Anatomy of the Treasury Market: Who Moves Yields?

Manav Chaudhary (Chicago), Zhiyu Julie Fu (WashU Olin), Haonan Zhou (HKU)

Which investors drive yields and this evolved over time?

Widely recognized investor demand is a key determinant of Treasury yields

...but how much does each investor drive yields, and how has this evolved?

Standard approaches to Treasury market not suitable,

- Term-structure/factor models silent on the heterogeneity
- Models zooming on specific investors limited in its aggregate implications

Calls for a unified framework of Treasury price and heterogeneous investors

A Framework for the U.S. Treasury Market's yield

An equilibrium-pricing framework for the U.S. Treasury market

- A parsimonious yet flexible approach to model different players jointly
- A machinery to decompose changes in yields by macro factors $\times$ investors

Provides machinery to uncover the "macrostucture" of the Treasury market:

- Who provides liquidity, and how effective is the market at accomodaing demand?
- How has the Treasury market ecosystem evolved after the Great Recession?
- Why do Treasuries appreciate during bad times? Who's fleeing to safety?

Uncovering the "macrostructure" of the Treasury market

1. Quantifying investors' sensitivities to yields and factors

- Inelastic market: macro multiplier of 1 ($\uparrow$ 1% Q $\Longrightarrow$ $\uparrow$ 1% P or $\downarrow$ 15*bp* yld)
- Investor-time heterogeneity reveals changing nature of liquidity provision

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2. Decomposing yield changes into their investor-level drivers

- Great Recession marks structural change in who drives yields...
- Foreign investors have stopped playing a big role, but the Fed now does

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3. Zooming into flight-to-safety episodes

- Domestic, rather than foreign investors, contribute most to rising yields
- Domestic seem to fly-to-quality, while foreigners use Treasuries as a hedge

Related Literature

- Drivers of yields and investor dynamics in the Treasury markets:
  - Pricing: Cochrane and Piazzesi, 2005; Joslin, Priebsch, and Singleton, 2014; Moench and Soofi-Siavash, 2022; Vayanos and Vila, 2021
  - Foreign investors: Warnock and Warnock, 2009; Ahmed and Rebucci, 2024
  - The Fed and the QE: Gagnon, Raskin, Remache, and Sack, 2011; Hamilton and Wu, 2012
- Estimating demand-based asset pricing models:
  - Methodology: Koijen and Yogo, 2019; Gabaix and Koijen, 2024; Qian, 2024; Chodorow-Reich, Gabaix, Koijen, and Viviano, 2024
  - Application to government bond markets: Koijen, Koulischer, Nguyen, and Yogo, 2017; Fang, Hardy, and Lewis, 2022; Jansen, Li, and Schmid, 2024; Zhou, 2023; Eren, Schrimpf, and Xia, 2023; Jansen, Li, and Schmid, 2024; Jiang, Richmond, and Zhang, 2024

Roadmap

- Model Framework
- Estimation and Identification
- Understanding macrostructure of the Treasury market:
  1. Quantifying investors' sensitivities
  2. Decomposing yield changes
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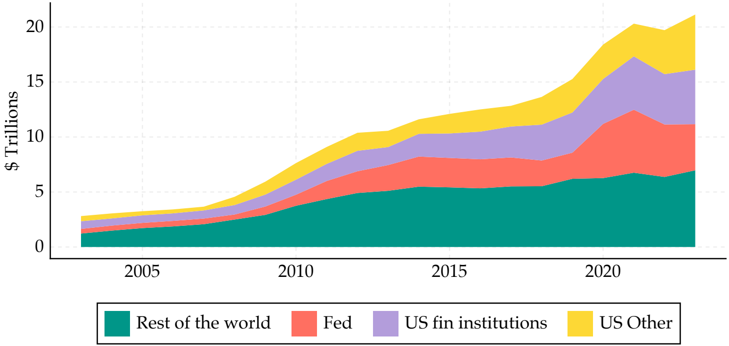
The Landscape of U.S. Treasury Market

Data: Financial Accounts + Treasury Internatial Capital + Call Reports

- Sectors are mutually exclusive + collectively exhaustive of market activity

Figure 1: Quarterly sector-level Treasury notes and bonds holdings



Model Demand for Treasuries for Different Investors

Major challenge: different sectors face different portfolio choice problems

- What is the correct objective?
  e.g. mean-variance, bond-in-the-utility, mimizing funding ratio volatility...
- How to model multitude of constraints?
  e.g. benchmarks, capital requirement, internal value-at-risk...

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Solution: first-order log-linearize of any sector *i*'s portfolio decision + difference:

$$\underbrace{\Delta q_{i,t}}_{\text{\% quantity}} = - \underbrace{\zeta_i}_{\text{elasticity}} \times \underbrace{\Delta p_t}_{\text{\% price}} + \underbrace{\nu_{i,t}}_{\text{demand shifter}}$$

ζ_i and $\nu_{i,t}$ are sector-specific functions of deep parameters & steady state values

Modelling demand shifters

$$\Delta q_{i,t} = -\zeta_i \Delta p_t + \nu_{i,t}$$

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Observed factors: measure with,

- Macro-financial: inflation level, and innovations in VIX and dollar indicies
- Policy: Fed fund change, lagged net supply, scheduled Fed purchases
- Expectations: change in 1yr and 10yr SPF yield consensus forecast

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Unobservabed factors: measure with principal components on residual flows

Idiosyncratic sector-specific shocks: e.g., wealth shocks, private info, regulations

▸ General Framework ▸ Full specification

Relating investor demand to equilibrium prices

1. Estimate sector-level demand curves: $\Delta q_{i,t} = -\zeta_i \Delta p_t + \bar{q}_i + \lambda_i \eta_t + u_{i,t}$

2. Apply market clearing: total change in flows (incl. supply) is zero,

$$\sum_{i \in sectors} S_i \Delta q_{i,t} = 0$$

where S_i is the sector i holding share of the Treasury market.

