

Duration Risk vs. Local Supply Channel in Treasury Yields: Evidence from the Federal Reserve's Asset Purchase Announcements

Cahill M., D'Amico S., Li C. and Sears J.
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Overview

- Exploiting the FOMC's announcements of Treasury purchase programs and New York Fed's statements about the programs' operational details, we document the presence of local supply and duration risk effects;
- Using new measures of *local supply surprise* and *duration risk surprise* we quantify the average impact of these supply channels on nominal Treasury yields;
- We analyze how the importance of these channels has evolved over time, across 5 events characterized by different market conditions and risk sentiments.

Importance of understanding these channels

- It is crucial for the transmission mechanism of this policy tool: are these channels always operating?
- It is crucial for the calibration of these policies and eventually their unwinding: max or min their impact depending on the stance of monetary policy;
- Documenting the relative importance of these channels across multiple programs from 2009 to 2012 helps understanding how impact:
 - has evolved over time
 - has varied across market conditions and risk sentiments.

Novelty of the Paper

- We distinguish between expected and unexpected component of the announcement *controlling for the pre-announcement market expectations* using the NY Fed Desk's survey of primary dealers conducted before each FOMC;
- New identification procedure that exploits prices' reactions to *both* 1) the FOMC announcement regarding the total size of the program and 2) the NY Fed Desk's releases of the program's operational details, which provided the intended distribution of purchases and sales across maturity sectors;
- New dataset consisting of *intraday* price quotes on *all* outstanding U.S. Treasury nominal securities from 2008 to 2012.

Why are these 3 new elements important?

- Using the total amount announced rather than only its unexpected component implies overestimation of the shock and underestimation of the price elasticity;
- Distinguishing total stock surprise (unexpected component of the total size of the program) and maturity distribution surprise (unexpected component of the weight allocated to each maturity sector) allows measurement of *supply 'shock' local to each maturity sector*;
- Observing high-frequency price reactions across different duration/maturity and liquidity characteristics of all outstanding Treasury securities is essential to identification.

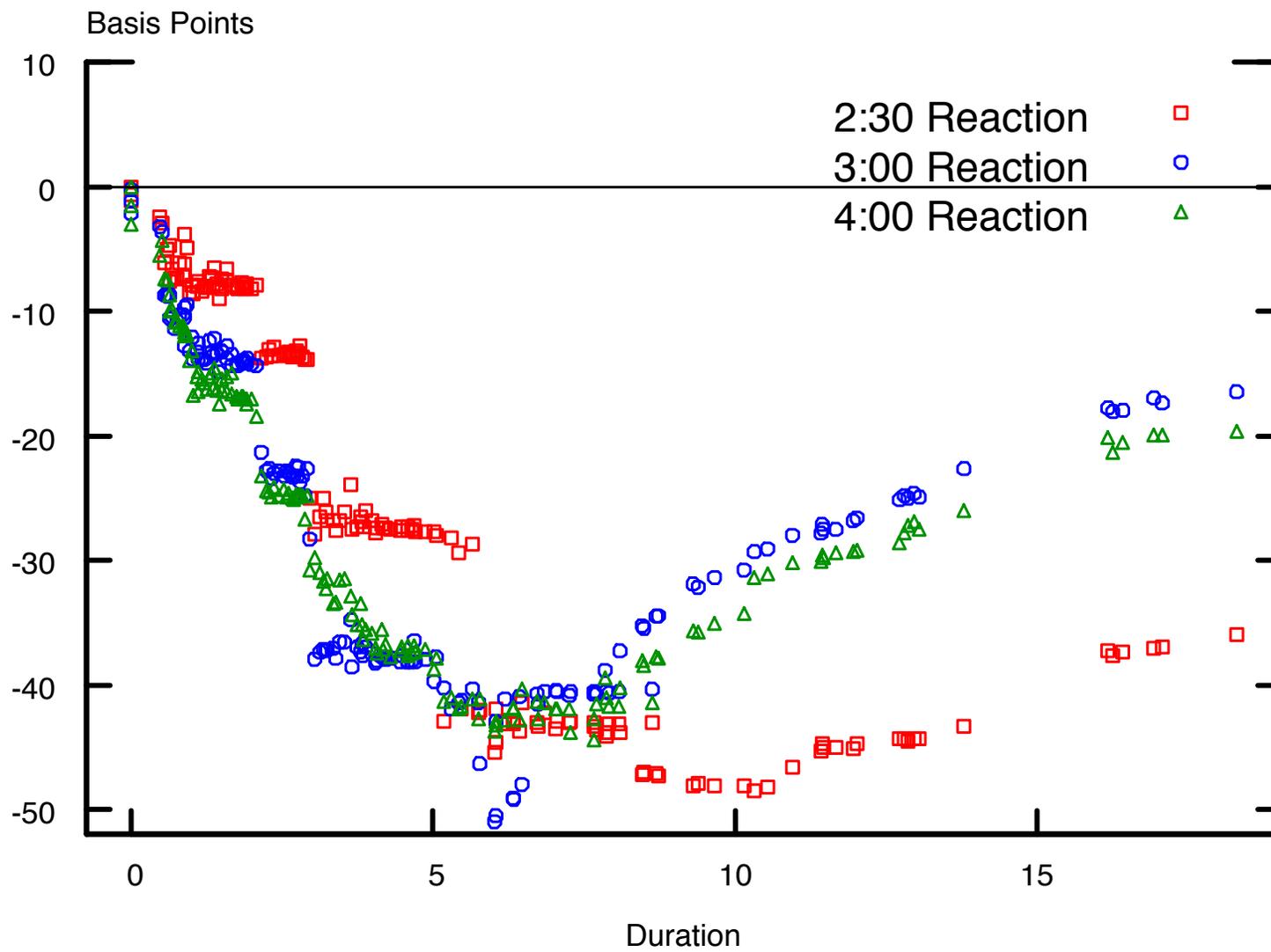
Preview of Empirical Results

- Local supply and duration risk ‘shocks’ together can explain most of the variation in Treasury yields reaction to the Fed purchase program announcements and each separately has about 25 to 50% explanatory power;
- Average impact on the 10-year nominal Treasury yield across all 5 events is about -5bp per \$100bn surprise from the duration risk effect and -4bp from the local supply effect;
- Once pre-announcement market expectations are carefully controlled for, there does not appear to be evidence that these two channels’ impact has declined over time;
- Suggesting they may be key factors in the determination of Treasury securities prices rather than exceptional mechanisms triggered by market disruption or extremely high risk aversion.

