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

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Overview

- Exploiting the FOMC's announcements of Treasury purchase programs and NY 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;

- Analyzing 5 events characterized by different market conditions and risk sentiments, we study how these channels' efficacy has evolved over time.

Definitions

- **Duration-risk** channel: is associated with the notion of interest rate risk and predicts that these programs affect yields across the entire maturity spectrum, with larger effects in longer-duration securities.

- **Local-supply** channel: derives its rationale from the PH approach and predicts that the impact is larger for securities where the shortage of supply is bigger, independently of their durations.

Importance of identifying the channels

- It is essential for the transmission mechanism, as we have less experience with policy tools that operate on term premiums;

- It is crucial for the calibration of these policies and their unwinding: max or min their impact depending on the stance of monetary policy;

- Documenting their relative importance across multiple programs helps understanding whether these channels are always operating or are exceptional mechanisms prompted by market disruptions.

Novelty of the Paper

- Distinction between expected and unexpected component of announcements, controlling for *the pre-announcement market expectations* using the NY Fed Desk's survey of primary dealers conducted before each FOMC;

- New identification procedure exploiting prices' reactions to *both* 1) the FOMC announcement about the total size of the program and 2) the NY Fed Desk's releases of the operational details, providing the intended distribution of purchases/sales across maturity sectors;

- New dataset of *intraday* price quotes on *all* outstanding U.S. Treasury nominal securities from 2008-12.

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 reaction;

- 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 to measure the *supply 'shock' local to each maturity sector*;

- Observing high-frequency price reactions across different duration and liquidity characteristics of all outstanding Treasury securities is essential to identification.

Preview of Empirical Results

- Local-supply and duration-risk 'shocks' together explain most of the variation in Treasury yields reaction to the Fed purchase announcements and each separately explains about 25-50%;