3. Re-arrange to relate price changes to sector-specific demand shifters:

$$\Delta p_t = \frac{1}{\zeta_S} \sum_{i \in sectors} S_i \left(\bar{q}_i + \lambda_i \eta_t + u_{i,t} \right)$$

where $\zeta_S \equiv \sum S_i \zeta_i$.

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$\implies$ we can fully decompose Δp_t into sector-specific demand shifters

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  2. Decomposing yield changes
  3. Zooming into flight-to-safety episodes

Need idiosyncratic demand shifter to address endogeneity

Classic challenge: $\Delta q_{i,t}$ and Δp_t are endogenous $\Longrightarrow$ we need instruments,

Tyipcal instruments: idiosyncratic demand shifters such as,

- Sector-specific regulation changes
- Particular episodes that induced balance sheet shocks
- Institution-specific mechanical rebalancing rules

Rely on shifters being orthogonal to other investors' unobserved shifters

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But we need multi-period instruments for all sectors
...typically used event/industry-specific instrument do not work

Solution: leverage model's idiosyncratic demand shifters

Sector's demand shifters have a common and idiosyncratic parts,

$$\Delta q_{i,t} = -\zeta_i \Delta p_t + \bar{q}_i + \lambda_i \eta_t + u_{i,t}$$

Idea: extract sector i's $u_{i,t}$ and instrument for price in sector j's demand.

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Identification assumption: sectors' idiosyncratic shifters are independent,

$$\mathbb{E}\left[u_{i,t} u_{j,t} \mid \eta_t\right] = 0. \ \ \forall i \neq j$$

- Granular instrument variables assumption (Gabaix and Koijen, 2024)

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Optimal estimator: more weight to shocks from sectors with larger price impact

- Overidentified system: N elasticities ζ_i and $\frac{N(N-1)}{2}$ moment conditions

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1. Quantifying Sensitivities: Aggregate Elasticity

Aggregate elasticity $\zeta_S = \mathbf{1.01}$. Macro multiplier $M \equiv \frac{1}{\zeta_S} = \mathbf{0.99}$

- 1% flow $\Rightarrow$ **15**bps in yields with average market duration ($\approx$ 6.5 years)

▸ Dynamic price impact ▸ Robustness ▸ Leave-one-out

Treasury market multiplier in ball park of other asset class multipliers:

- Individual corporate bond micro multiplier $\approx$ 0.02
- Individual equity mico multipliers $\approx$ 1
- Euro area govt. bond macro multiplier $\approx$ 0.3
- Corporate bond rating-level portfolio multiplier $\approx$ 3.5
- Equity market macro multiplier $\approx$ 5

1. Quantifying Sensitivities: Sectoral Price Elasticities

Top contributors:

- Households (Resid.): Small but highly elastic
- Federal Reserve
- RoW: less elastic but large
- Banks

Table 1: Elasticity: Top contributors

Sector	$S(\%)$	ζ	ζ **Share (%)**
Aggregate		1.03	100.0
		(0.77, 1.3)	
Households	5.74	10.54	58.55
		(5.33, 15.76)	
Fed	22.08	0.42	9.28
		(0.11, 0.74)	
Rest of World	44.45	0.42	17.8
		(0.23, 0.61)	
Banks	5.26	0.52	2.61
		(0.28, 0.76)	

▸ Leave-one-out

1. Quantifying Sensitivities: Sectoral Price Elasticities

Least contributors:

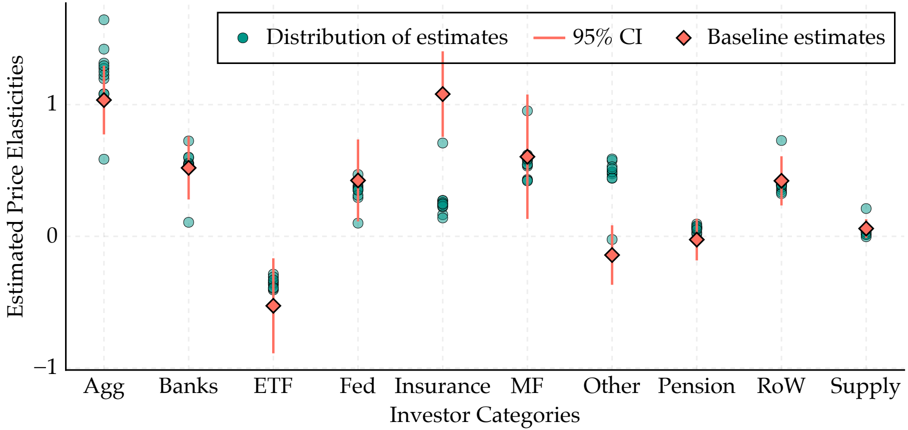
- Supply:
  Inelastic (stated policy)
- Broker-Dealers:
  Elastic but too small
- Pensions
- ETFs

Table 2: Elasticity: Least contributors

Sector	$S(\%)$	ζ	ζ **Share (%)**
Aggregate		1.03	100.0
		(0.77, 1.3)	
Supply	100.0	0.06	5.74
		(-0.01, 0.13)	
Broker-dealers	0.81	2.22	1.73
		(-6.45, 10.88)	
ETF	1.18	-0.53	-0.6
		(-0.89, -0.17)	
Pension	5.42	-0.02	-0.13
		(-0.18, 0.13)	

Broker-dealers Leave-one-out Case study

1. Quantifying Sensitivities: Leave-one-out Robustness CheckEstimates



1. Quantifying Sensitivities: Change Nature of Liquidity Provision

Post-GFC liquidity provision:

