The Liquidity State-Dependence of Monetary Policy

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16th Annual Paul Woolley Centre Conference and 4th Annual Conference on Non-Bank Financial Sector and Financial Stability

7 June 2024

Motivation

"The effectiveness of changes in central-bank targets (...) in affecting spending decisions is wholly dependent upon the impact of such actions upon other financial-market prices such as longer-term interest rates (...) These are plausibly linked, through arbitrage relations to the short-term interest rates most directly affected by central-bank actions." (Woodford, 2003)

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- Growing consensus that frictions to arbitrage matter for the macroeconomy Gromb-Vayanos (2002), He-Krishnamurthy (2013).
- Frictions even in the most liquid market in the world: US Treasuries (Duffie, 2023) and UK gilts (Pinter-Siriwardane-Walker, 2024)
- Conventional monetary policy transmission relies on arbitrage, but even in liquid bond markets arbitrage is imperfect

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Use both macro and micro data to explore if arbitrageur activity is a driver (Nakamura-Steinsson (2018) meets Vayanos-Villa (2021)

What we find

- **Result 1**: Transmission of monetary policy shocks to long-maturity interest rates occurs when liquidity is *high*
  - 100 bps shock to nominal 1Y yield $\rightarrow$ 10Y moves by 38 bps
  - When liquidity is high, same shock moves 10Y by 124 bps!

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- **Result 3**: Persistent state-dependent response also for mortgage rates (macro-relevance)

Both macro and micro data show that arbitrage activity is a key driver!

Data

1. **Aggregate data**
   - Proxy liquidity with the noise measure of Hu et al (2013)
   - Proxies for arbitrage capital (hedge fund strategies returns)
   - Zero-coupon Yield Curves (Gurkaynack, Sack and Swanson (2006))
   - High-Frequency MP shocks (Nakamura-Steinsson (2018), Acosta (2023))

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2. **Granular transaction-level dataset (MIFID II)**
   - Trades by UK-regulated entities in US Treasuries (6%< of the market)
   - identify arbitrageurs from trading behavior (in line with theory)
   - More trading done by arbitrageurs in days where liquidity is high, particularly so for longer maturities

The Liquidity-State Dependence

$\Delta f_{i,t}^{(\tau)} = \alpha + \beta_i^{(\tau)} \Delta mps_t + \epsilon_{i,t}^{(\tau)}$

Table: The Liquidity State Dependence in Nakamura-Steinsson (QJE, 2018)

	Baseline		
	Nom.	Real	Inf.
3M Treasury yield	0.67***		
	(0.14)		
6M Treasury yield	0.85***		
	(0.11)		
1Y Treasury yield	1.00***		
	(0.14)		
2Y Treasury yield	1.10***	1.06***	0.04
	(0.33)	(0.24)	(0.18)
3Y Treasury yield	1.06***	1.02***	0.04
	(0.36)	(0.25)	(0.17)
5Y Treasury yield	0.73***	0.64***	0.09
	(0.20)	(0.15)	(0.11)
10Y Treasury yield	0.38**	0.44***	-0.06
	(0.17)	(0.13)	(0.08)
2Y Treasury inst. forward rate	1.14**	0.99***	0.15
	(0.46)	(0.29)	(0.23)
3Y Treasury inst. forward rate	0.82*	0.88***	-0.06
	(0.43)	(0.32)	(0.15)
5Y Treasury inst. forward rate	0.26	0.47***	-0.21**
	(0.19)	(0.17)	(0.08)
10Y Treasury inst. forward rate	-0.08	0.12	-0.20**
	(0.18)	(0.12)	(0.09)

The Liquidity-State Dependence

$$\Delta f_{i,t}^{(\tau)} = \alpha + \beta_{i,hl}^{(\tau)} \Delta mps_t 1_{\text{HighLiq}_{t-1}} + \beta_{i,ll}^{(\tau)} \Delta mps_t 1_{\text{LowLiq}_{t-1}} + \epsilon_{i,t}^{(\tau)}$$

Table: The Liquidity State Dependence in Nakamura-Steinsson (QJE, 2018)