- The average impact of $100bn surprise on the 10-year nominal Treasury yield across all 5 events is about -5bp 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.
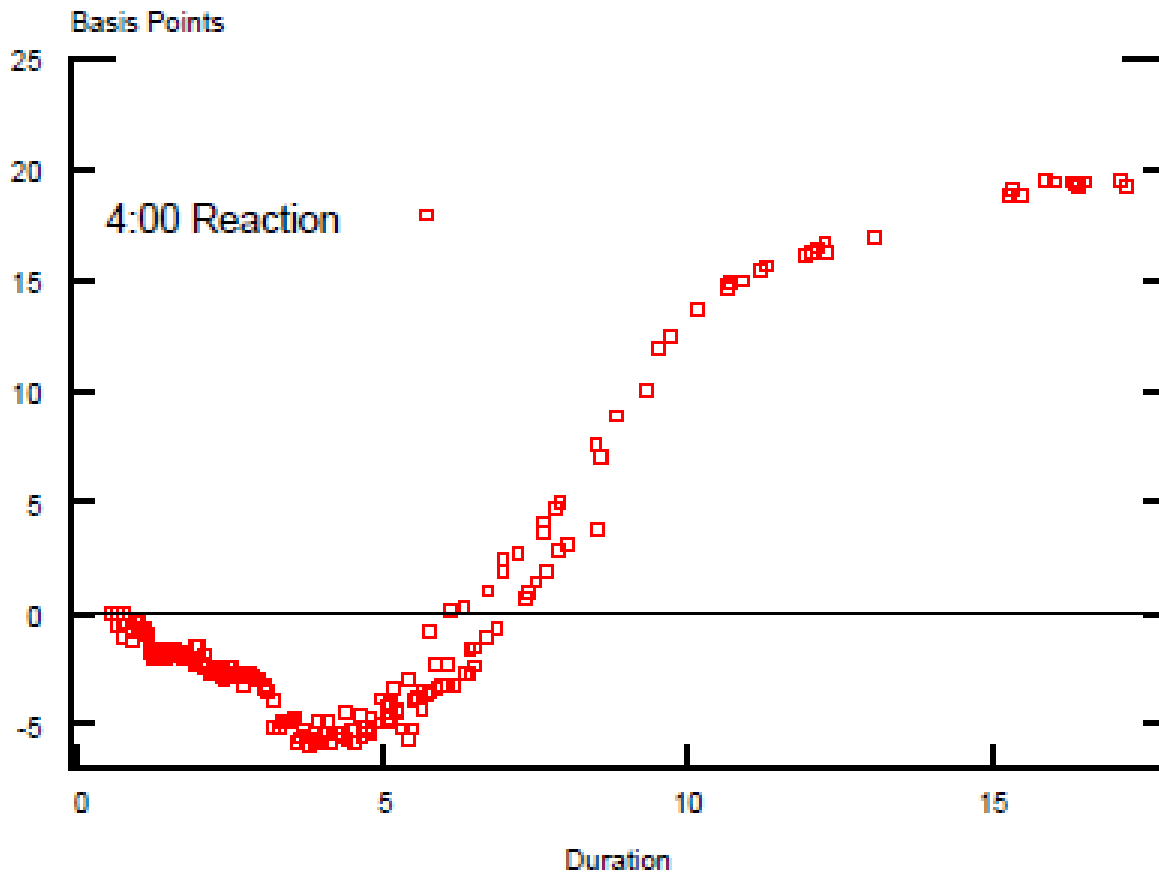