Flow and Stock Effects of Large-Scale Treasury Purchases

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Overview

- Fed announced plan to buy up to $300 billion of longer-term Treasuries on March 18, 2009.
- Intent was to decrease long-term interest rates.
- From a theoretical perspective, it is not obvious this should work.
  - Perfect arbitrage models suggest that supply/demand factors do not affect financial asset prices.
- Our question: Did it work?

Overview

- Why does this matter?
  - Immediate policy relevance
  - Broader academic importance - test of 'preferred habitat' models
- Previous work on effects of supply fluctuations is somewhat inconclusive.
- Innovations of our approach:
  - Security-level panel data
  - Controls for purchases of "substitutes"
  - Sample splits by security characteristics
  - Stock and flow effects

Plan of the talk

- Previous theory and evidence
  - Preferred habitat / portfolio balance / imperfect asset substitution theories generate a role for supply in pricing
  - Previous work is consistent with this idea, but it is hard to say for sure because of the aggregate nature of the data
- Overview of the LSAP program and our data
- Estimates of Stock Effects
  - Explain cross-section of returns during the program
  - *Results:*
    - *Purchases shifted the yield curve persistently down by 20 to 50 bp.*
    - *Effects were more segmented for less liquid securities*
- Estimates of Flow Effects
  - Explain change in prices on days when purchases occurred (panel)
  - *Results:*
    - *Purchase operations on average shifted yields in the purchased sector down by 3.5 bp.*
    - *Effects were more segmented and more persistent for less liquid securities*

Theoretical motivation

- In standard arbitrage-free models with risk-neutral traders and exogenous short-term rate there is no role for Treasury supply.
- In order for changes in bond supply to affect pricing, a friction must exist that limits arbitrage across different types of assets: imperfect substitutability.
- Models with preferred-habitat investors and risk-averse arbitrageurs formalize this view. Greenwood-Vayanos(2008) and Vayanos-Vila (2009).

Preferred-habitat view generates 4 hypotheses that we test:

- H1. Changes in Treasury supply have significant effects on Treasury yields
- H2. Those effects are larger for purchased securities, somewhat smaller for similar maturities, and minimal for distant maturities
- H3. These differences in responses are more pronounced in segmented portions of the market
- H4. For securities in those portions, even anticipated purchases might have effects when they actually occur, resulting in persistent price changes

Previous Evidence

- Bernanke et al. (2004) studied responses of yield curve during several episodes of government interventions.
- Taharan(1995), and Kuttner (2006) test responses of yields to Fed interventions
- Greenwood and Vayanos (2008), Krishnamurthy and Vissing-Jorgenson (2007), Hamilton and Wu (2010) look at aggregate measures of supply
- Time-series and event studies of the LSAP programs – Gagnon et al. (2010) and others.
- All aggregate-level studies suggest negative effects of supply on yields, but substantial variance across magnitudes and statistical significance of estimates
- Aggregate data complicate identification and limit what can be learned about differences in impact across term structure

Review of Treasury LSAP

- Program announced March 18, 2009.
- Extension through October and tapering announced on August 12.
- $300 billion purchased, 95% in nominal securities.
- 60 operations in bi-weekly cycles from March 25 – October 29.
  - Maturity ranges pre-announced.
  - Excluded securities announced the morning of the operation.
  - Offers accepted through ~11 AM.
  - Purchases settled the following day.

Table 1. Characteristics of Nominal Treasury LSAP Purchases

	Average of LSAP purchases	Average of all outstanding coupon securities
Remaining maturity	6.5 years	5.7 years
Coupon	3.7%	3.8%
Yield	2.4%	1.9%
Time since issued	4.0 years	3.9 years
% On-the-run	29.0%	4.9%
% Notes	79.5%	82.8%