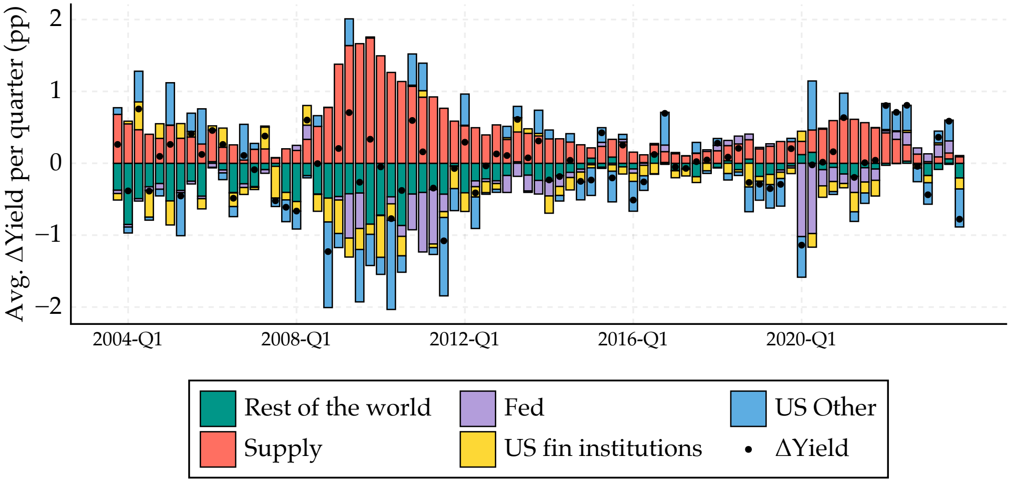
Fed: now provide backstop
...stepp-in in bad-times

Foreigners: stepped-back
...contrary to big role pre-crisis

U.S. Banks: also stepped-back
...consistent with ↑regulatory burden

Sector	ζ	ζ **Share (%)**
Fed (03-08)	0.0	-
	-	
Fed (09-23)	0.57	12.53
	(0.32, 0.83)	
Rest of World (03-08)	0.76	30.38
	(0.48, 1.04)	
Rest of World (09-23)	0.3	13.39
	(0.15, 0.46)	
U.S. Banks (03-08)	0.84	3.98
	(0.47, 1.2)	
U.S. Banks (09-23)	0.41	2.13
	(0.21, 0.61)	

2. Decomposition Yields: Sectoral Contributions



Latent shocks by sector

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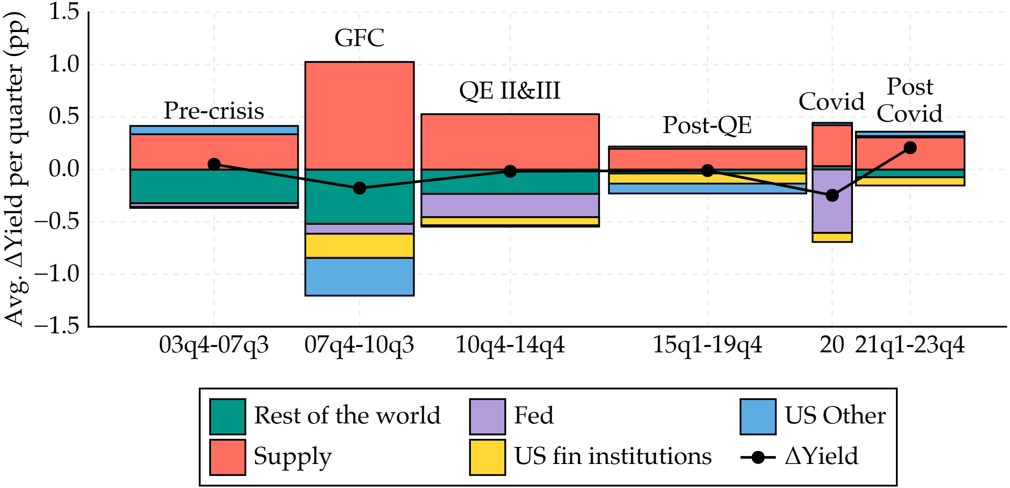
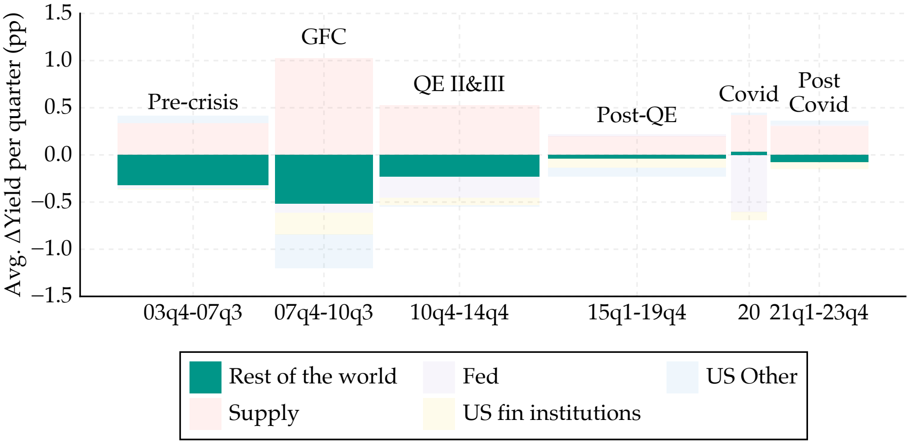