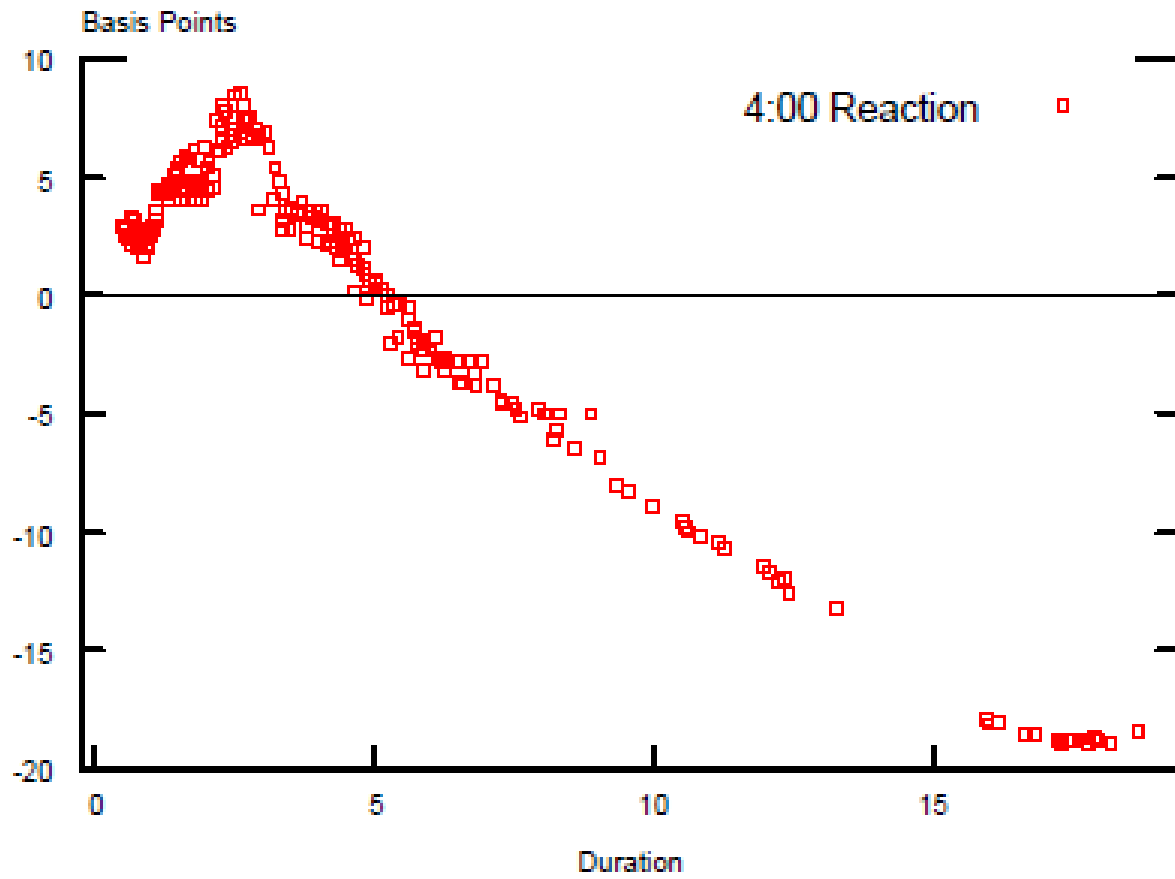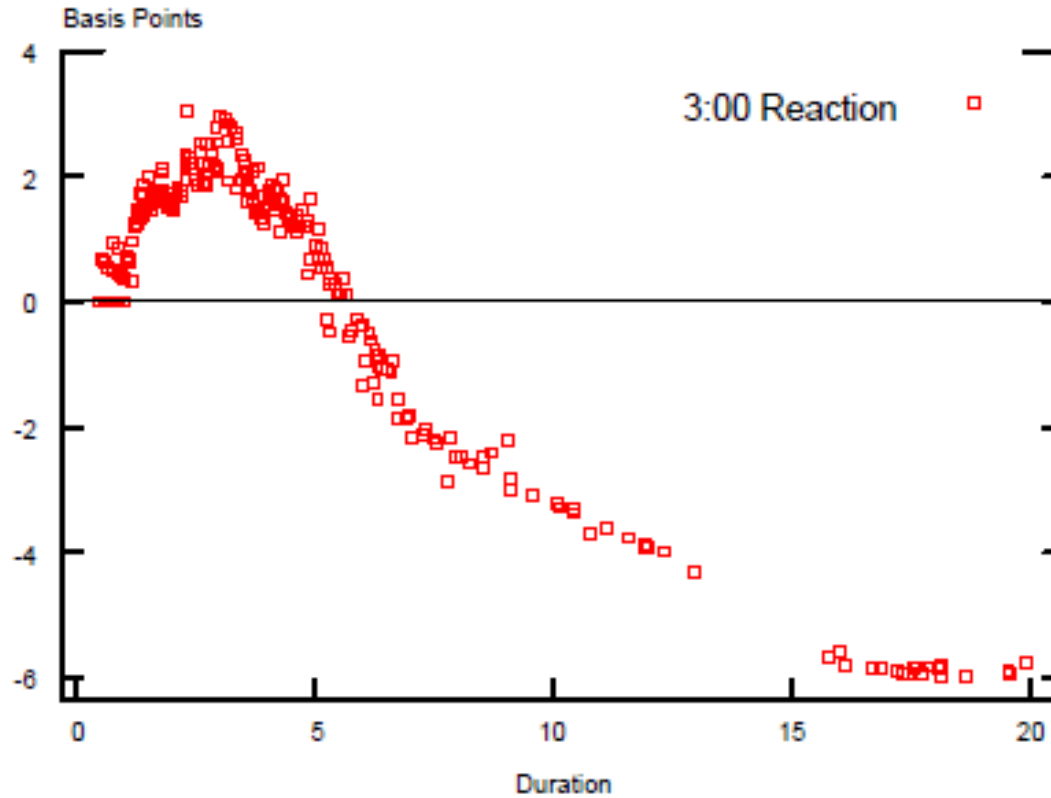
LSAP1