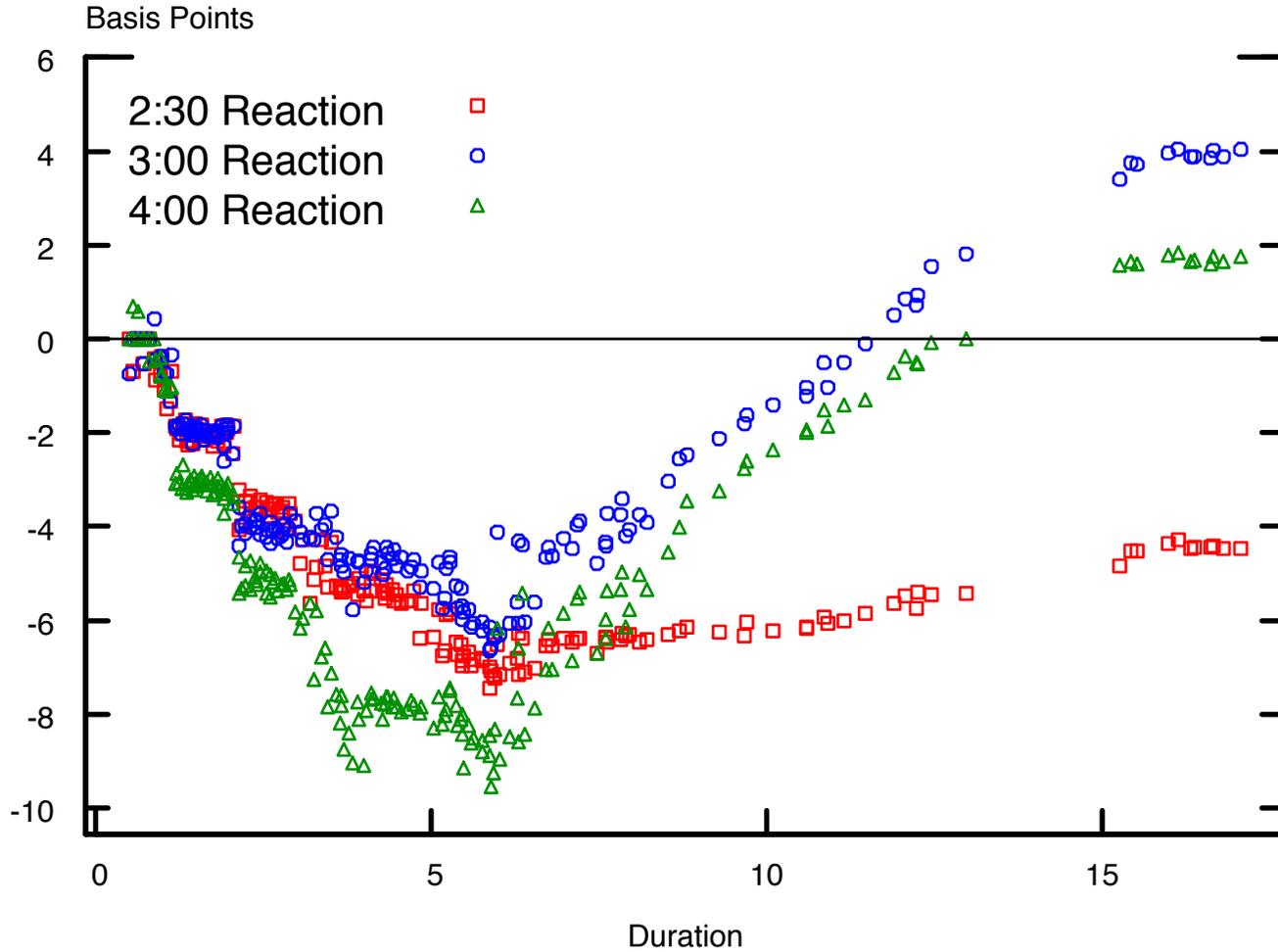
Previous Evidence

- Event studies of the LSAP programs – Gagnon et al. (2011), Neely (2011), Krishnamurthy and Vissing-Jorgenson (2012)...
 - Do not distinguish between expected and unexpected component, do not use data at the individual security level, and do not exploit reactions to release of operational details about the program.
- Event studies of the Bank of England's QE announcements:
 - Joyce and Tong (2012) use intraday data on individual securities but do not focus on reactions to operational details and cannot separately identify the unexpected component of the total size and maturity distribution of each QE program.
 - Benerjee, Latto, McLaren and Daros (2012) study how the announced operational changes to the QE program affected gilt yields, but cannot measure unexpected component of duration risk;
- D'Amico, English, Lopez-Salido and Nelson (2012):
 - First case study analyzing reaction to surprises in maturity distribution of purchases, but focused on a single event and a few securities.