	Baseline			Low noise			High noise		
	Nom.	Real	Inf.	Nom.	Real	Inf.	Nom.	Real	Inf.
3M Treasury yield	0.67***			0.61***			0.69***		
	(0.14)			(0.16)			(0.19)		
6M Treasury yield	0.85***			0.74***			0.90***		
	(0.11)			(0.16)			(0.14)		
1Y Treasury yield	1.00***			1.48***			0.81***		
	(0.14)			(0.12)			(0.18)		
2Y Treasury yield	1.10***	1.06***	0.04	1.83***	1.69***	0.14	0.69*	0.70**	-0.01
	(0.33)	(0.24)	(0.18)	(0.23)	(0.32)	(0.33)	(0.41)	(0.29)	(0.20)
3Y Treasury yield	1.06***	1.02***	0.04	1.92***	1.72***	0.20	0.57	0.62**	-0.05
	(0.36)	(0.25)	(0.17)	(0.27)	(0.33)	(0.28)	(0.43)	(0.29)	(0.20)
5Y Treasury yield	0.73***	0.64***	0.09	1.68***	1.58***	0.10	0.34	0.26*	0.08
	(0.20)	(0.15)	(0.11)	(0.24)	(0.20)	(0.18)	(0.21)	(0.14)	(0.14)
10Y Treasury yield	0.38**	0.44***	-0.06	1.24***	1.24***	0.00	0.03	0.11	-0.08
	(0.17)	(0.13)	(0.08)	(0.20)	(0.16)	(0.12)	(0.17)	(0.12)	(0.11)
2Y Treasury inst. forward rate	1.14**	0.99***	0.15	2.25***	1.76***	0.49*	0.50	0.55*	-0.05
	(0.46)	(0.29)	(0.23)	(0.35)	(0.38)	(0.29)	(0.51)	(0.33)	(0.25)
3Y Treasury inst. forward rate	0.82*	0.88***	-0.06	1.96***	1.77***	0.18	0.17	0.38	-0.21
	(0.43)	(0.32)	(0.15)	(0.45)	(0.42)	(0.20)	(0.44)	(0.31)	(0.19)
5Y Treasury inst. forward rate	0.26	0.47***	-0.21**	1.17***	1.26***	-0.09	-0.12	0.15	-0.26**
	(0.19)	(0.17)	(0.08)	(0.30)	(0.25)	(0.13)	(0.19)	(0.17)	(0.11)
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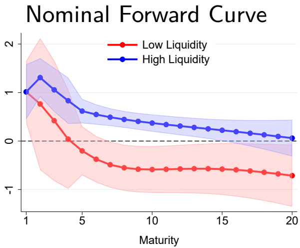
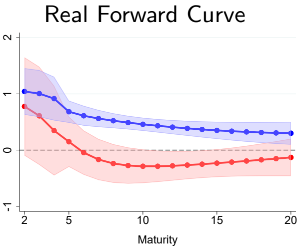
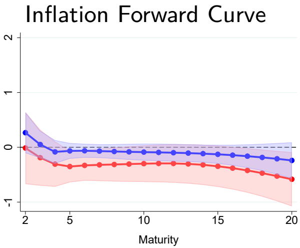
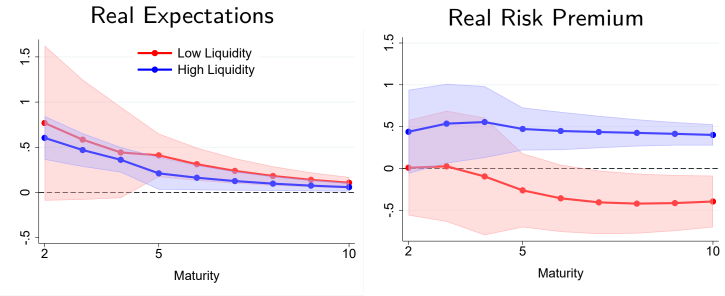






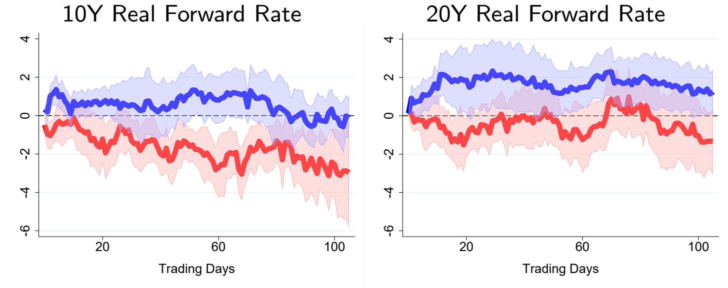
Expectations vs Risk Premium

$f_{i,t}^{(\tau)} = eh_{i,t}^{(\tau)} + rp_{i,t}^{(\tau)}$



Persistence

$f^{(\tau)}_{r,t+k-1} - f^{(\tau)}_{r,t-1} = \alpha_k + \beta^{(\tau)}_{k,hl} mps_t + \nu_{k,t}$



Inspecting the Mechanism

- Hu, Pan & Wang (2013) motivation: $\uparrow$ liquidity $\Leftrightarrow$ $\uparrow$ arbitrage capital

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- We test this mechanism in two ways:
  1. **Aggregate data**: test if arbitrageurs capital can explain liquidity and liquidity state-dependence
  2. **Transaction-Level data**: test if arbitrageurs activity is higher in high liquidity FOMC days

Inspecting the Mechanism

What Explains Noise?