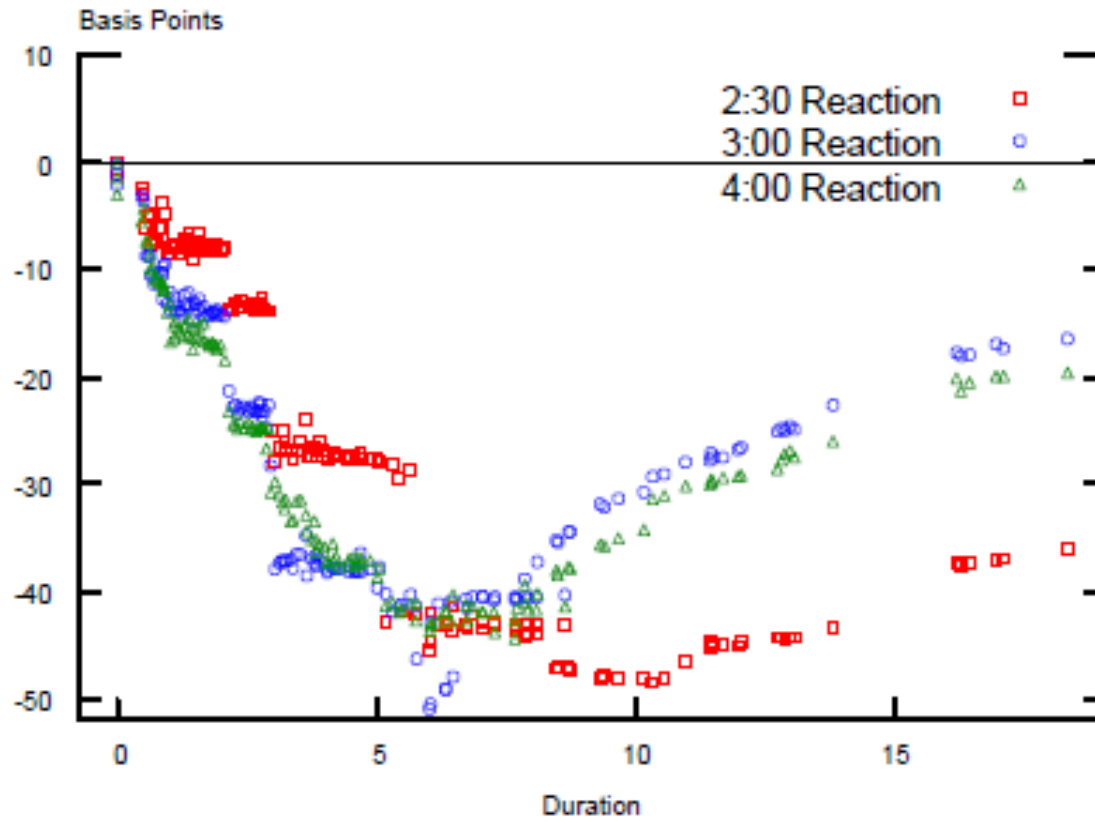
Reinvestment Program
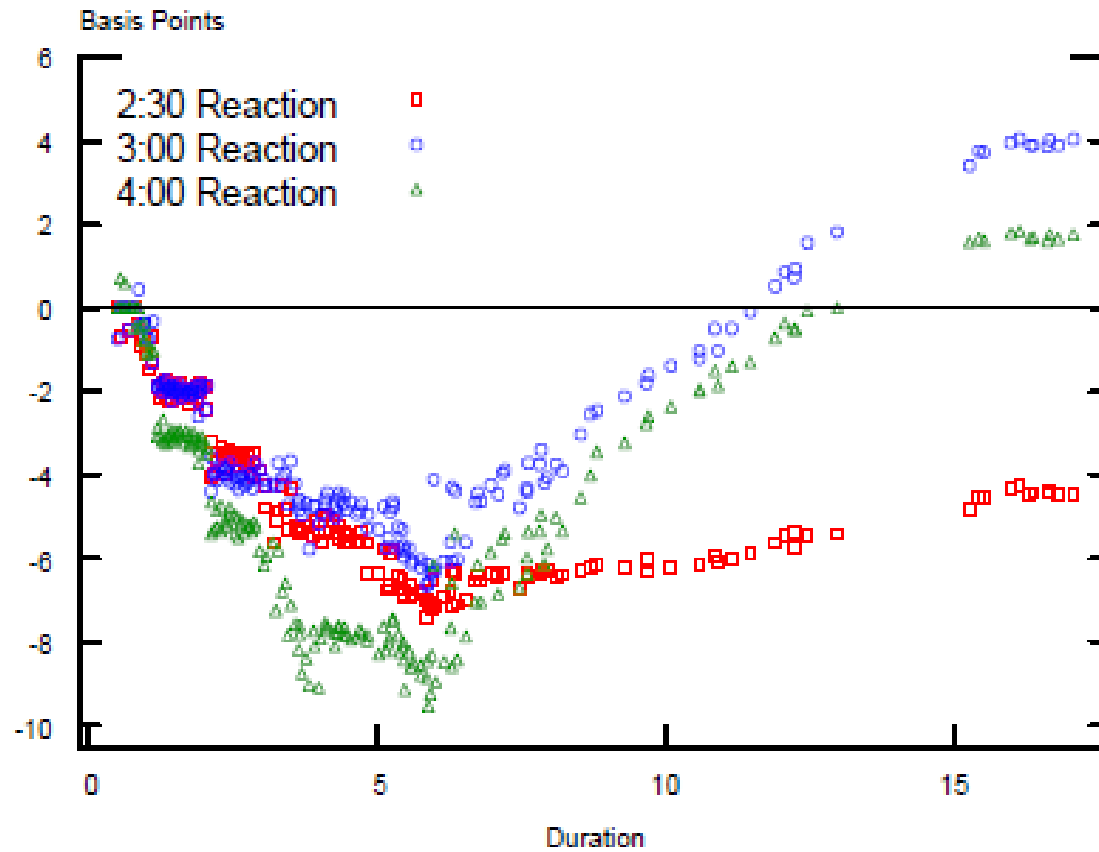
LSAP2