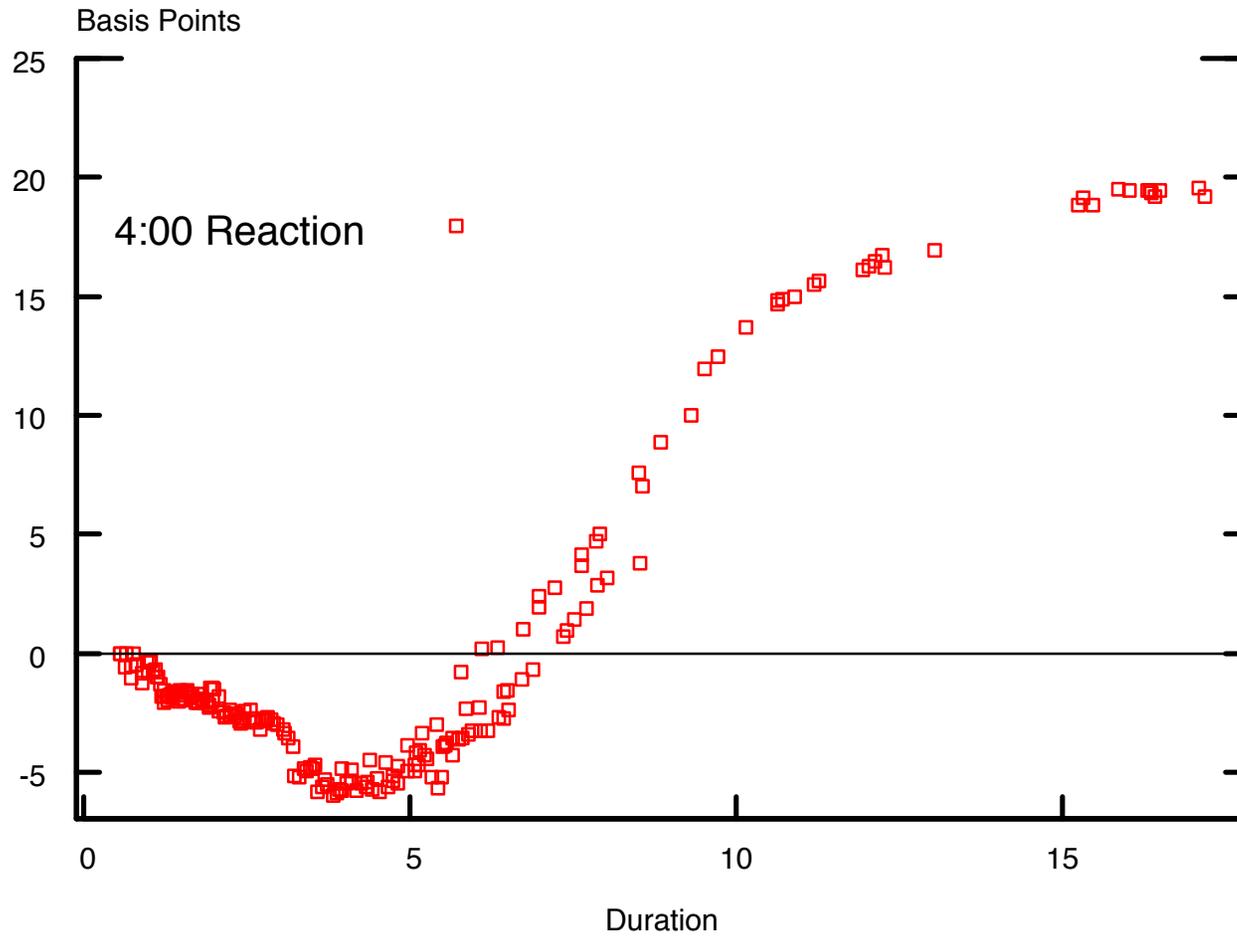
LSAP1



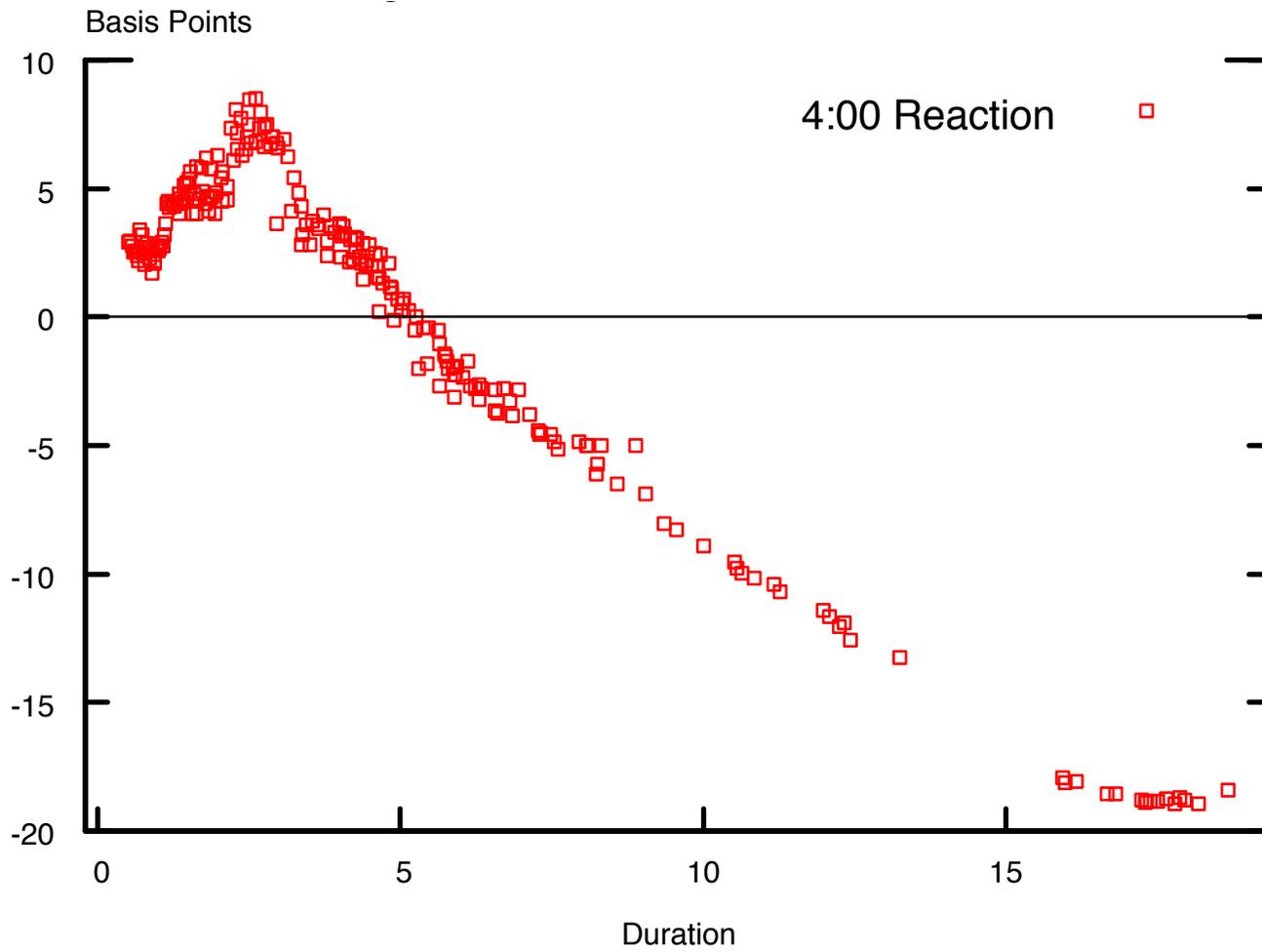
Reinvestment Program



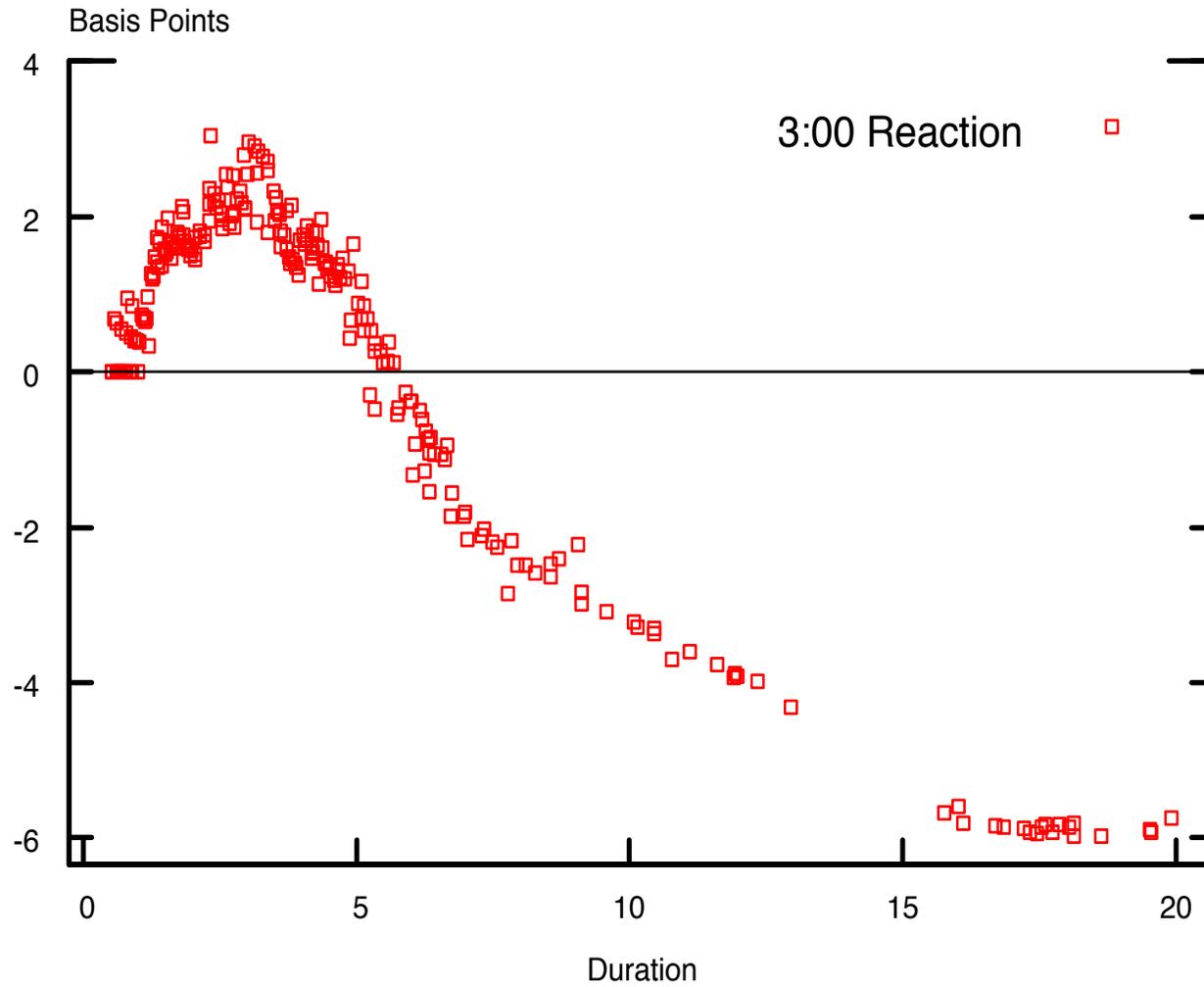
LSAP2



MEP



MEP Extension



Estimation of the channels' impact

- For each program we construct the local supply (ls) surprise and the individual duration risk (idr) surprise
- We run the following regression:

$$\Delta y_i = \alpha + \beta_1 ls_i + \beta_2 idr_i + u_i$$

- $\Delta y(i)$ is the yield change from 15 minutes before the FOMC announcement to 4:00 p.m. of next day
- $ls(i)$ is the local supply shock for each security
- $idr(i)$ is the duration risk shock for each security

Local supply surprise

- For each program, we estimate investors' prevailing expectations of its probability to occur, P , its total size $E(Q)$, and associated vector of maturity bucket weights $E(W_k)$;
- The surprise for each maturity bucket k is difference between actual and expected maturity distribution of purchase amount:

$$SQ_k = Q * W_k - P * E(Q | program_occurs) * E(W_k)$$

- Within a bucket, SQ_k is allocated to each security i based on the security's relative amount outstanding in that bucket;
- For each security, $ls(i)$ is obtained as the weighted sum of own and nearby securities' normalized surprises, with weight:

$$\delta_{ij} = \left(1 - \frac{|\tau_j - \tau_i|}{\theta * \tau_j}\right) 1_{\{|\tau_j - \tau_i| \leq \theta * \tau_j\}}$$