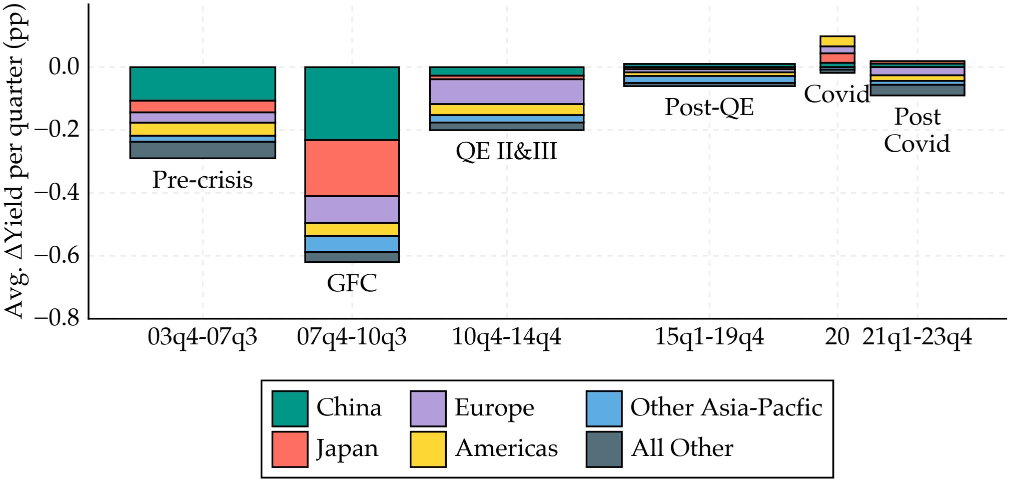
Latent shocks by sector

2. Decomposition Yields: Post-GFC Diminishing Role of Foreigners

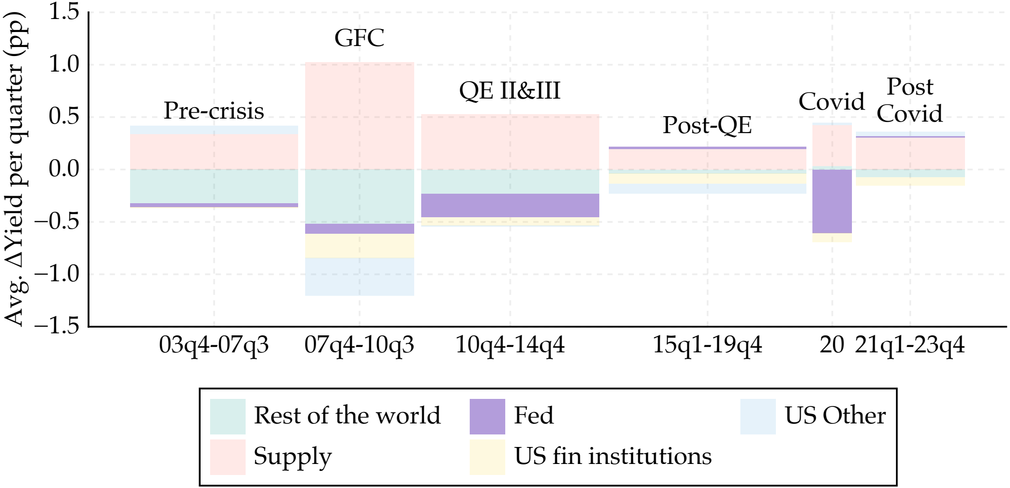


$\Longrightarrow$ Pre-GFC consistent with “savings glut” compressing yields...but no longer

2. Decomposition Yields: China and Japan role particularly diminished



2. Decomposition Yields: GFC and Covid, and the Fed



....More on the tranforming role of the Federal Reserve

Table 3: Price elasticity and loadings: Federal Reserve

Period	$S(\%)$	ζ	$\epsilon^{VIX}_{(std.)}$	Δ **FFR**	$Inf.$
09-23	22.08	0.57	1.55	-9.4	-0.43
		(0.32, 0.83)	(0.74, 2.36)	(-12.39, -6.41)	(-1.55, 0.7)

- Before GFC: All pre-scheduled and predictable
- After GFC: Treasury purchase as part of the standard central bank toolkit
  - Price elastic: stabilize the Treasury market
  - State-contingent: deployed during market distress
  - Coordination between direct purchase with conventional monetary policy

3. Zooming into flight-to-safety: who increases Treasury demand?

Conventional wisdom: **foreigners**

- Key explanation of "exorbitant privilege"
  e.g, Jiang, Krishnamurthy, and Lustig (2024)

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...at least no longer the case

Sector	$S(\%)$	$\epsilon^{VIX}_{(std.)}$	$\epsilon^{VIX}_{(std.)}$ **Share (%)**
Aggregate (09-)		0.75	100.0
		(0.0, 1.49)	
Households	5.74	16.12	124.11
		(6.12, 26.13)	
Fed (09-)	22.08	1.55	45.94
		(0.74, 2.36)	
Rest of World	44.45	-0.2	-11.69
		(-0.87, 0.48)	
Supply	100.0	-0.19	-25.02
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Mutual Funds	6.75	-1.94	-17.6
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$\Longrightarrow$ Foreigner behavior consistent with using Treasuries as a hedge
...rather domestic investors exhibit flight-to-quality

3. Zooming into flight-to-safety: in fact foreigners sell in bad times

Figure 2: 2003-2023 Quarterly

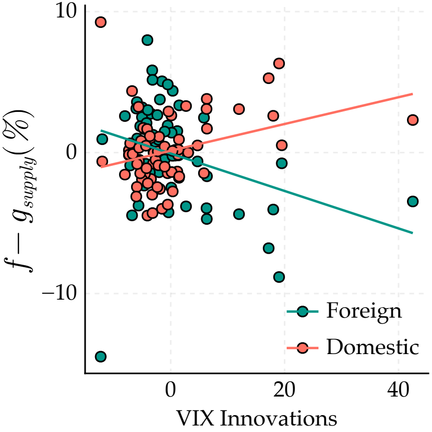
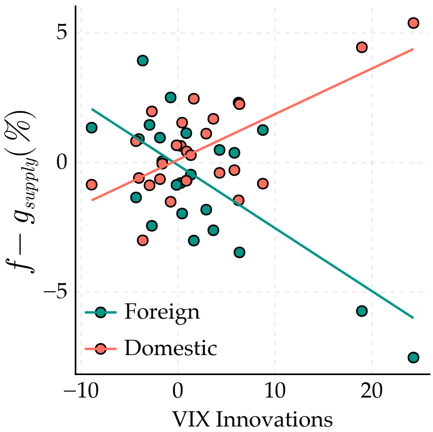