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:

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

- *Δy(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

Measuring Expected Components

- For each program, we estimate investors' prevailing expectations of its probability to occur, P, its total size $E(Q)$, and the vector of maturity bucket weights, $E(W_k)$;

- We use the Desk Primary Dealer Survey compiled by the NY Fed before each FOMC meeting, and also supplement it with information from PD market commentaries;

- We set pre-announcement $E(W_k)$ equal 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

Local supply surprise

1. The surprise for each maturity bucket k is difference between *actual* and *expected* maturity distribution of purchase amount:

$$SQ_k = Q * W_k - P * E(Q \mid program\_occurs) * E(W_k)$$

2. Within a bucket, SQ_k is allocated to each security i based on the security's relative amount outstanding in that bucket:

$$s_i = \frac{SQ_k * h_i}{H_k}$$

3. For each security, $ls_{(i)}$ is obtained as the weighted sum of own, $s_{(i)}$, and nearby securities' normalized surprises, $s_{(j)}$, with weight:

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

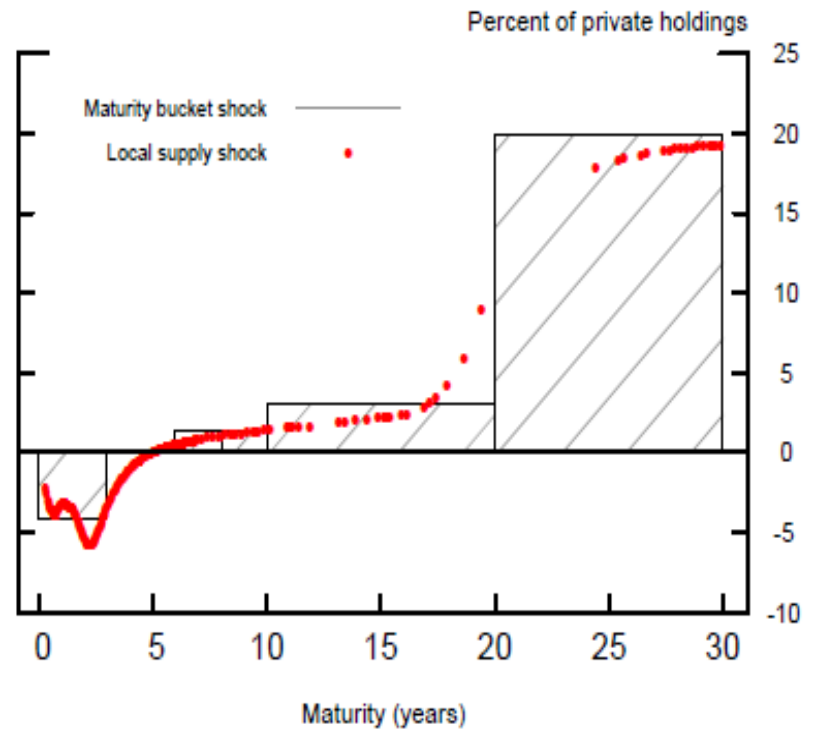# Example of *ls(i)* computations for MEP
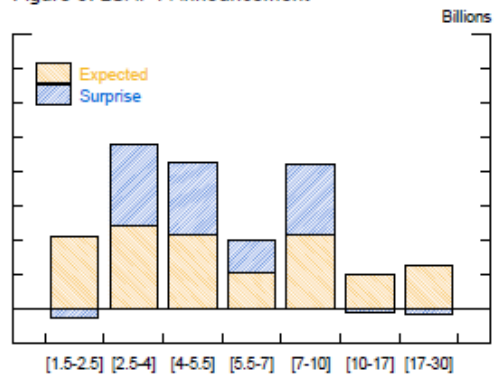
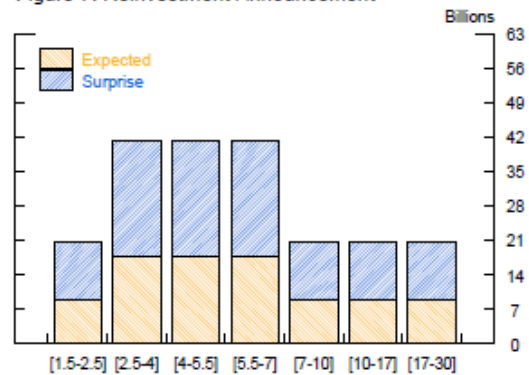Figure 6. LSAP1 Announcement

Figure 7. Reinvestment Announcement

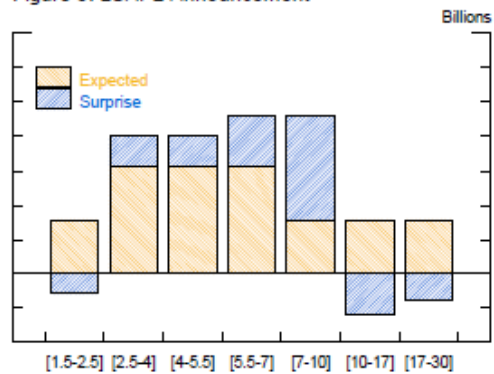Figure 8. LSAP2 Announcement

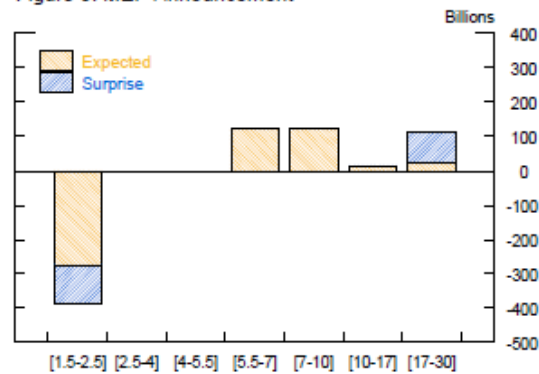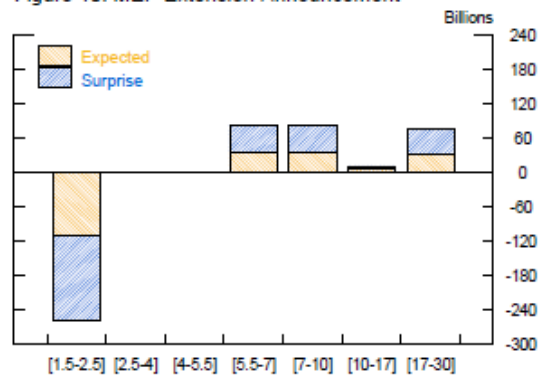Figure 9. MEP Announcement

