Foreign Holdings of U.S. Treasuries and U.S. Treasury Yields

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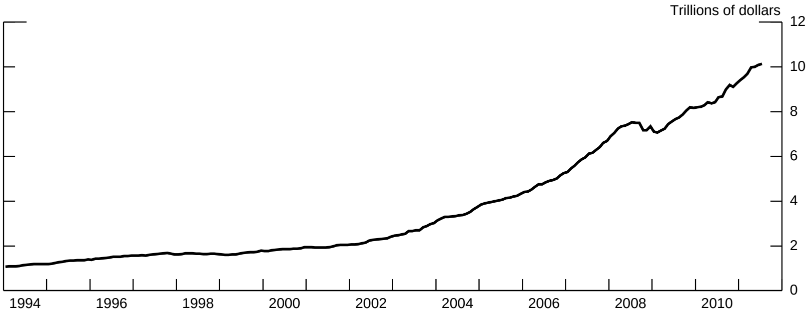
Intro

Motivation

- Rapid growth in foreign official holdings of Treasuries since 1994
  - China, Japan, and other EMEs have been channeling their savings through the official sector, which has been acquiring foreign exchange reserves, and investing a significant portion in U.S. Treasuries
- Why should we care about this?
  1. Effectiveness of monetary policy (e.g. Greenspan's conundrum, LSAPs?)
  2. Clouding of signals extracted from movements in long-term interest rates
- Since 2007, purchases from EMEs are slowing
  - Smaller CA surpluses
  - Reserve diversification

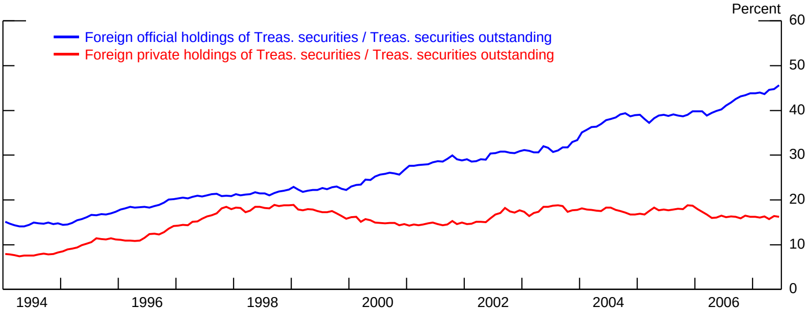
$\Rightarrow$ How do foreign official purchases affect Treasury yields?

Rapid growth in global FX reserves



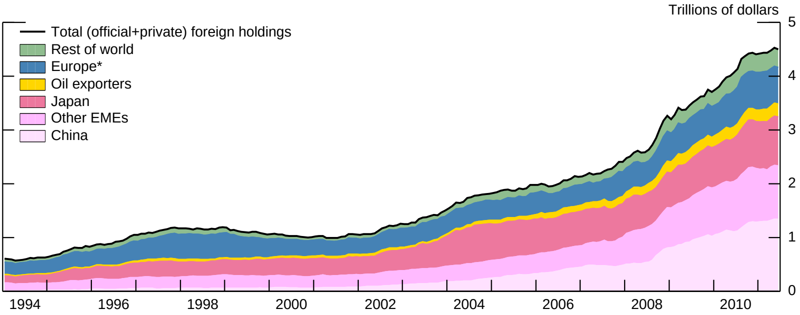
Source: IMF

Rapid growth in foreign official holdings of LT Treas.



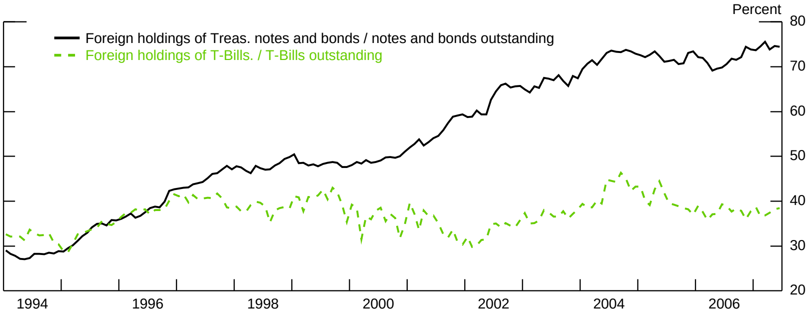
Source: Treasury International Capital data

Growth mostly from EMEs



Source: Treasury International Capital data

Preference for longer-term Treasuries



Source: Treasury International Capital data

Goal

- What is the overall effect of the global savings glut on U.S. yields through high foreign savings that are invested in U.S. Treasuries by the official sector?