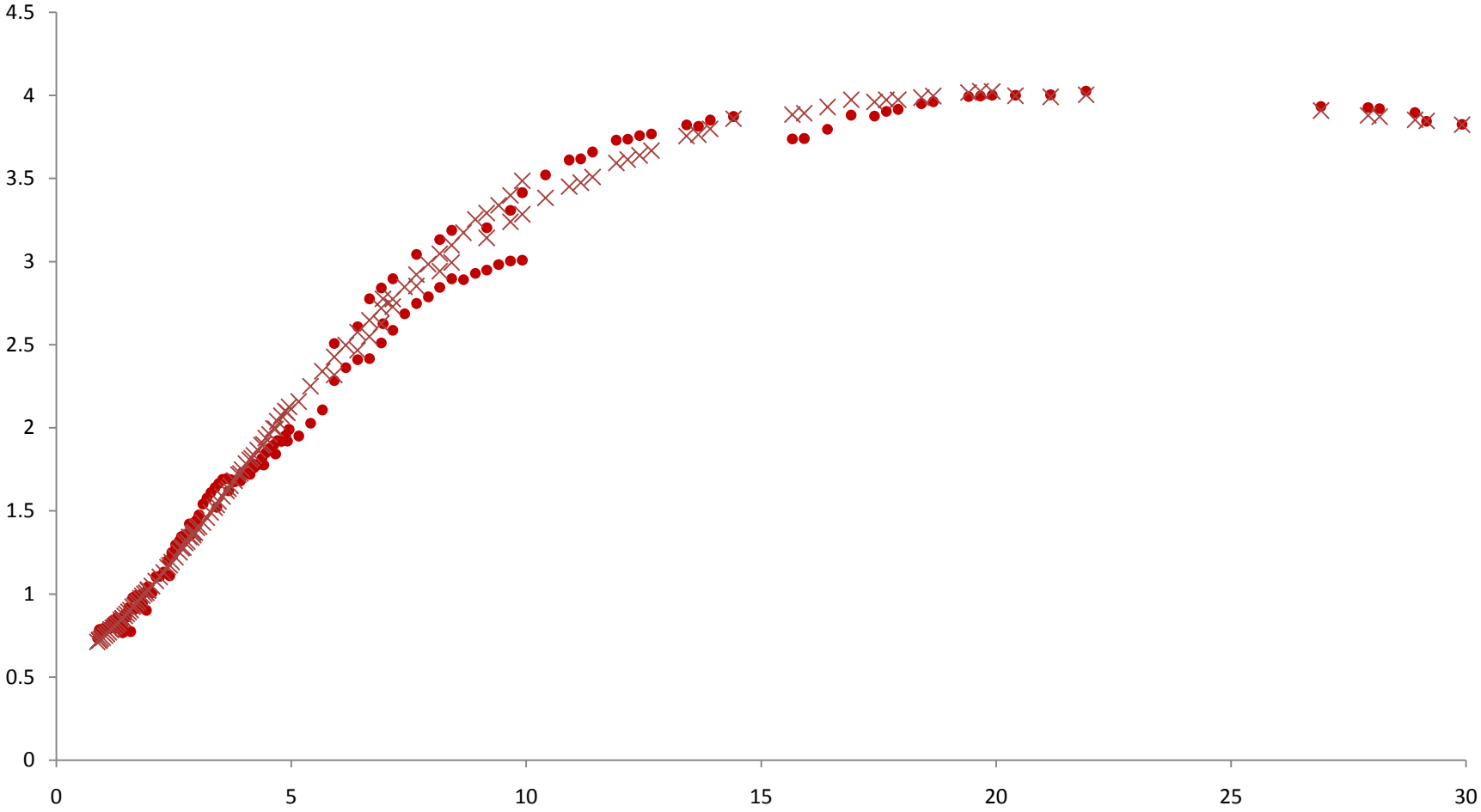
Note: All figures are dollar-weighted.