Measuring Expected Components

- To measure P and $E(Q)$ we use the Desk Primary Dealer Survey compiled by the NY Fed before each FOMC meeting;
- We also supplement it with information from market commentaries;
- We set pre-announcement maturity weights $E(W_k)$ to be identical to those observed under the immediately preceding program, except for:
 - LSAP1, assume weights to be proportional to % amount outstanding in each maturity sector
 - MEP, renormalize weights for 6- to 30-y sector s.t. sum = 1

Figure 6. LSAP1 Announcement

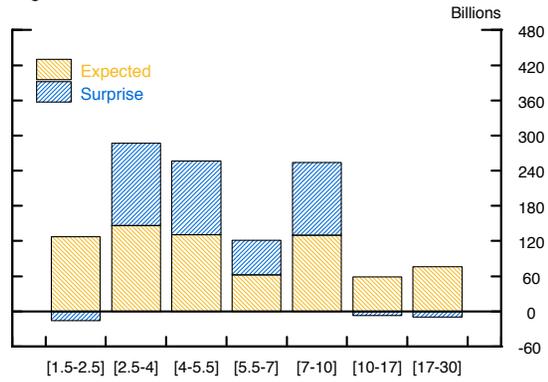


Figure 7. Reinvestment Announcement

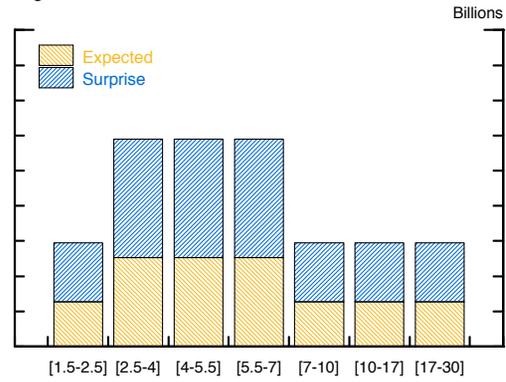


Figure 8. LSAP2 Announcement

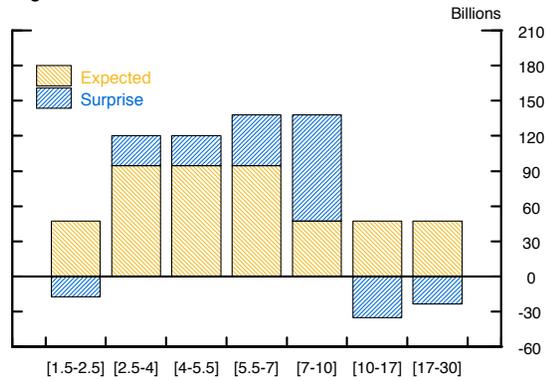


Figure 9. MEP Announcement

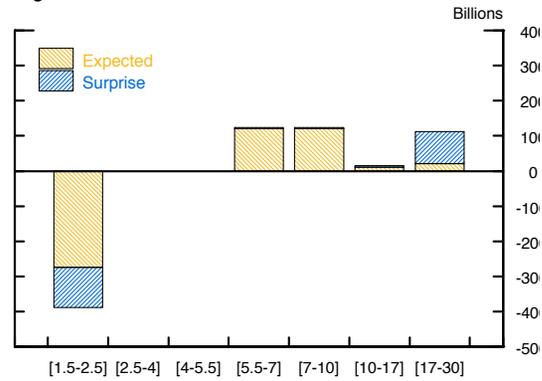
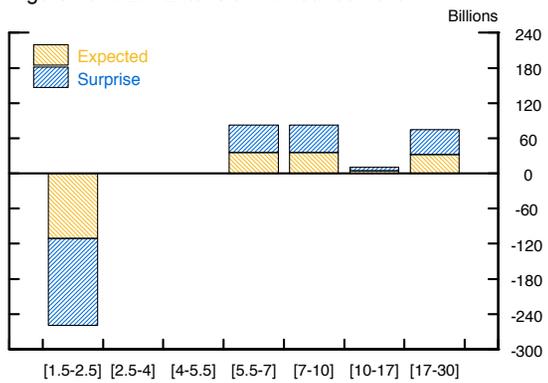
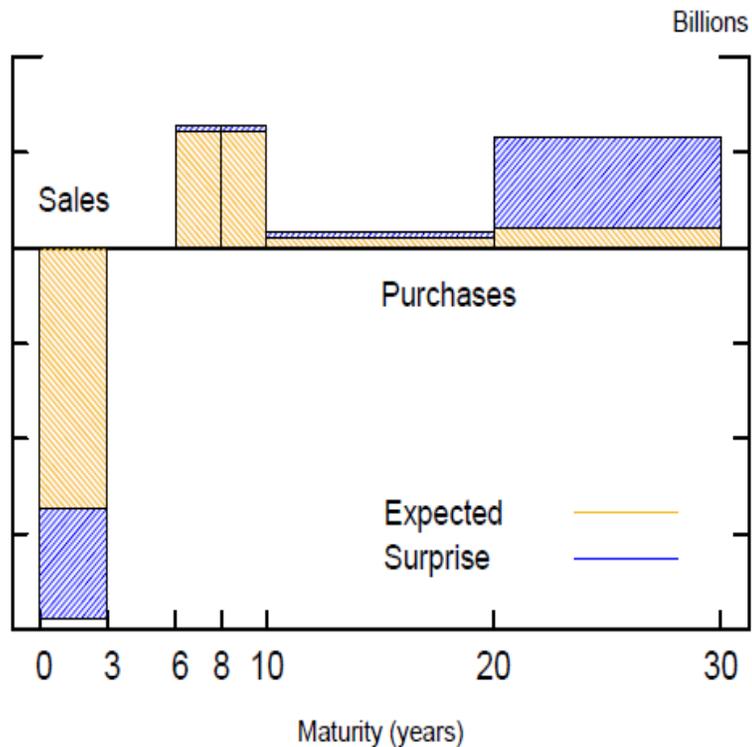