Figure 3: GFC (07-09 Monthly)



Conclusion

An unified equilibrium-pricing framework for the U.S. Treasury market

- A parsimonious yet flexible approach to model different players jointly
- A machinery to decompose changes in yields by macro factors $\times$ investors

Provides machinery to uncover the “macrostucture” of the Treasury market:

- Treasury market is quite inelastic, with large heterogeneity across investors
- Post-GFC, large changes in Treasury market—foreigners, Fed, and banks
- Contrary to the conventional wisdom, the foreigers do not fly-to-safety

References

- Ahmed, Rashad and Alessandro Rebucci (2024). **“Dollar Reserves and U.S. Yields: Identifying the Price Impact of Official Flows”.** In: *Journal of International Economics* 152, p. 103974. URL: https://www.sciencedirect.com/science/article/pii/S0022199624001016.
- Chodorow-Reich, Gabriel et al. (July 5, 2024). ***Propagation of Shocks in Networks: Identification and Applications.*** DOI: 10.2139/ssrn.4885984. Pre-published.
- Cochrane, John H. and Monika Piazzesi (Mar. 2005). **“Bond Risk Premia”.** In: *American Economic Review* 95.1, pp. 138–160. URL: https://ideas.repec.org/a/aea/aecrev/v95y2005i1p138-160.html.
- Eren, Egemen, Andreas Schrimpf, and Fan Dora Xia (2023). **“The Demand for Government Debt”.** In: *SSRN Electronic Journal*. ISSN: 1556-5068. DOI: 10.2139/ssrn.4466154.
- Fang, Xiang, Bryan Hardy, and Karen K. Lewis (May 2022). ***Who Holds***

Post-Credit: What if China sold all US Treasuries

- Assuming no political repercussion, no contigent purchase by other sectors, unanticipated and no guidance on the future path

$$\Delta p_t = \underbrace{M}_{1.0} \times \underbrace{\Delta q_{China}}_{-3.5\%} = -3.5\% \implies \Delta y_t = 60bps$$

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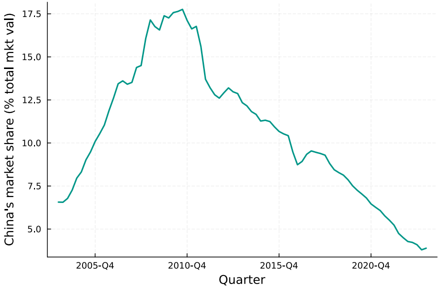
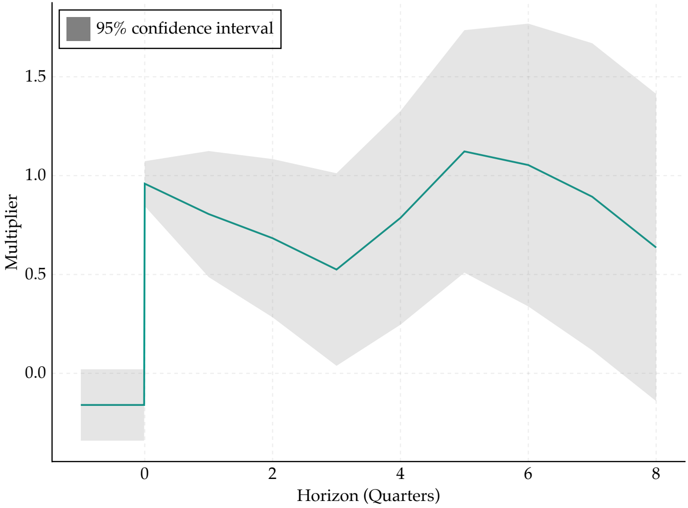


Dynamic Price Impact: Local Projections ▸ Back



General Model

$$\left.\begin{aligned} q_{i,t} &= -p_t \times \mathbf{C}'_{i,t}\zeta + \mathbf{X}'_{i,t}\beta + u_{i,t}, \\ 0 &= \sum_i S_{i,t} q_{i,t} \end{aligned}\right\} \Longrightarrow p_t = \frac{1}{\mathbf{C}'_{S,t}\zeta}\left[\mathbf{X}'_{S,t}\beta + u_{S,t}\right],$$

- Elasticity parameterized by $\mathbf{C}_{i,t}$, entity-specific and time-varying
- Moment conditions become $\mathbb{E}\left[u_{i,t}u_{j,t} \mid \eta_t, \mathrm{C}_t, \mathrm{S}_t\right] = 0$
- $S_{i,t}$ can also be time-varying and do not necessarily sum to 1

Back

Full Specification

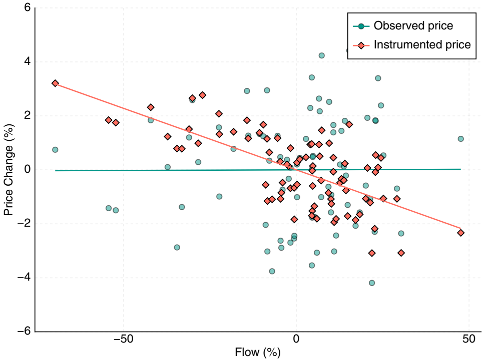
- Financial Account (Z.1) + TIC for foreigners + Call report for banks, 03Q4-23Q4

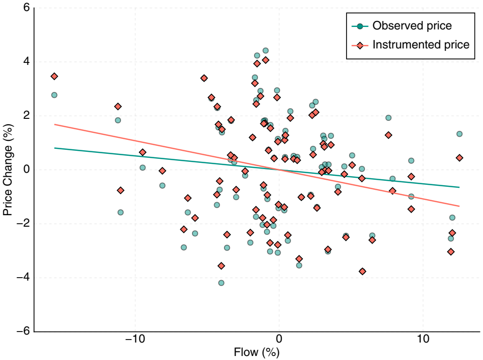
$$\Delta q_{i,t} = -\zeta_{i,r(t)} \Delta p_t + \lambda_{\text{obs},i,r(t)} \eta_{\text{obs},t} + \lambda_{\text{pc,i}} \eta_{\text{pc},t} + \bar{f}_i + u_{i,t} \quad \forall i$$