Table 2. Indicators of Liquidity in the Nominal Treasury Market

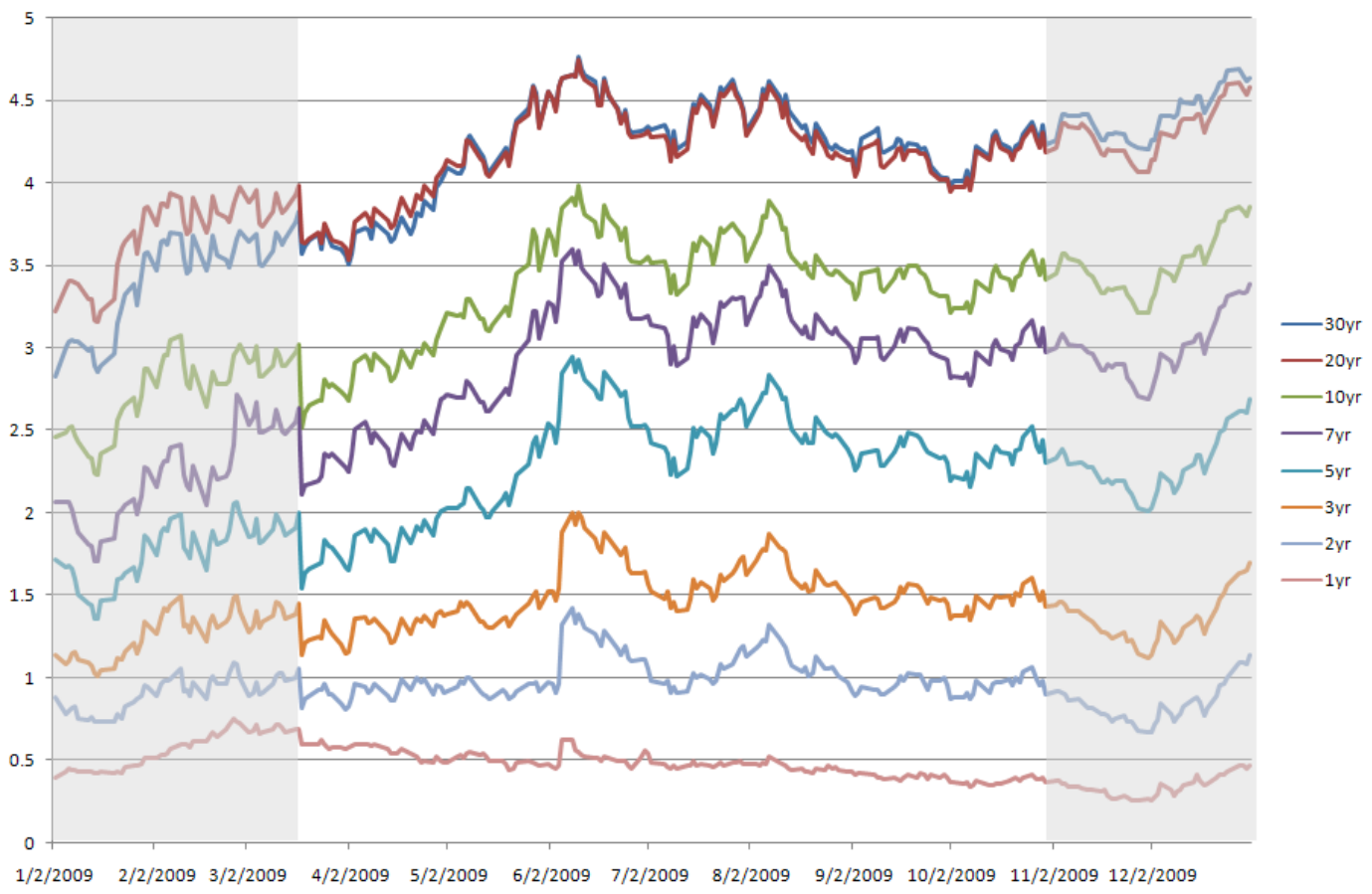
	Daily market volume	10-year on-the-run premium	Fails to deliver	Average absolute fitting errors of Svensson curve
March 25-July 6 2009	$100 bil	38 bp	$73 bil	6.4 bp
July 7-October 29 2009	$120 bil	28 bp	$15 bil	3.3 bp

Notes: Volume data come from Bloomberg, and fails-to-deliver data come from the FR 2004 reports. The on-the-run premium is the difference between the yield on the on-the-run 10-year note and 10-year value from a Svensson curve fit to off-the-run securities.

Nominal Treasury coupon yields: 17 March 2009



Selected Treasury Yields during Treasury LSAP Program



Data

- Daily percentage price changes on 204 Treasury coupon securities(including 44 never purchased).
  - Exclude:
    - TIPS
    - Remaining maturities < 90 days
- For each LSAP operation:
  - CUSIPS eligible for purchase
  - Amount of each CUSIP actually purchased
- Amounts of each CUSIP outstanding, vintage, coupon, maturity, fitting error, accrued coupon payments, % held by SOMA.

Why CUSIP-level data?

- To capture differences in returns between securities that were purchased in different amounts, identifying impact of purchases.
- To parse price reactions more finely (for example, examine differential effects of purchases across securities characteristics).
- To estimate substitution effects across securities by constructing for each CUSIP buckets of Treasuries with similar maturities.

Stock effects

- The fact that yields generally moved up does not mean that the program was ineffective.
  - Yields might have been even higher without LSAPs.
  - Hard to get at this with time-series information alone.

- Our identification comes from *cross-sectional* variation in yields.
  - Did yields rise less for securities we purchased more of?