Do foreign official purchases affect yields?

- July 21, 2007, 7:00 a.m. (EST)
  - China announces that it will no longer peg its currency strictly to the dollar (basket instead), and revalues renminbi slightly
  - Signal that China would not need to buy as many Treasuries
  - 10-yr T-note yield jumps 7 b.p.

Empirically, a hard nut to crack

- Two-way causality between prices and foreign demand
  - Foreign official investors may opportunistically sell Treasuries when prices are high because of increased risk aversion on the part of private investors
- Long-term interest rates influenced by (typically unobservable) forward looking variables (e.g. long-run inflation expectations)
- Reaction of private investors
  - Changes in asset prices induced by shifts in foreign official demand may be, in time, partially offset by the actions of private investors
- Potential for "discovering" spurious relationships when fitting data in levels

Exogenous flows?

- Previous studies assume foreign governments do not optimize their reserves portfolio
- Two-thirds of central banks employ external managers
- BIS surveys of central banks suggest that they behave much like private asset managers
    - Care about liquidity, capital preservation, **and returns**
    - Respond to changes in asset prices and macroeconomic variables
    - Use value-at-risk methodologies to measure market risk, and mean-variance portfolio diversification strategy

$\Rightarrow$ We treat foreign purchases of Treasuries as endogenous

Roadmap

1. Intro
2. Data
3. Regressions using the term premium
   - Short-term elasticity
   - Long-term elasticity
4. Regressions using realized excess returns
5. Comparison to other studies
6. Conclusion

Data

Basic notation

- R_t^n = yield of n-period zero coupon bond at time t
- $r_t \equiv R_t^1$ (short rate)
- P_t^n = price of n-period zero coupon bond at time t

Measuring risk premia

- Term premium for an n-year bond (ex-ante)

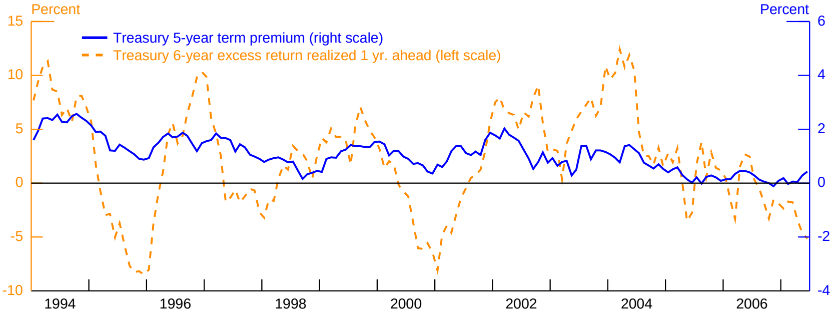
$$TP_t^{(n)} \equiv R_t^{(n)} - \underbrace{\frac{1}{n}\sum_{i=0}^{n-1} E_t(r_{t+i})}_{\text{EH component}} \tag{1}$$

- Excess holding period return realized at $t+1$ (ex-post)

$$D_{t+1}^{(6)} = \ln \frac{P_{t+1}^{(5)}}{P_t^{(6)}} - r_t. \tag{2}$$

- Use 5-year maturity
  - Close to average maturity of U.S. Treasury and agency securities held by foreigners
  - Prices of 5-year Treasury notes are readily observed

5-year term premium and future realized excess returns

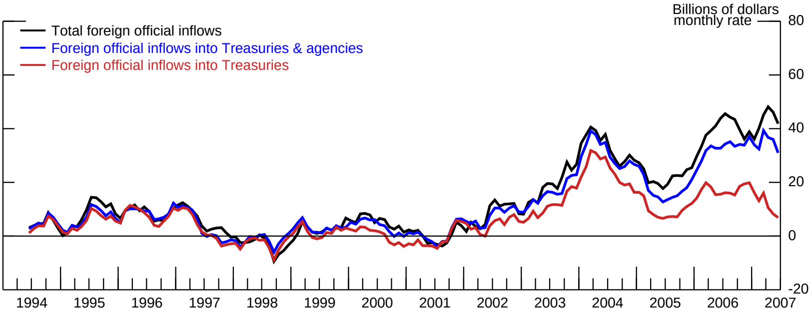


Source: D'Amico et al. (2010) and authors' calculations

Monthly TIC “S” data on foreign flows

- Most comprehensive data source on foreign net purchases of U.S. LT securities
- Known problems with TIC S data
  - Undercounts official acquisitions through foreign intermediaries
  - Financial center bias
- Warnock & Warnock (2009) use survey-adjusted S data
- We perform an additional adjustment based on changes in custody holdings at FRBNY