- $\Delta q_{i,t}$: Quarterly transaction divided by $S_{i,t}$ (avg. mkt share over sample period)
- $r(t)$: Sector-specific regime shifts in elasticities/loadings (09Q1)
- Consolidate sectors into categories: ▸ Composition
  - Impose homogeneous ζ within categories
  - (e.g. close-end & open-end funds; individual banks; China & Japan)

▸ Back

Comparison: Households (left) vs. Mutual Funds (right) ▸ Back





Common Factors

- Factors include both:
  - Observable macro variables
  - Unobservable factors extracted from granular data using PCA
- Three-step approach:
  1. Regress price & quantities on factors η ;
  2. Estimate $\hat{\zeta}_i$ using residuals (no issue with s.e.);
  3. Recover loadings using $\hat{\zeta}_i$ and coefficients in step 1.

Back

Asymptotic Efficiency of the Optimal GIV Estimator

Theorem

The optimal GIV estimator $\hat{\zeta}$ is consistent and asymptotically normal:

$$\sqrt{T}\left(\hat{\zeta}-\zeta\right)\xrightarrow{d}\mathcal{N}\left(0,V^{\zeta}\right),$$

for $T\to\infty$. Moreover, V^{ζ} achieves the semi-parametric efficiency bound

$$V^{\zeta}=\zeta_S^2\times Inv\left(\begin{bmatrix}\frac{1}{\sigma_1^2}\sum_{i\neq 1}S_i^2\sigma_i^2 & S_1S_2 & \cdots\\ S_1S_2 & \frac{1}{\sigma_2^2}\sum_{i\neq 2}S_i^2\sigma_i^2 & \cdots\\ \vdots & \vdots & \ddots\end{bmatrix}\right)$$

Missing Intercept

- Estimating factor loadings requires consistently estimating price elasticities!
- e.g., A one-factor model without shocks: $q_{i,t} = -\zeta_i p_t + \lambda_i \eta_t$.

$$\lambda_i^q \equiv \frac{\mathbb{E}\left[q_{i,t}\eta_t\right]}{\mathbb{E}\left[\eta_t^2\right]} = \frac{\mathbb{E}\left[\left(-\zeta_i p_t + \lambda_i \eta_t\right)\eta_t\right]}{\mathbb{E}\left[\eta_t^2\right]} = \lambda_i - \frac{\zeta_i}{\zeta_S}\lambda_S.$$

Relation with Standard GIV

- Standard GIV:
  - Assuming ζ_i is homogeneous, i.e., $\boldsymbol{\zeta} = \zeta \boldsymbol{\iota}$.
  - A size-minus-precision weighting scheme to solve ζ analytically
- Define the vector $\mathbf{E}_i = \frac{1/\sigma_i^2}{\sum_i 1/\sigma_i^2}$. GIV shows

$$\mathbf{E}' \mathbb{E}[\mathbf{u}_t \mathbf{u}_t'] (\mathbf{S} - \mathbf{E}) = \mathbf{0}$$

Under the homogeneity assumption of ζ, it is equivalent to

$$\mathbb{E}[(q_{E,t} + \zeta p_t)(q_{S,t} - q_{E,t})] = 0$$

It is then implementable by regressing $q_{E,t}$ on p_t instrumented by $q_{S,t} - q_{E,t}$.

Back

Evolution of Treasury Yields

Figure 4: Average yields and duration

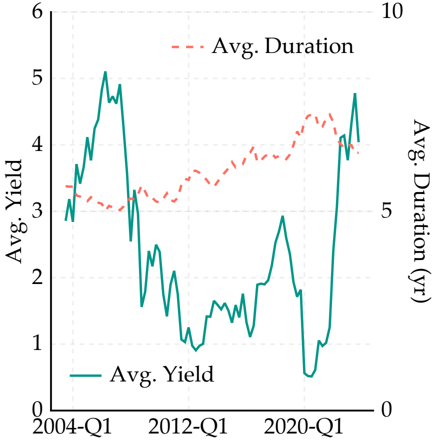
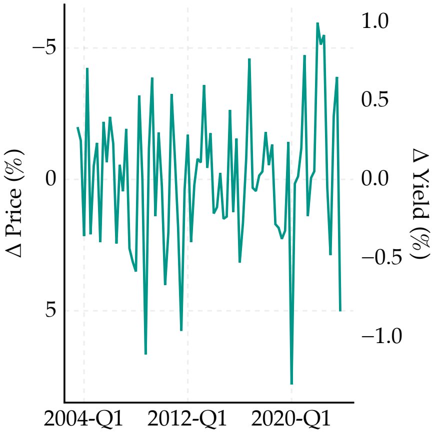
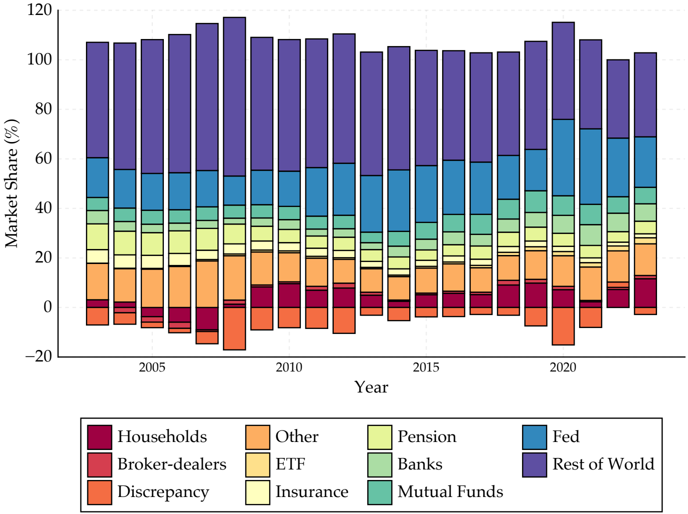