Stock effects

- Some issues:
  - Our use of *total cumulative* changes avoids having to deal with expectations and timing issues.
    - Includes effects of March 18 announcement
  - *But*, it leads to a possible endogeneity problem:
    - What if we were more likely to purchase those securities whose yields rose most?
    - To deal with this, we use IV, where our instruments are pre-determined.

Substitutes

- We might also think that a security's yield is affected by purchases of other, similar securities.

- Thus, for each security *i*, we define buckets of substitutes, based on maturity:
  - *Near substitutes*: within 2 years of *i*
  - *For the flow effects*
  - *Mid-substitutes*: 2 – 6 years from *i*
  - *Far substitutes*: 6 – 14 years from *i*

- We also instrument these variables.
  - Same instruments, plus average each instrumental variables over the bucket of substitute.

Stock effects

- IV cross section of returns from March 17 – October 30, 2009.
- Our basic setup is

$$R_i = \alpha + \beta \widehat{q^{own}}_i + \gamma \widehat{q^{sub}}_i + \phi_1 M + \phi_2 M^2 + e_i$$

gross return

instrumented own purchases

instrumented substitute purchases

Remaining maturity terms

- allow for the coefficients to depend on the security characteristics – old and new bonds and notes

Coefficient interpretation

- β reflects the own-price elasticity
- Its magnitude is mainly indicative of purchase effects on yield-curve fitting error
- γ reflects cross-elasticity of Treasury prices with respect to other Treasury securities
- Its magnitude affects aggregate level and term structure of yields

Dependent Variable: Actual LSAP Purchases

Independent Variables: Security Characteristics as of March 17

Intercept	0.051*** (0.015)
Remaining maturity	0.015*** (0.003)
Remaining maturity squared	-0.0006*** (0.00009)
Svensson fitting error	0.208*** (0.038)
% of issue held by Fed	-0.271*** (0.083)
On-the-run dummy	0.091*** (0.024)
< 2-years dummy	-0.044*** (0.014)
# Obs	148
Adjusted R^2	0.431

Stock Effects—IV Second-Stage Pooled

	Gross returns	*Adjusted returns*
Own Purchases (IV)	2.17*** (0.43)	1.15*** (0.25)
Purchases of near substitutes (IV) (maturity w/in 2 yrs of own)	0.13** (0.07)	0.09** (0.04)
Remaining maturity	-0.003** (0.001)	-0.0004 (0.0006)
Remaining maturity squared	0.00003 (0.00004)	-0.00004* (0.00002)
Intercept	0.011*** (0.002)	0.009*** (0.0012)
# Obs	148	148
Adj. R^2	0.695	0.847