Figure 10. MEP Extension Announcement

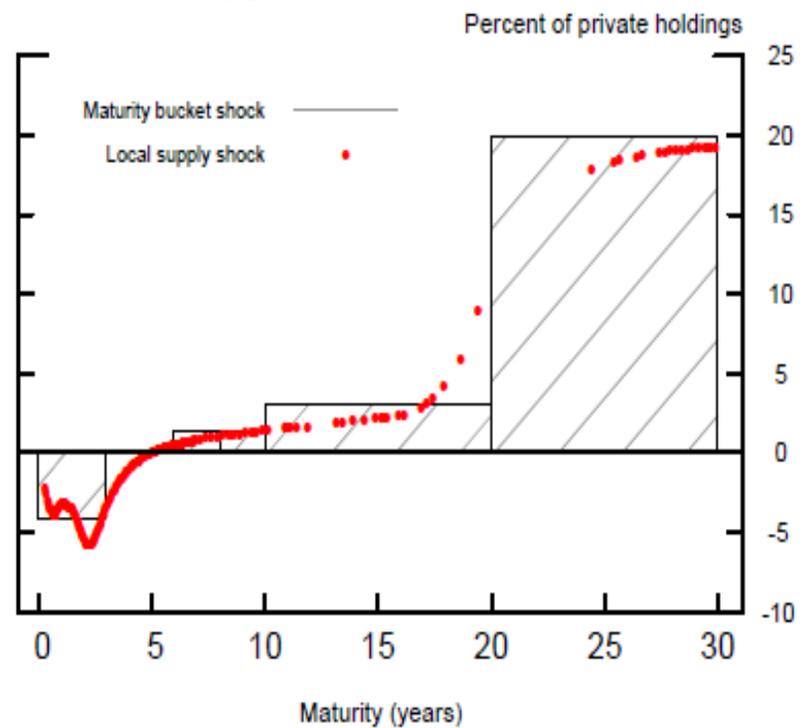


Example of $ls(i)$ computations for MEP

Maturity bucket surprises: MEP



Bond local supply shocks: MEP



Duration risk surprise

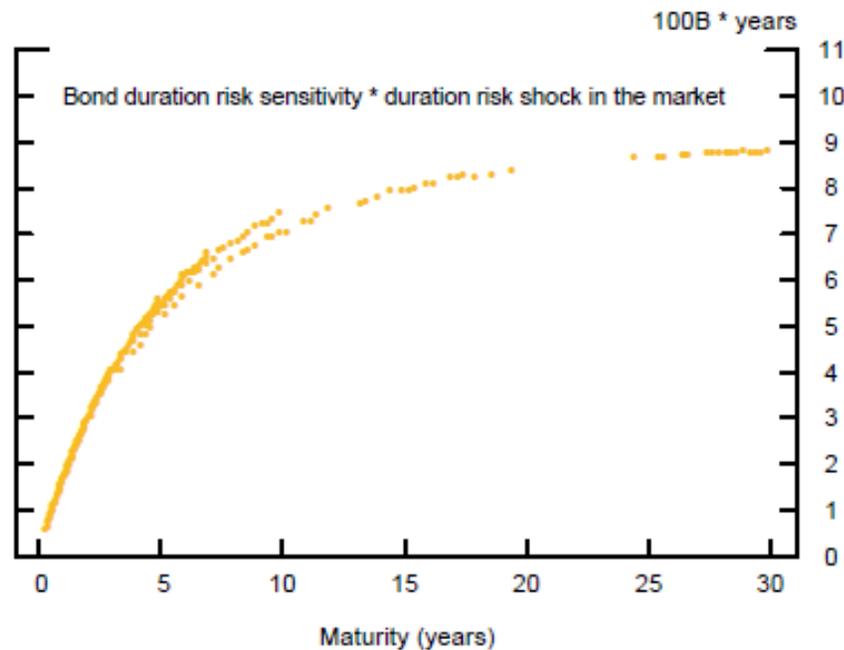
- In V&V (2009) model the risk premium is defined as

$$rp_i = a\sigma^2 \left(\sum_i x(d_i)d_i \right) \frac{(1 - \exp(-\gamma d_i))}{\gamma} = \sigma\lambda f(d_i)$$

- Where the market price of risk λ is mainly determined by the dollar value of the aggregate duration: $\lambda = a\sigma \sum_i x(d_i)d_i$
- We measure λ with the amount of ten-year equivalents left in the hands of private investors.
- The surprise in aggregate duration risk (SDR) is the unexpected change in the total ten-year equivalents
- Individual duration risk $idr(i)$ is determined by the security's exposure to SDR:
$$idr_i = f(d_i) * SDR$$

Example of $idr(i)$ computations for MEP

Bond duration risk premium shock: MEP



Note: Bond duration risk sensitivity is $[1 - \exp(-k * d)]/k$, where d is bond duration and the parameter k is set as 0.2 according to Li and Wei (2012).

Regression results

Table 1: Yield change regression results with variable window size, $\theta=0.5$ and $\gamma=0.2$

| | LSAP1 | Reinvestment | LSAP2 | MEP | MEP2 | Pooled |
|---------------------|---------------------------------|-------------------|--------------------|--------------------|--------------------|--------------------|
| | Two-day yield change regression | | | | | |
| Constant | 0.466 (0.52) | -1.078 (-2.45) | -2.982 (-4.65) | 3.169 (3.32) | 0.367 (0.91) | 0.629 (1.92) |
| Duration risk shock | -3.000 (-22.07) | -1.280 (-3.11) | -0.952 (-1.97) | -2.189 (-11.75) | -0.399 (-3.60) | -1.803 (-21.36) |
| Local supply shock | -0.385 (-12.51) | -1.632 (-5.76) | -1.210 (-25.16) | -1.481 (-19.16) | -0.480 (-12.00) | -0.807 (-31.58) |
| R-squared | 0.84 | 0.69 | 0.76 | 0.91 | 0.76 | 0.72 |
| Observations | 163 | 200 | 208 | 232 | 245 | 1048 |

Note: t-statistics in parenthesis.

Economic interpretation of coefficients

Table 2: Implied effect on the 10-year yield from an unexpected \$100B program

| | LSAP1 | Reinvestment | LSAP2 | MEP | MEP2 | Average |
|---|-------|--------------|-------|-------|------|---------|
| Impact in basis points using individual regression's coefficients | | | | | | |
| Total* | -8.9 | -9.4 | -9.2 | -13.1 | -3.7 | -8.9 |
| of which, bond duration | -7.6 | -3.4 | -2.5 | -8.5 | -1.5 | -4.7 |
| of which, local supply | -1.8 | -5 | -3.8 | -7.8 | -2.6 | -4.2 |

*Includes the estimated constant term.

Isolating impact of program's design

Table 3: Implied effect on the 10-year yield from an unexpected \$100B program

| | LSAP1 | Reinvestment | LSAP2 | MEP | MEP2 | Average |
|---|-------|--------------|-------|-------|-------|---------|
| Impact in basis points using pooled regression's coefficients | | | | | | |
| Total* | -7.7 | -6.6 | -6.5 | -10.6 | -10.6 | -8.4 |
| of which, bond duration | -4.6 | -4.8 | -4.7 | -7 | -6.9 | -5.6 |
| of which, local supply | -3.8 | -2.4 | -2.5 | -4.3 | -4.3 | -3.5 |

*Includes the estimated constant term

Variation explained by each channel

Table 4: Relative importance of the duration channel and the local-supply channel

| | LSAP1 | Reinvestment | LSAP2 | MEP | MEP2 | Pooled |
|---------------------------------------|---------------------------------|--------------|-------|------|------|--------|
| | Two-Day Yield Change Regression | | | | | |
| Total variation explained (R-squared) | 0.84 | 0.69 | 0.76 | 0.91 | 0.76 | 0.72 |
| of which, bond duration | 0.58 | 0.33 | 0.01 | 0.41 | 0.32 | 0.29 |
| of which, local supply | 0.26 | 0.36 | 0.75 | 0.50 | 0.44 | 0.43 |