Figure 5: Price change in market portfolio



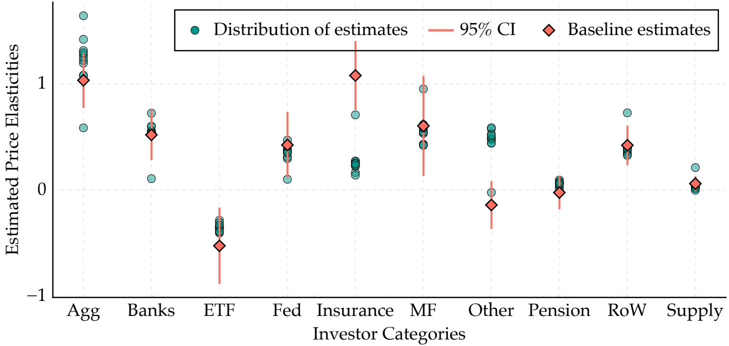
Investor Base of the U.S. Treasury Market



Robustness: Price Elasticities ▸ Back

Sector	Baseline	5 factors	1970-2023	Including Bills
Aggregate	1.04	1.08	1.3	2.09
	(0.81, 1.27)	(0.83, 1.34)	(1.11, 1.5)	(1.26, 2.91)
Other	-0.24	-0.11	0.19	0.56
	(-0.46, -0.01)	(-0.34, 0.11)	(0.02, 0.36)	(0.26, 0.87)
Households	10.07	11.09	10.5	4.34
	(5.26, 14.88)	(5.71, 16.46)	(7.29, 13.7)	(0.78, 7.9)
Pension	0.2	0.2	-0.23	0.17
	(0.04, 0.36)	(0.04, 0.36)	(-0.39, -0.07)	(-0.07, 0.4)
Insurance	0.51	0.38	-0.67	-0.01
	(0.21, 0.81)	(0.09, 0.66)	(-0.93, -0.41)	(-0.51, 0.49)
Mutual Funds	0.58	0.51	0.47	0.55
	(0.11, 1.05)	(0.03, 1.0)	(0.23, 0.72)	(-0.11, 1.21)
ETF	-0.1	-0.2	0.23	-0.33
	(-0.46, 0.26)	(-0.56, 0.17)	(0.04, 0.42)	(-0.83, 0.17)
Dealers	7.42	7.94	-1.47	1.11
	(-1.49, 16.32)	(-1.22, 17.1)	(-8.37, 5.43)	(-10.11, 12.33)
Fed	0.44	0.49	0.03	0.24
	(0.15, 0.72)	(0.2, 0.79)	(-0.06, 0.13)	(-0.13, 0.6)
Banks	0.53	0.43	1.0	0.63
	(0.35, 0.7)	(0.26, 0.6)	(0.51, 1.49)	(0.42, 0.85)
RoW	0.44	0.39	0.39	0.57
	(0.3, 0.58)	(0.25, 0.53)	(0.27, 0.52)	(0.36, 0.79)

Price Elasticities: Leave-one-out Estimation ▸ Back



The Role of Broker-Dealers

Figure 6: Raw Dollar Flows

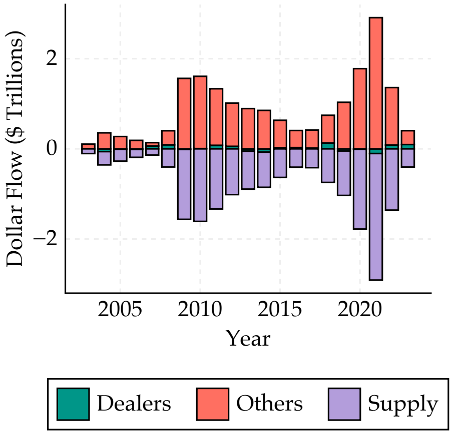
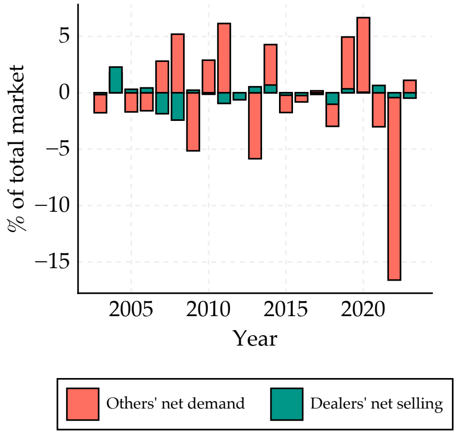
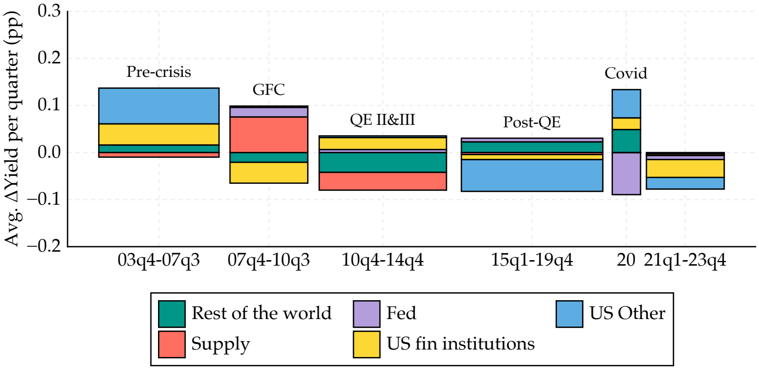