Foreign official inflows into Treasury and agency securities



Note: 6-month moving average. Source: Treasury International Capital data

Estimation sample

- Benchmark sample: monthly data from January 1994 to June 2007
- Financial crisis events would likely obscure the relations we care about
  - Lehman, AIG, TARP, European crisis, Large Scale Asset Purchases (LSAP)
- As a robustness check, use sample that ends in June 2011

Other explanatory variables

- Implied vol. of options on U.S. and German 5-yr sovereign note futures
- Liquidity premium (difference between the synthetic off-the-run and on-the-run five-year Treasury note yields)
- VIX index of stock market volatility (correlated with flight-to-safety flows and dollar appreciations)
- Year-over-year percent change in industrial production
- VAR estimates of exogenous oil-specific demand shocks using the data from Kilian (2009)
- U.S. federal government budget balance
- Cochrane and Piazessi (2005) factors, linear combinations of forward rates
- Credit Suisse global risk appetite measure

Instruments for foreign official flows

- Foreign exchange interventions by Japan's Ministry of Finance
- Exogenous oil-specific supply shocks from a VAR (Kilian (2009))
- Sum of Chinese trade balance and direct investment inflows

Short-term elasticity

Regressions using the term premium

Effect on 5-year yield of $100 bn foreign official inflow = -46 to -50 bp

	(1) OLS: ΔTP_t	(2) IV: 1st Stage $\Delta FOI_t / DEBT_{t-1}$	(3) IV: 2nd Stage ΔTP_t	(4) IV: 1st Stage $\Delta FOI_t / GDP_{t-1}$	(5) IV: 2nd Stage ΔTP_t
Flow Variables					
$\Delta FOI_t / DEBT_{t-1}$	0.052*		-0.135**		
	(0.030)		(0.061)		
$\Delta FPVT / DEBT_{t-1}$	0.046**	-0.026	0.041		
	(0.021)	(0.052)	(0.027)		
$\Delta FOI_t / GDP_{t-1}$					-0.696**
					(0.343)
$\Delta FPVT / GDP_{t-1}$				0.017	0.182*
				(0.053)	(0.110)
Control Variables					
ΔIP_t^{yoy}	0.025*	0.005	0.027*	0.000	0.026*
	(0.013)	(0.033)	(0.014)	(0.008)	(0.015)
ΔIP_{t-1}^{yoy}	-0.033**	0.010	-0.033**	0.004	-0.031**
	(0.013)	(0.033)	(0.015)	(0.008)	(0.015)
ΔVIX_t	-0.007**	-0.017**	-0.010***	-0.004**	-0.011***
	(0.003)	(0.007)	(0.003)	(0.002)	(0.003)
ΔVIX_{t-1}	-0.001	-0.017**	-0.005	-0.004***	-0.005
	(0.003)	(0.007)	(0.003)	(0.002)	(0.003)
ΔUS_VOL_{t-1}	0.019	0.018	0.018	0.006	0.021
	(0.020)	(0.052)	(0.022)	(0.012)	(0.022)
ΔDE_VOL_t	0.011	-0.056	0.006	-0.015	0.003
	(0.026)	(0.068)	(0.028)	(0.016)	(0.030)
$\Delta STR\_BUDGET\_BALANCE_t$	0.089**	-0.235**	0.023	-0.042*	0.020
	(0.040)	(0.101)	(0.042)	(0.023)	(0.043)
$\Delta LP5_{t-1}$	-0.005	0.002	-0.004	0.000	-0.005
	(0.004)	(0.010)	(0.004)	(0.002)	(0.004)
$OIL\_DEMAND\_SHOCK_t$	0.010	-0.026	0.005	-0.006	0.004
	(0.010)	(0.026)	(0.011)	(0.006)	(0.012)
$\Delta CP^{1\text{-}5}_{t-1}$	0.035*	-0.058	0.025	-0.014	0.022
	(0.020)	(0.051)	(0.024)	(0.012)	(0.025)
$\Delta CP^{6\text{-}9}_{t-1}$	0.018***	-0.010	0.016**	-0.002	0.016**
	(0.006)	(0.015)	(0.006)	(0.004)	(0.007)
Instruments					
$JPYFXINT_t$		0.016***		0.003***	
		(0.003)		(0.001)	
$OIL\_SUPPLY\_SHOCK_t$		0.070		0.016	
		(0.045)		(0.011)	
Observations	160	160	160	160	160
R-squared	0.266	0.447	0.070	0.342	0.013
Durbin-Watson	1.802	1.488		1.441	
Cragg-Donald Wald F-Stat			15.72		9.894
Weak instrument test, critical value[1]			11.59		11.59
Pagan-Hall Test (P-Value)			0.671		0.789
Cumby-Huizinga Test (P-Value)			0.0159		0.0158
Endogeneity Test (P-Value)			0.0192		0.0339
Hansen J Test (P-Value)			0.3498		0.3147