Figure 18. LSAP 1 Announcement

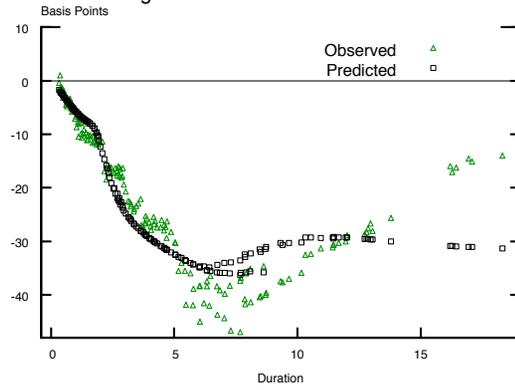


Figure 19. Reinvestment Announcement

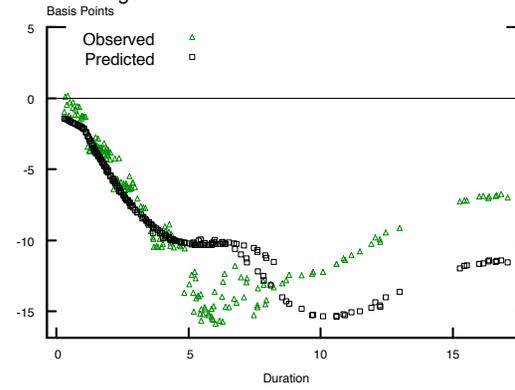


Figure 20. LSAP 2 Announcement

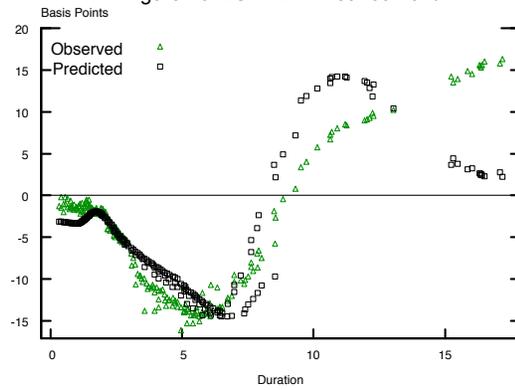


Figure 21. MEP Announcement

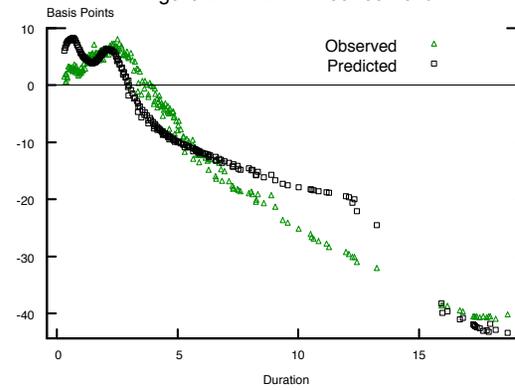
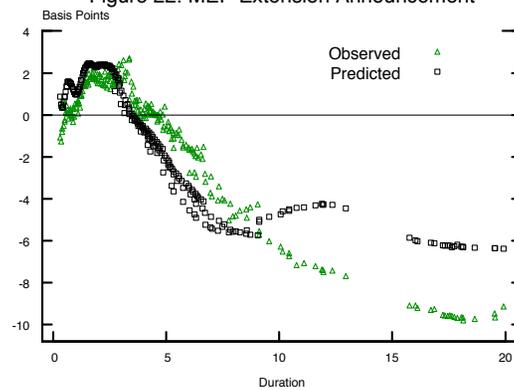


Figure 22. MEP Extension Announcement



Robustness to parameters' values

Table 8: Yield change regression results with variable window size, $\theta=0.769$ and $\gamma=0.095$

| | LSAP1 | Reinvestment | LSAP2 | MEP | MEP2 | Pooled |
|---------------------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| Two-day yield change regression | | | | | | |
| Constant | -2.551 (-3.31) | -1.399 (-4.27) | -3.177 (-14.52) | 1.847 (1.91) | 0.196 (0.61) | -0.624 (-2.44) |
| Duration risk shock | -1.375 (-17.37) | 1.638 (6.97) | 0.065 (0.56) | -1.571 (-12.08) | -0.314 (-5.01) | -0.992 (-20.81) |
| Local supply shock | -0.680 (-18.61) | -4.746 (-15.49) | -2.003 (-68.93) | -1.542 (-13.35) | -0.539 (-11.69) | -1.043 (-40.58) |
| R-squared | 0.85 | 0.76 | 0.96 | 0.94 | 0.87 | 0.79 |
| Observations | 163 | 200 | 208 | 232 | 245 | 1048 |

Note: t-statistics in parenthesis.

Variation explained by each channel using optimal parameters' values

Table 9: Relative importance of the duration risk and local-supply channels, $\theta=0.769$ and $\gamma =0.095$

| | LSAP1 | Reinvestment | LSAP2 | MEP | MEP2 | Pooled |
|---------------------------------------|---------------------------------|--------------|-------|------|------|--------|
| | Two-Day Yield Change Regression | | | | | |
| Total variation explained (R-squared) | 0.85 | 0.76 | 0.96 | 0.94 | 0.87 | 0.79 |
| of which, bond duration | 0.40 | 0.26 | 0.04 | 0.47 | 0.41 | 0.27 |
| of which, local supply | 0.48 | 0.49 | 0.92 | 0.48 | 0.46 | 0.52 |

Figure 24. LSAP 1 Announcement

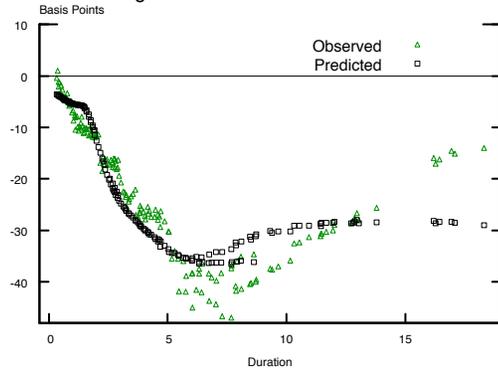


Figure 25. Reinvestment Announcement

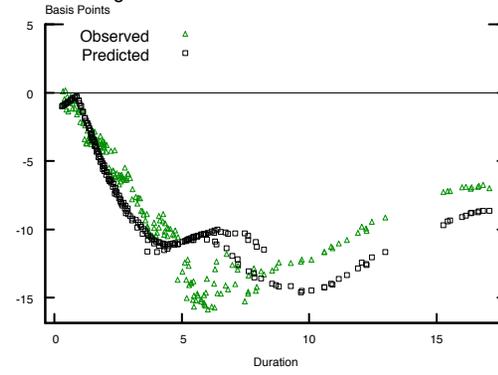


Figure 26. LSAP 2 Announcement

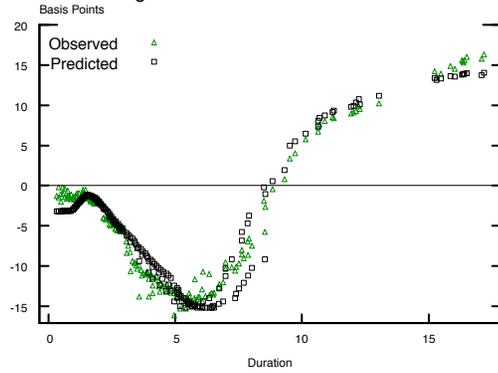


Figure 27. MEP Announcement

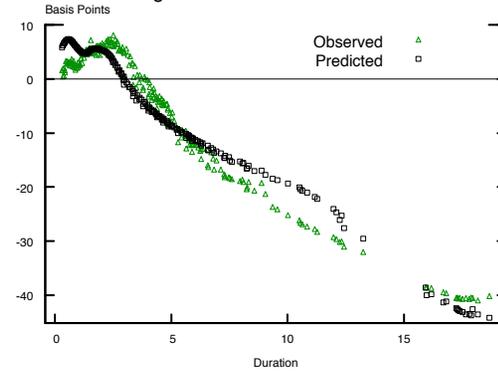
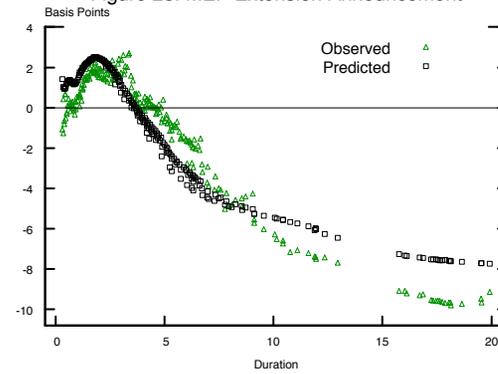


Figure 28. MEP Extension Announcement



Economic interpretation of coefficients using optimal parameters' values

Table 10: Implied effect on 10-year yield from an unexpected \$100B program, $\theta=0.769$ and $\gamma=0.095$

| | LSAP1 | Reinvestment | LSAP2 | MEP | MEP2 | Average |
|--|-------|--------------|-------|-------|------|---------|
| Impact in basis points using individual coefficients | | | | | | |
| Total* | -10.8 | -10.2 | -9 | -12.3 | -3.3 | -9.1 |
| of which, bond duration | -5 | 6.2 | 0.2 | -8.8 | -1.7 | -1.8 |
| of which, local supply | -3.2 | -15 | -6 | -5.4 | -1.8 | -6.3 |

*Includes the estimated constant term.

Table 11: Implied effect on 10-year yield from an unexpected \$100B program, $\theta=0.769$ and $\gamma=0.095$

| | LSAP1 | Reinvestment | LSAP2 | MEP | MEP2 | Average |
|---|-------|--------------|-------|------|------|---------|
| Impact in basis points using pooled regression coefficients | | | | | | |
| Total* | -9.1 | -7.7 | -7.4 | -9.8 | -9.6 | -8.7 |
| of which, bond duration | -3.6 | -3.7 | -3.7 | -5.6 | -5.5 | -4.4 |
| of which, local supply | -4.9 | -3.3 | -3.1 | -3.6 | -3.4 | -3.7 |

*Includes the estimated constant term.