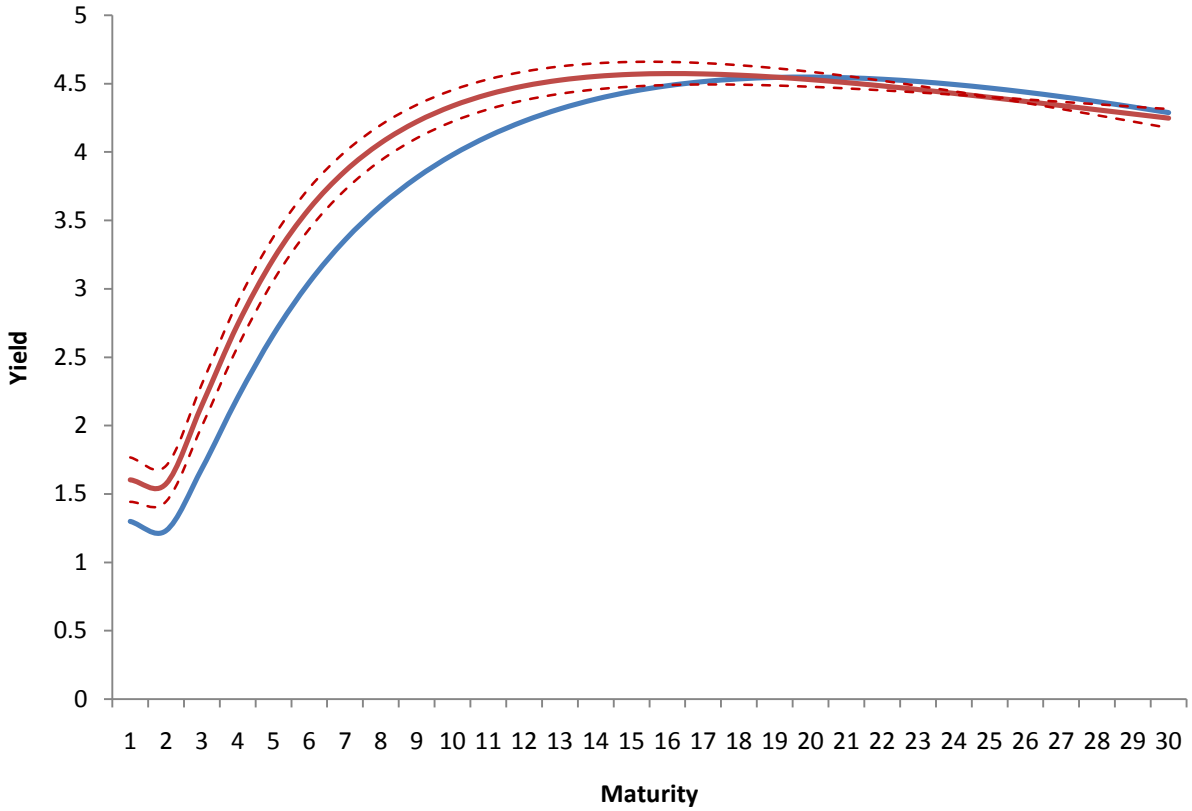
Stock Effects (IV)—Subsamples

	Notes Far off-the-run	Bonds < 15 years	Notes Near-on the-run	Bonds > 15 years
Own Purchases (IV)	1.39 (0.93)	1.13*** (0.37)	0.32 (0.53)	0.22 (0.34)
Purchases of near substitutes (IV) (maturity w/in 2 yrs of own)	0.07* (0.04)	0.14*** (0.05)	0.08* (0.05)	0.19** (0.08)
Remaining maturity	-0.0009 (0.0007)			
Remaining maturity squared	-0.00002 (0.00003)			
Intercept	0.010*** (0.001)			
# Obs	148			
Adj. R^2	0.893			

Counterfactual yields

- We use these results to estimate cumulative effects of LSAPs on aggregate yield curve.
  - For each security, using actual value of own purchases and its near substitutes, together with coefficients of appropriate subsamples, compute estimated total price change due to LSAP.
  - Subtract this value from actual end-of period price to get counterfactual price of each security.
  - Prices are then smoothed using Svensson curve to obtain counterfactual end-of-period yields

Stock effect of LSAP on nominal yield curve



FLOW EFFECTS

- Response of prices to ongoing purchases operations.
- Purchase operations are announced in advanced, list of CUSIPs and sizes of operations are predictable, so no significant response at aggregate level.
- The particular CUSIPs that are purchased and the distribution of amount purchased should matter, causing portfolio rebalancing activity.
- On top of portfolio rebalancing, significant response should reflect liquidity and microstructure issues.

Flow effects

- Panel framework: CUSIP level data on operation days.
- Our basic setup is

$$R_{it} = \alpha_i + \delta_t + \beta q_{it}^{own} + \sum_{j=1}^{3} \gamma_j q_{ijt}^{sub} + e_{it}$$

change in price

fixed effect

time dummy

own purchases

substitute purchases

error term

Notes

- The time dummies control for lots of things in a limited portion of the curve(maturity sector)
  - Macro data, Treasury issuance
- The fixed effects control for lots of things.
  - Vintage, maturity, coupon rate
- Market participants don’t know in advance total amount to be purchased and distribution of purchased across CUSIPs.

Timing and Sample

- Eligible vs. non-eligible
- Notes vs. Bonds
- Near on-the-run vs. Far off-the-run
- First half vs. second half of the program
- Day of purchase vs. day after

Flow Effects on Day of Purchase—Eligible Securities <15y

	Mar 25 – Jul 6	Jul 7 – Oct. 29	Notes	Bonds	Near on-the-run	Far off-the-run
Own Purchases	0.3442*** (0.094)	0.2975*** (0.089)	0.2669*** (0.068)	0.2498*** (0.090)	0.2318** (0.107)	0.2488*** (0.065)
Purchases of:						
Near substitutes (maturity w/in 2 yrs of own)	0.2863*** (0.086)	0.3038*** (0.083)	0.2503*** (0.062)	0.1694** (0.083)	0.2435** (0.105)	0.1584*** (0.057)
Mid-substitutes (maturity 2 to 6 years away)	0.1989*** (0.082)	0.2037** (0.073)	0.2088** (0.055)	0.0929 (0.080)	0.2501*** (0.092)	0.0744 (0.055)
# Obs.	563	360	769	154	249	674
# CUSIPS	131	121	123	23	53	114
Adj. R^2	0.974	0.975	0.976	0.986	0.986	0.977