Alternative IV specifications

Effect on 5-year yield of $100 bn foreign official inflow = -48 to -50 bp

	(1) IV: ALL COUNTRIES	(2) IV: ALL COUNTRIES	(3) IV: JAPAN	(4) IV: CHINA	(5) IV: MID-EAST OIL EXPORTERS
First Stage: Instruments					
$JPYFXINT_t$	0.019***	0.019***	0.017***		
	(0.003)	(0.003)	(0.002)		
ΔBOP_CN_t	0.006	0.007		0.006**	
	(0.006)	(0.006)		(0.002)	
$OIL\_SUPPLY\_SHOCK_t$		0.061			0.019**
		(0.051)			(0.008)
Second Stage: Official Flows					
$\Delta FOI_t / DEBT_{t-1}$	-0.140**	-0.145**			
	(0.057)	(0.058)			
$\Delta FOI\_JAPAN_t / DEBT_{t-1}$			-0.147**		
			(0.059)		
$\Delta FOI\_CHINA_t / DEBT_{t-1}$				0.207	
				(0.423)	
$\Delta FOI\_MIDEAST_t / DEBT_{t-1}$					-0.000
					(0.862)
Observations	126	126	160	126	160
R-squared - 2nd Stage	0.106	0.095	0.210	0.305	0.254
Cragg-Donald Wald F-Stat	18.25	12.71	97.59	6.053	6.119
Weak instrument test, cricial value[1]	11.59	12.83	8.96	8.96	8.96
Endogenous Variables	1	1	1	1	1
Exogenous Instruments	2	3	1	1	1
Pagan-Hall Test (P-Value)	0.862	0.890	0.429	0.539	0.545
Cumby-Huizinga Test (P-Value)	0.138	0.127	0.0169	0.387	0.192
Endogeneity Test (P-Value)	0.00932	0.00882	0.0229	0.925	0.408
Hansen J Test (P-Value)	0.9074	0.9013	n.a.	n.a.	n.a.

Alternative IV specifications using Treas. & agencies

Effect on 5-year yield of $100 bn foreign official inflow = -43 to -70 bp

	(1) IV: *ALL COUNTRIES*	(2) IV: *ALL COUNTRIES*	(3) IV: *ALL COUNTRIES*
First Stage: Instruments			
$JPYFXINT_t$	0.002***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)
ΔBOP_CN_t		0.004**	0.004**
		(0.002)	(0.002)
$OIL\_SUPPLY\_SHOCK_t$			0.008
			(0.012)
Second Stage: Official Flows			
$\Delta FOI\_TA_t / GDP_{t-1}$	-0.983**	-0.606	-0.637*
	(0.489)	(0.382)	(0.385)
Observations	160	126	126
R-squared - 2nd Stage	n.a.	0.116	0.100
Cragg-Donald Wald F-Stat	7.829	10.29	6.950
Weak instrument test, critical value[1]	8.96	11.59	12.83
Endogenous Variables	1	1	1
Exogenous Instruments	1	2	3
Pagan-Hall Test (P-Value)	0.850	0.847	0.878
Cumby-Huizinga Test (P-Value)	0.0101	0.201	0.185
Endogeneity Test (P-Value)	0.0433	0.0661	0.0577
Hansen J Test (P-Value)	n.a.	0.3486	0.5437

