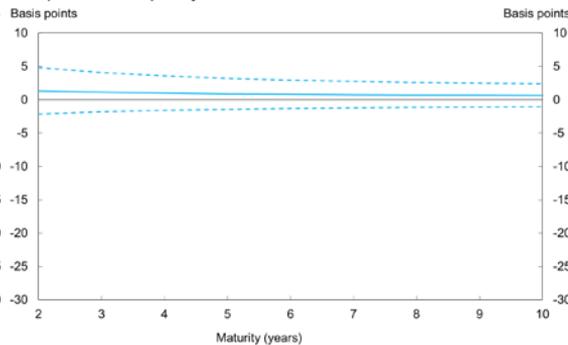
Source: FRBNY Calculations

Response of Expected Inflation



Source: FRBNY Calculations

Response of Liquidity



Source: FRBNY Calculations

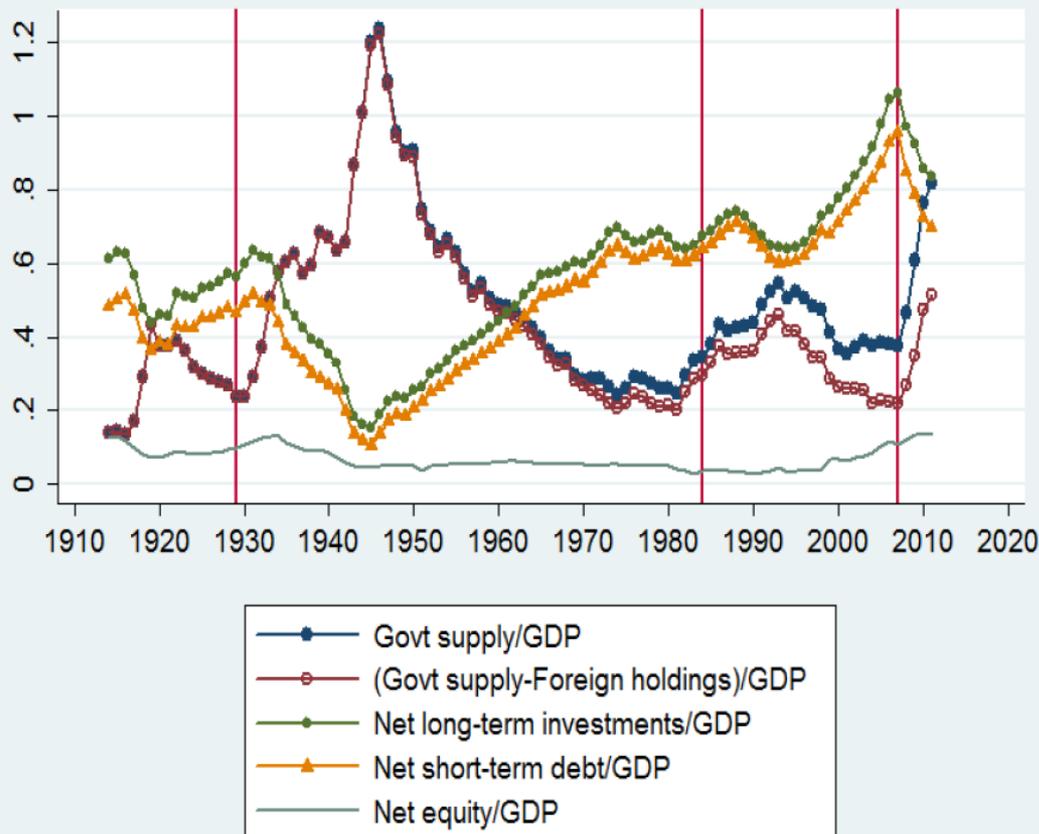
- The AACM term structure model allows decomposition of Treasury and TIPS reactions to LSAP announcements.

- The main impact of the nominal yield curve is due to the movement of the real forward curve, inflation expectations do not react.

- The liquidity premium also reacts significantly to the LSAP announcements.

- The interpretation is that LSAPs remove interest rate risk and liquidity risk, but do not change the outlook for inflation, and only marginally impact expectations of future short rates.

# Impact of Treasury Supply on Financial Sector Balance Sheets



- Krishnamurthy and Vissing-Jorgensen (2013) link Treasury supply to financial stability:
  1. Financial sector's *net supply of short-term debt* (ST debt minus financial sector's Treasury holdings) is crowded out by Treasury supply.
  2. Net short-term debt should be a good predictor of *financial crisis* (better than loans, the standard predictor used).
- Short term debt to GDP might be a better financial stability indicator than credit to GDP.

# Outline

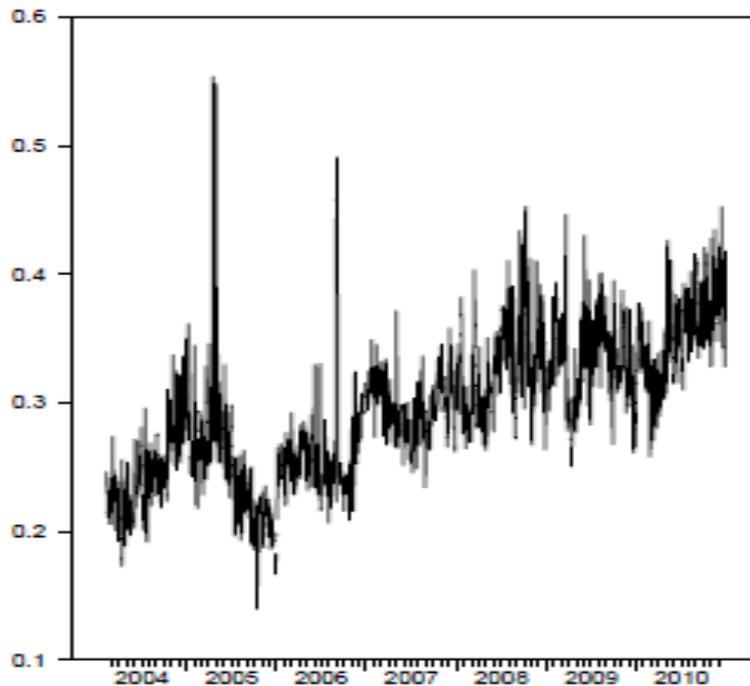
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# The Rise of Electronic Trading and High Frequency Trading in the Treasury Market

Share of High Frequency Trading



Source: Liu, Lo, Nguyen, Valente (2013)

- Electronic trading has increased dramatically across markets, including the Treasury market.
- Particularly notable is the subset of electronic trading due to high frequency trading, that comprises more than one third of total trading.
- Electronic and high frequency trading changes the dynamics of market and funding liquidity, and potentially raises new sources of liquidity risk.
- Much work remains to be done to understand the impact of electronic and high frequency trading.

# Summary

- Liquid Treasury securities have a lower yield than less liquid Treasuries or other securities with similar cash flows.
- This liquidity premium increases in times of market stress or crises due to flight to quality.
- The private sector substitutes for changes in Treasury supply by debt issuance or money creation.
- The liquidity role of Treasury securities is an aspect of debt management policy that has received much attention in the recent literature.

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