Table: $\Delta Noise_t = \alpha + \beta' X_t + \epsilon_t$

	Monthly Changes in Noise							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔMOVE	0.02***							0.01***
	(4.24)							(3.59)
ΔUnemp.		0.14***						0.10***
		(2.68)						(2.95)
ΔUnc.			0.71**					-0.32
			(2.44)					(-1.27)
ΔLev.				1.43***				0.59*
				(3.90)				(1.93)
FIA Ret.					-0.41***		-0.18***	-0.17***
					(-7.95)		(-3.02)	(-2.63)
ConvArb Ret.						-0.45***	-0.32***	-0.32***
						(-5.35)	(-3.38)	(-2.82)
Adj. R^2	15.94	2.53	16.10	16.35	34.52	40.89	43.47	50.77
N	205	240	240	240	240	240	240	205

- Evidence points to specialized investors (Duffie (2010), Siriwardane et al (2023))

State-Dependence with Fixed-Income Arb. Returns

$$\Delta f_{j,t}^{(\tau)} = \alpha + \beta_{j,hr}^{(\tau)} \cdot [mps_t \times 1_{HighFIAret_{t-1}}] + \beta_{j,lr}^{(\tau)} \cdot [mps_t \times 1_{LowFIAret_{t-1}}] + \epsilon_{j,t}^{(\tau)}$$

Figure: Real Forward Curve($j = r$)

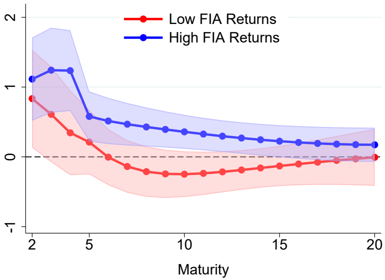
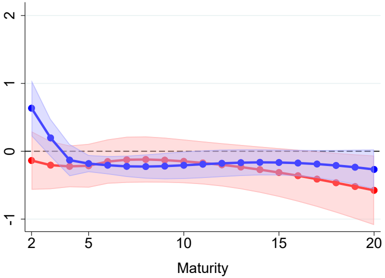


Figure: Inflation Forward Curve ($j = i$)



Inspecting the Mechanism - Transaction-Level Data

Question: is there more arbitrage activity around FOMC meeting when yield-curve noise is low?

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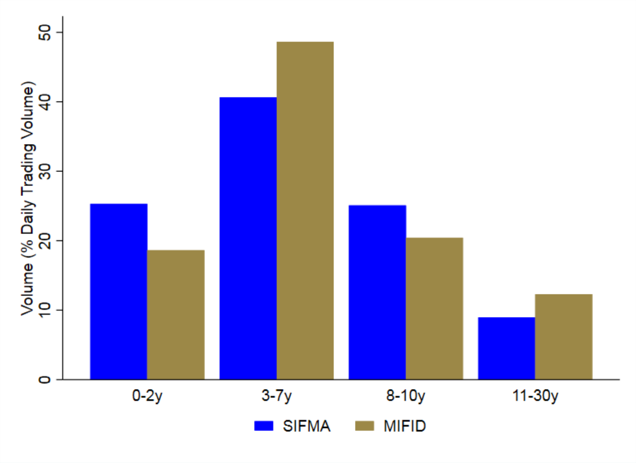
MiFID II dataset covering the universe of UK financial market participants

- **Key advantages:** client identifiers and coverage ($>$6% of US treasury volume)
- **Limitations:** shorter sample period (2018 - present)

Sample Representativeness



Identifying Arbitrageurs from Trades

Measuring two dimensions of arbitrage:

1. Trading across the yield curve
   - standard deviation of maturities traded (weighted by trade size)
2. Duration-neutral exposure
   - net duration exposure of all trades

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$$I_i = \frac{1}{N_{i,t}} \sum_{t=1}^{T} I_{i,t}$$