Long-term elasticity

Cointegrated VAR approach

- Differentiate between short-run and long-run dynamics
- Recognize interdependencies between foreign holdings and term premium
- Endogenous variables: term premium, foreign official holdings, foreign private holdings
- Exogenous variables: industrial production, U.S. and German volatility of 5-yr note futures, VIX

VAR long-run coefficients (-17 to -20 bp effect)

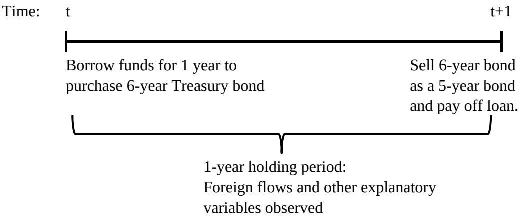
	12 lags	6 lags	2 lags	1 lag
Cointegrating vector, β^1				
Term premium (normalized)	1	1	1	1
Foreign official	0.046	0.062	0.055	0.063
Foreign private	0.061	0.05	0.037	-0.001
T-stat - cointegration coef.				
Foreign official	5.782	4.633	3.403	3.866
Foreign private	2.883	1.521	0.952	-0.033
Loading Factors, α^2				
Term premium	-0.481	-0.21	-0.186	-0.216
Foreign official	-0.54	-0.295	-0.153	-0.224
Foreign private	0.096	0.23	-0.017	0.08665
T-stat. - loading factors				
Term premium	-5.831	-4.559	-5.129	-4.957
Foreign official	-2.378	-2.288	-1.442	-2.522
Foreign private	0.274	1.219	-0.113	0.633
Criteria for lag selection				
Schwarz	4.07	2.74	1.97	1.88
Hannan-Quinn	2.61	1.94	1.6	1.6
Akaike	1.6	1.4	1.34	1.42
Residual tests (p-values)				
Serial Independence[3]	0.58	0.61	0.1	0
Normality[4]	0.55	0.49	0.04	0.09
Homoskedasticity[5]	0.26	0.72	0.16	0.01

Regressions using realized excess returns

A priori-hypothesis

- Foreign flows during the holding period increase realized excess returns at the end of the holding period