Sale versus purchase price elasticity

Table 5: Regression results with different local-supply coefficients for sales and purchases

| | MEP | LSAP2 | Pooled |
|---|----------------------------|---------------------|----------------------------|
| Constant | 3.6707 (2.58) | -3.1313 (-5.10) | -2.0322 (-5.917) |
| Duration risk shock | -2.2719 (-9.77) | -0.6038 (-1.20) | -1.3817 (-14.80) |
| Local supply shock, ≤ 5 years MEP sales | -1.3964 (-7.23) | | -2.0869 (-22.56) |
| Local supply shock, > 5 years MEP purchase | -1.4844 (-19.00) | | -1.6162 (-22.79) |
| Local supply shock ≤ 5 years LSAP2 purchases | | -2.006 (-10.80) | -2.0128 (-10.34) |
| Local supply shock > 5 years LSAP2 purchases | | -1.1531 (-24.06) | -1.1708 (-23.56) |
| R-squared | 0.91 | 0.78 | 0.88 |

¹² In plotting yield responses against maturities following the MEP announcement, 5-year maturity is where yields responses change from positive to negative values.

Summary of Results

- *Idr* and *ls* shocks are statistically significant and have expected negative sign;
- The two shocks seem to have similar importance in explaining the Treasury yield responses:
 - The two channels are always operating
 - their impacts did not decrease over time and
 - not strongly affected by market conditions or risk sentiment
- Programs removing both quantity and duration from market seem more effective than those concentrating a larger amount in the 2-10-year maturity sector.

Implications of our results

- Both duration risk and local supply channel are important for the transmission mechanism of the Fed asset purchase programs to the nominal term structure of Treasury yields.
- This suggests that it is not only the total size of the program (in either par or 10-year equivalents) but also its design that matters.
- It signifies the importance of the Committee's communication strategy, as it can strongly influence all three components—the size, the location, and the total dollar duration—of the shocks

Caveats

- Other factors may affect yields within the event study window
- Average forecasts from PDS may not be a good measure of market expectations
- Different assumptions about $W_{(k)}$ may lead to different results
- The duration risk may not capture all dimensions of interest rate risk
- Little information about persistency of the effects