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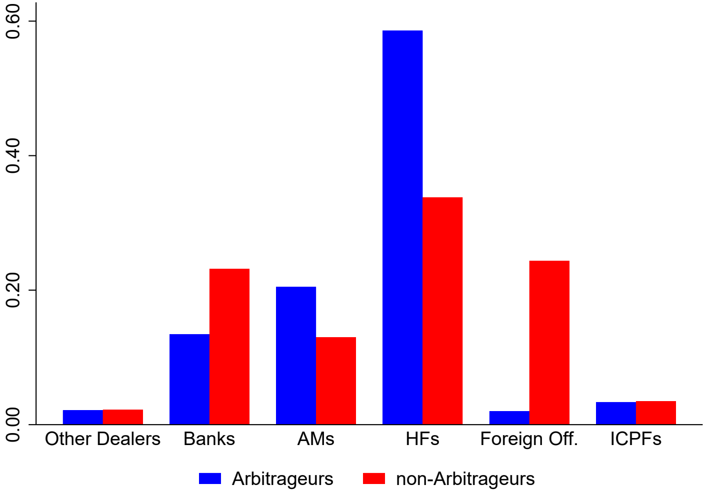
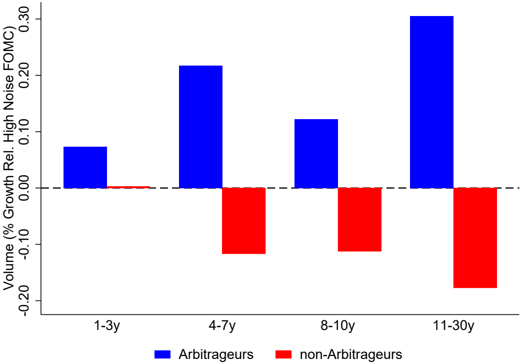
[⇒] Arbitrageurs are IDs in the top-tercile of the index

Who are the Arbitrageurs?



Arbitrageurs Trade More When Noise is Low



- Arbs > 0, increase trading (almost) monotonically across maturities (15%-25% more trading)
- Non-arbs < 0: they trade less

Robustness

- Macro results hold with all main measures of monetary policy shocks, accounting for information effects and other known predictability anout our baseline shocks by Nakamura & Steinsson (2018), including: Jarocinski & Karadi (2015), Bauer & Swanson (2023), Karnaugh & Vokata (2022), and Swanson (2021)
- Robust to excluding recessions, QE dates, easing cycles and purging from the Fed Information Effect
- Robust to different ways of de-trending the noise measure, or using the original series without de-trending
- Results also hold when we include a number or controls or purge the liquidity measure from the component explained by these controls
- Results hold for different time samples, including a pre-GFC sample (for nominal only, lack of real data), and using different model decompositions into expectations and risk premium components
- Results also apply to the UK

Policy Implications and Future Work

- The Liquidity State-Dependence is entirely about the long-term real rates and it is persistent: it matters for macroeconomic policy
- The role of arbitrageurs is supported by evidence from both aggregate and transaction-level data
- Policy complementarity: market functioning/liquidity in bond markets important for both financial stability and monetary policy

THANK YOU FOR YOUR ATTENTION!

Appendix: The Noise Measure

Hu, Pan Wang (2013)

Each day t, there are N_t government bonds trading in the market

- Denote the (cont. compounded) yield on the maturity-τ bond $y_t^{(\tau)}$
- Svensson (1994) to find line of best fit: the *yield curve* $\hat{y}_t^{(\tau)}$

$$Noise_t = \sqrt{\frac{1}{N_t} \sum_{\tau=1}^{N_t} \left(y_t^{(\tau)} - \hat{y}_t^{(\tau)}\right)^2}$$

- Cross-sectional dispersion of actual yields around the fitted curve
- Captures information over entire curve (not just on-/off-the run)/ not driven by demand shocks for individual bonds / not related to level, slope or volatility of interest rates
  - Shown to be priced aggregate liquidity, not just UST-specific liquidity
  - Priced in HFs and carry trade returns

  $\rightarrow$ Close link with supply of capital by arbitrage desks

Appendix: The Noise Measure

Hu, Pan Wang (2013)

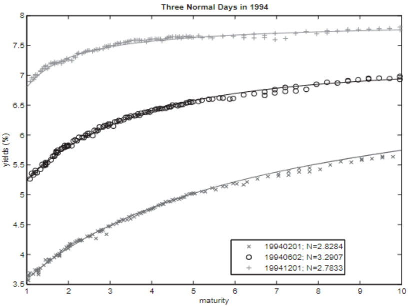


Figure: On normal days

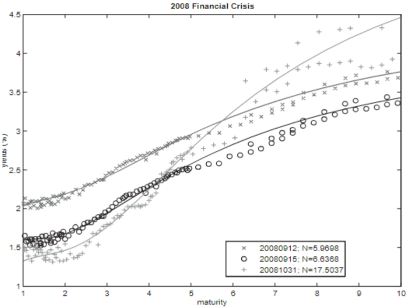


Figure: Lehman Bankruptcy

Source: Hu, Pan and Wang (2013)

- **High Liquidity ⇔ Low Noise** back