$$D^{(6)}_{t+1} = \ln \frac{P^{(5)}_{t+1}}{P^{(6)}_{t}} - r_t.$$



Excess returns regressions

Effect on 5-year yield of $100 bn foreign official inflow = -42 bp

	(1) OLS: XR_6_t	(2) IV: 1st Stage $\Sigma_{12}FOI_t / DEBT_{t-12}$	(3) IV: 2nd Stage XR_6_t	(4) IV: 1st Stage† $\Delta(\Sigma_{12}FOI_t / DEBT_{t-12})$	(5) IV: 2nd Stage† ΔXR_6_t
Flow Variables					
$\Sigma_{12}FOI_t / DEBT_{t-12}$	0.172		0.595***		0.424
	(0.119)		(0.184)		(0.545)
$\Sigma_{12}FPVT_t / DEBT_{t-12}$	0.656***	0.056	0.616***	-0.036	-0.723***
	(0.144)	(0.067)	(0.137)	(0.053)	(0.251)
Control Variables					
IP_t^{yoy}	-0.942***	0.198	-0.988***	-0.031	-0.282
	(0.330)	(0.154)	(0.317)	(0.074)	(0.328)
IP_{t-1}^{yoy}	0.293	-0.246	0.303	-0.093	0.106
	(0.321)	(0.150)	(0.310)	(0.073)	(0.336)
VIX_t	0.156***	-0.047*	0.175***	-0.019*	0.139***
	(0.057)	(0.027)	(0.044)	(0.011)	(0.049)
DE_VOL_t	-0.361	-0.704***	-0.155	-0.037	-0.730*
	(0.491)	(0.251)	(0.524)	(0.097)	(0.427)
US_VOL_{t-1}	0.026	-0.409***	-0.095	0.073	-0.514*
	(0.315)	(0.155)	(0.300)	(0.069)	(0.312)
$LP5_{t-1}$	0.001	-0.069*	0.040	-0.010	0.035
	(0.081)	(0.038)	(0.084)	(0.015)	(0.070)
$\Sigma_{12} OIL\_DEMAND\_SHOCK_t$	-0.297***	-0.063	-0.261***	-0.010	-0.061
	(0.112)	(0.056)	(0.095)	(0.037)	(0.164)
$CP^{1\text{-}5}_{t-13}$	2.266***	-0.259	2.601***	0.059	-0.147
	(0.380)	(0.176)	(0.428)	(0.068)	(0.294)
$CP^{6\text{-}9}_{t-13}$	0.423***	-0.052	0.395***	0.006	0.048
	(0.143)	(0.067)	(0.144)	(0.023)	(0.111)
$RISK\ APPETITE_t$	-0.494***	-0.050	-0.484***	-0.046	-0.501**
	(0.124)	(0.058)	(0.106)	(0.048)	(0.198)
$\Sigma_{12} STR\_BUDGET\_BAL_t/GDP_{t-12}$	0.168	-0.730***	0.627**	-0.101	-0.549
	(0.310)	(0.145)	(0.284)	(0.182)	(0.892)
Instruments					
$\Sigma_{12} JPYFXINT$		0.025***		0.024***	
		(0.002)		(0.003)	
$\Sigma_{12} OIL\_SUPPLY\_SHOCK_t$		0.239***		0.051	
		(0.057)		(0.040)	
Observations	158	158	158	158	158
R-squared	0.784	0.915	0.765	0.365	0.104
Durbin-Watson	1.326	0.421		1.486	
Cragg-Donald Wald F-Stat			92.79		32.77
Weak instrument test, critical value[1]			11.59		11.59
Pagan-Hall Test (P-Value)			0.224		0.928
Cumby-Huizinga Test (P-Value)			6.84e-06		0.0970
Endogeneity Test (P-Value)			5.01e-06		0.00374
Hansen J Test (P-Value)			0.3563		0.3902

Comparison to other studies

Comparison of estimates of effects of purchases on Treasury yields

	Basis points per 100 $billion	Investor type	Data frequency
Short-run "flow" effect			
1. This study: Term-premium regs.	-46 to -50	For. Off.	Monthly flows
2. D'Amico and King (2011)	-67	Fed	Daily purchases
3. Bernanke et al. (2004)	-66	Jpn. Official	Daily interventions
4. McCauley and Jiang (2004)	-70 to -100	For. Off.	Weekly flows
Medium-run "flow" effect			
1. This study: Excess returns regs.	-39 to -62	For. Off.	12-month flows
2. Warnock and Warnock (2009)	-68	For. Off.	12-month flows
3. Rudebusch et al. (2006)	no effect	For. Off.	12-month flows
Long-run "stock" effect			
1. This study: Cointegration	-17 to -20	For. Off.	Holdings (level)
2. Bertaut et al. (2011)	-11 to -15	For. Off.	Holdings (level)
3. Gagnon et al. (2011)	-2 to -5	Fed	Cumulated purchases
4. D'Amico and King (2011)	-10	Fed	Cumulated purchases
5. Hamilton and Wu (2011)	-4	Fed	Cumulated purchases

LSAP purchases vs. foreign official purchases

- LSAPs are temporary
- LSAPs may increase inflation risk premium
- Expectations of future LSAPs move with economic fundamentals, hard to measure

Conclusion

Conclusion, I

- Foreign official inflows into Treasury notes respond to such things as implied volatility of U.S. and German bonds, liquidity premium, structural budget deficit, and implied stock market volatility (VIX)
- Short-run effect ranges from -40 bp to -60 bp per $100bn
- Long-run effect roughly -20 bp
- Estimates using 1994-2011 sample period imply slightly lower effects
- Between 1995 and 2000 China acquired roughly $1.1 trillion in Treasuries
    - Absent these flows, our estimates suggest that, all else equal, 5-yr yields would be roughly 2 percentage points higher

Conclusion, II

- We estimated the "average" effect over the last few decades
- But true effect of a large sale of U.S. Treasuries by a foreign official investor would depend on the timing and magnitude of sales
  - Sudden, unexpected dumping of massive amounts of Treasuries could disrupt market functioning
  - Behavior of private investors would depend on perceived safe-haven status
- Our results likely overstate the effect of reserve diversification (e.g. from Treasuries into Bunds)