FOMC(2:15 p.m.) and NY Desk(2:45 p.m.) Announcements

Figure 1. LSAP 1 Announcement

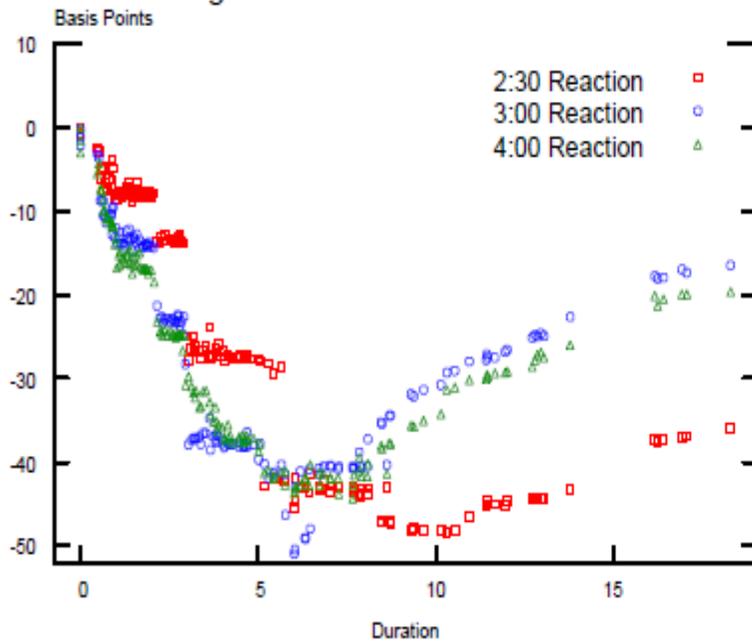


Figure 2. Reinvestment Announcement

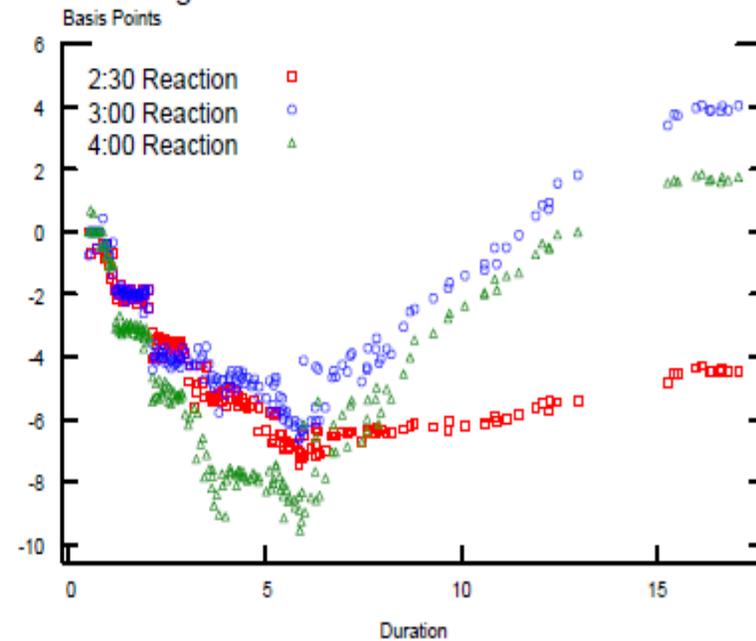


Figure 13. LSAP 1 Announcement

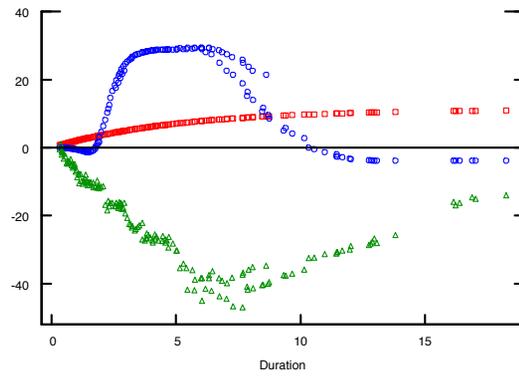


Figure 14. Reinvestment Announcement

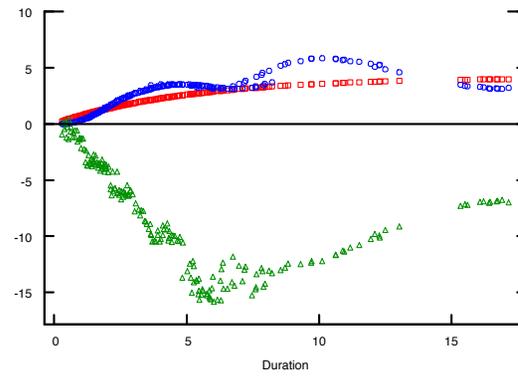


Figure 15. LSAP2 Announcement

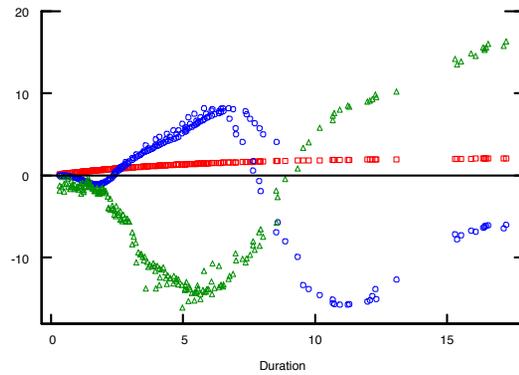


Figure 16. MEP Announcement

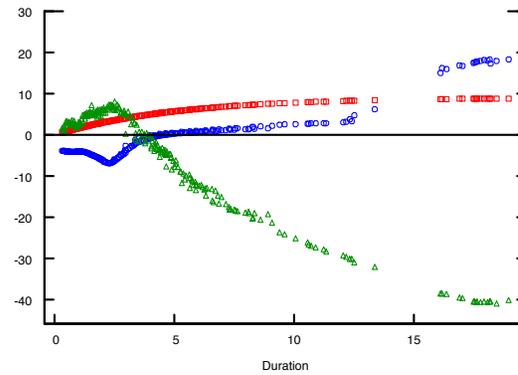
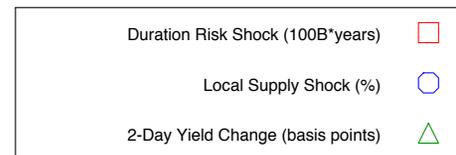
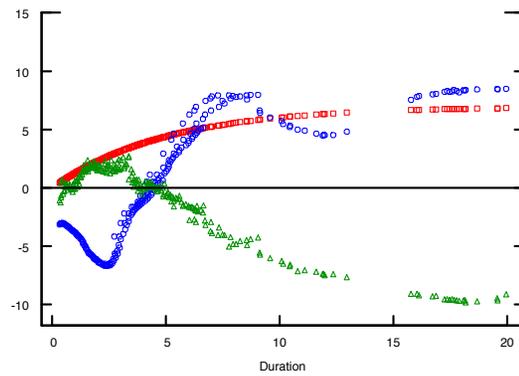


Figure 17. MEP Extension Announcement



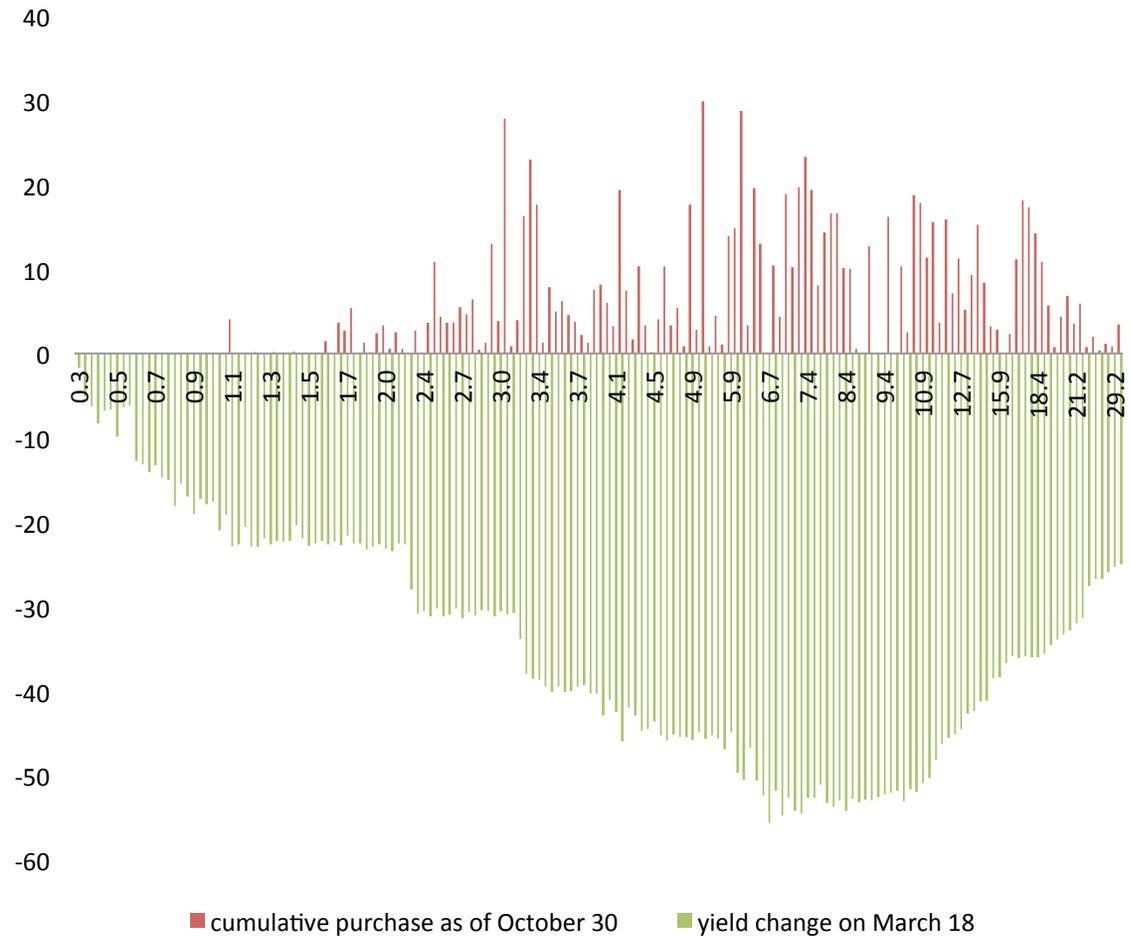
Theoretical motivation

- In standard arbitrage-free models 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).
- Similar to notions from other papers of portfolio balance or market segmentation.

Implications of preferred-habitat:

- ❑ Changes in outstanding Treasury supply have effects on Treasury yields
- ❑ Effects are larger for purchased securities, somewhat smaller for similar maturities, and minimal for distant maturities
- ❑ Differences in responses are more pronounced in segmented portions of the market
- ❑ Even anticipated purchases might have effects when they actually occur, resulting in persistent price changes

The Announcement Effect on Yields versus Subsequent Purchases

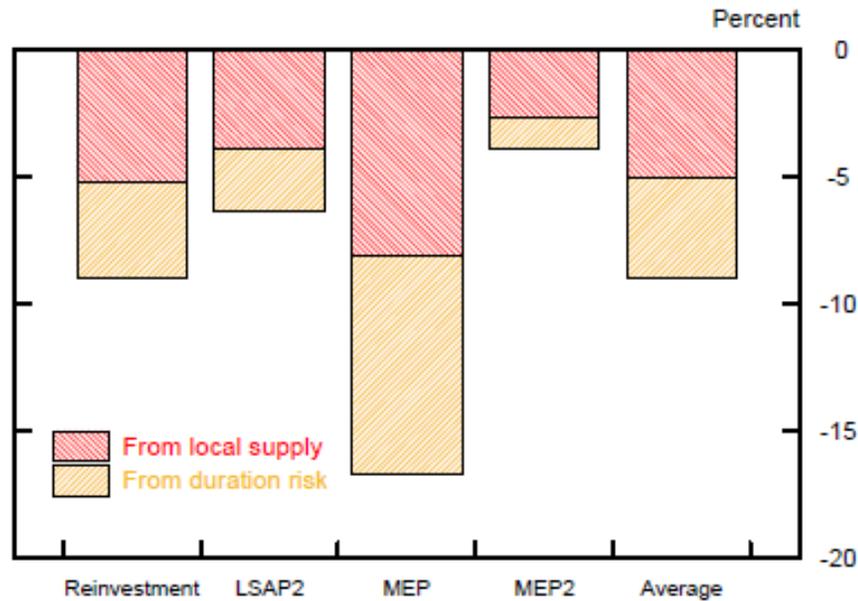


Conclusions

- 2009 Treasury LSAP succeeded in meaningfully reducing Treasury yields
- Average stock-effect elasticity of $\sim 1\text{bp} / \$10\text{ bil}$, plus flow effects
- Strong evidence of preferred habitat / imperfect substitution / portfolio balance / segmentation
- Caution extrapolating: magnitude of results may hinge on risk aversion

Effect on the 10-year Treasury yield

Implied effect on 10-year yield from 100B purchase



Note: Purchases/sales in each program are assumed to be the same as the actual purchase distribution in that program.

Was this just a relative-price anomaly in LSAP1?

- We study the impact and relative importance of the local-supply channel and the duration risk channel for the subsequent four Treasury-only purchase programs
- We conduct 5 event-studies using **intraday** security-level Treasury prices as differences in reactions across duration/maturity are essential to identification
- Even more crucial is the use of new information not only about total size of the program (FOMC announcement), but about distribution of purchases across maturity sectors (FRBNY Desk technical note)