Flow Effects on Day of Purchase—All Securities

	Eligible		Ineligible	
	<15y to maturity	>15y to maturity	<15y to maturity	>15y to maturity
Own Response (β)	0.2763*** (0.053)	-0.1063 (0.098)	---	---
Cross Responses (γ_j):				
Near substitutes (within 2 years)	0.2403*** (0.048)	-0.1238*** (0.044)	0.0665*** (0.018)	-0.0268 (0.053)
Mid-substitutes (2 to 6 years away)	0.1700*** (0.045)	0.0501* (0.026)	0.0047 (0.0099)	-0.007 (0.021)
Far substitutes (6 to 14 years away)	---	---	-0.0238** (0.008)	0.0021 (0.003)
# Obs.	923	145	8008	1104
# CUSIPS	146	23	181	23
Adj. R^2	0.976	0.985	0.52	0.96

Flow Effects on Day of Purchase, by Sub-Period

	Eligible		Ineligible	
	Mar 25 – Jul 6	Jul 7 – Oct. 29	Mar 25 - Jul 6	Jul 7 – Oct. 29
Own Response (β)	0.3442*** (0.094)	0.2975*** (0.089)	---	---
Cross Responses (γ_j):				
Near substitutes (within 2 years)	0.2863*** (0.086)	0.3038*** (0.083)	-0.127*** (0.025)	0.3844*** (0.031)
Mid-substitutes (2 to 6 years away)	0.1989*** (0.082)	0.2037** (0.073)	-0.143*** (0.015)	0.2021*** (0.017)
Far substitutes (6 to 14 years away)	---	---	-0.153*** (0.014)	0.0925*** (0.011)
# Obs.	563	360	4529	3479
# CUSIPS	131	121	167	172
Adj. R^2	0.974	0.975	0.51	0.57

Day after, Notes	Eligible		Ineligible	
	Mar 25 – Jul 6	Jul 7 – Oct. 29	Mar 25 – Jul 6	Jul 7 – Oct. 29
Own Response (β)	-0.379*** (0.143)	-0.145 (0.116)	---	---
Near substitutes (within 2 years)	-0.478*** (0.145)	-0.152 (0.108)	-0.464*** (0.039)	-0.135*** (0.049)
Mid-substitutes (2 to 6 years away)	-0.620*** (0.139)	-0.106 (0.087)	-0.436*** (0.035)	-0.009 (0.039)
Far substitutes (6 to 14 years away)	---	---	-0.308*** (0.039)	0.134*** (0.038)
# Obs.	442	327	3891	2960
# CUSIPS	108	111	144	149
Adj. R^2	0.986	0.974	0.573	0.51

Day after, Bonds	Eligible		Ineligible	
Own Response (β)	0.377*** (0.145)	0.58*** (0.117)	---	---
Near substitutes (within 2 years)	0.157 (0.098)	0.556*** (0.119)	-0.047 (0.046)	0.086* (0.047)
Mid-substitutes (2 to 6 years away)	0.111 (0.082)	0.472*** (0.125)	-0.057*** (0.018)	-0.046*** (0.020)
Far substitutes (6 to 14 years away)	---	---	-0.049*** (0.014)	0.015*** (0.013)
# Obs.	121	33	638	519
# CUSIPS	23	10	23	23
Adj. R^2	0.99	0.99	0.94	0.93

Robustness

- Same exercise using yields: similar conclusion
- Clustered errors by maturity: similar conclusions
- Estimation of balanced panel by FGLS: very similar results
- Role for expectations: actual purchase distribution vs expected purchase distribution. The cross section responses are not affected by the surprise effect.

Conclusions

We estimate that:

- average purchase operation temporarily reduced yields by about 3.5 basis points.
- The program as a whole shifted the yield curve down by 23 basis points on average.
- Effects are larger in less-liquid segments of the market.

A motivating exercise:
Explaining the cross-section of yield changes on March 18

Dependent variable: Percentage price changes on 3/18, by CUSIP	
Intercept	-0.008*** (0.0007)
Fitting error	0.013*** (0.003)
Fitting error squared	0.068*** (0.012)
Remaining maturity	0.006*** (0.0001)
Remaining maturity squared	-0.0002*** (0.0000)
On-the-run dummy	-0.0009 (0.0013)
Vintage	0.00009** (0.00002)
Adj. R^2	0.97

Nominal Treasury coupon yields: 30 October 2009