Figure 7: BD Flows vs Net Demand by Others

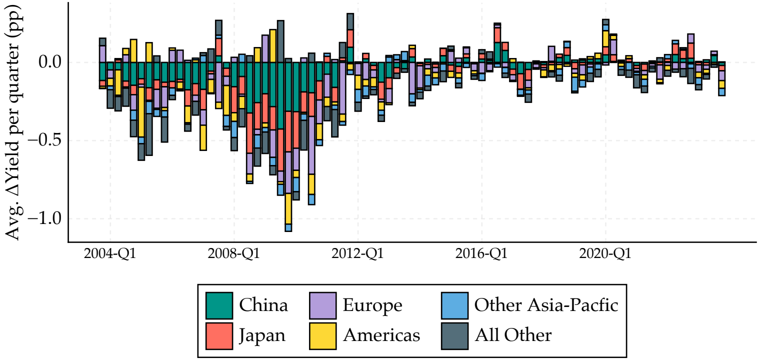


Yield Decomposition: Contribution of Latent Shocks



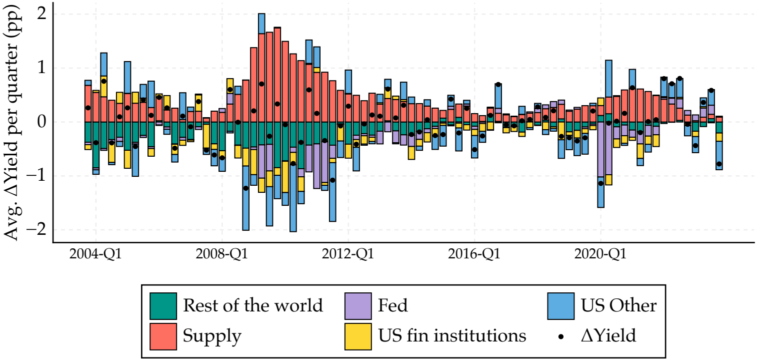
Back

Foreign Demand and Yield: Quarter-by-Quarter Decomposition



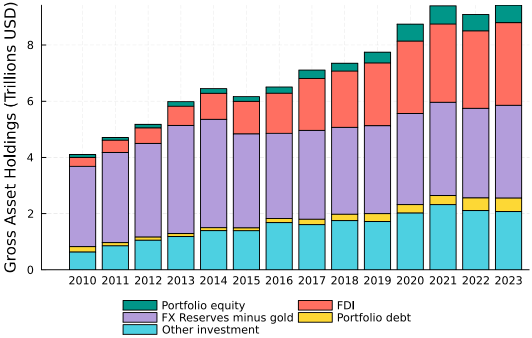
Back

Quarter-by-Quarter Yield Decomposition

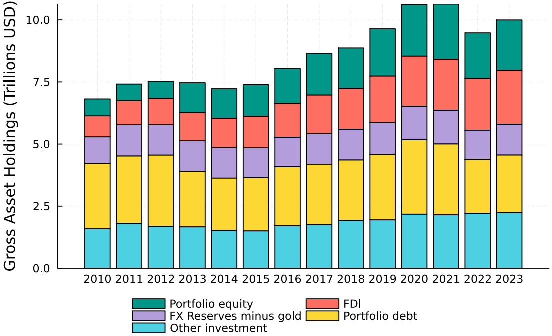


Back

Gross external assets of China and Japan: 2010-2023



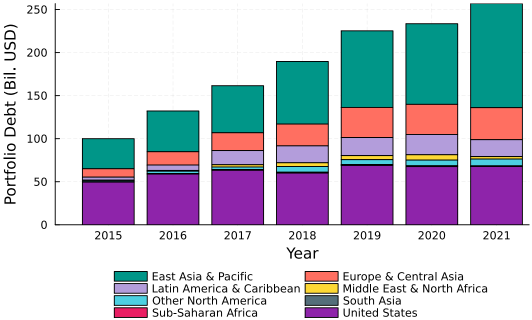
China



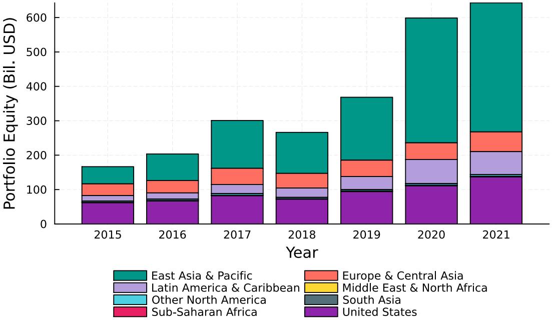
Japan

Back

Regional distribution of China's private portfolio investment



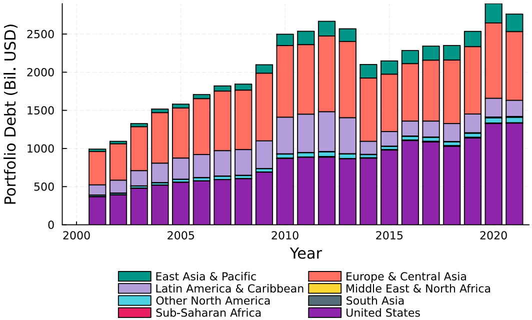
Portfolio debt assets (billions USD)

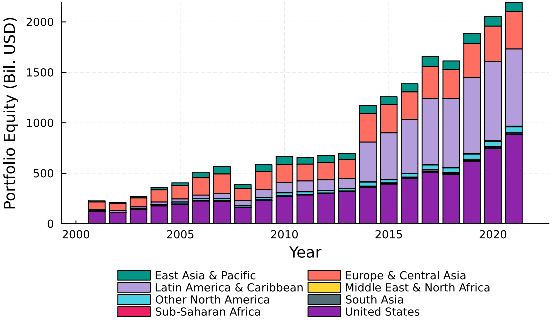


Portfolio equity assets (billions USD)

Back

Regional distribution of Japan's private portfolio investment





Portfolio debt assets (billions USD)

Portfolio equity assets (billions USD)

Back