Figure 10. MEP Extension Announcement

Duration risk surprise

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

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

- The market price of risk λ is mainly determined by the dollar value of the aggregate duration: $\quad \lambda = a\sigma \sum_i x(d_i)d_i$

- 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

100B * years

Bond duration risk sensitivity * duration risk shock in the market

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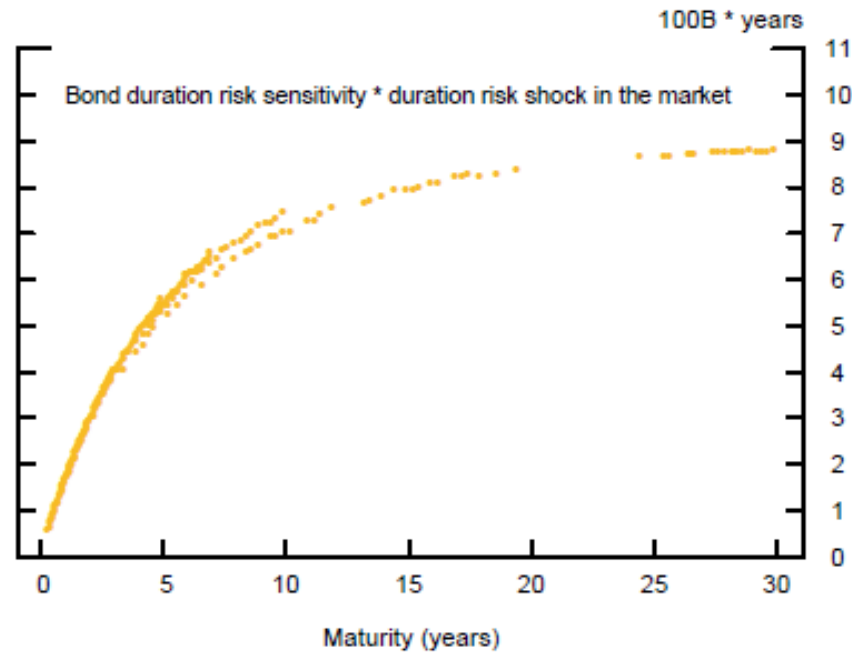
Note: Bond duration risk sensitivity is [1 - exp(-k * d)]/k, where d is bond duration and the parameter k is set as 0.2 according to Li and Wei (2012).

Regression results

Table 1: Yield change regression results with variable window size, θ=0.5 and γ =0.2

	LSAP1	Reinvestment	LSAP2	MEP	MEP2	Pooled
	Two-day yield change regression					
Constant	0.466	-1.078	-2.982	3.169	0.367	0.629
	(0.52)	(-2.45)	(-4.65)	(3.32)	(0.91)	(1.92)
Duration risk shock	-3.000	-1.280	-0.952	-2.189	-0.399	-1.803
	(-22.07)	(-3.11)	(-1.97)	(-11.75)	(-3.60)	(-21.36)
Local supply shock	-0.385	-1.632	-1.210	-1.481	-0.480	-0.807
	(-12.51)	(-5.76)	(-25.16)	(-19.16)	(-12.00)	(-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 2a: 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, duration risk	-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.

Total impact of the actual surprises

Table 2b: Implied effect on the 10-year yield from the actual surprises

	Surprise (billion)	10-year yield reaction (basis points)	
		Total	*per $1 billion surprise*
LSAP1 2009	418.19	-37.2	-0.089
Reinvestment 2010	117.6	-11.0	-0.094
LSAP2 2010	109.5	-10.07	-0.092
MEP 2011	114.0	-14.9	-0.131
MEP extension 2012	148.30	-5.48	-0.037

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

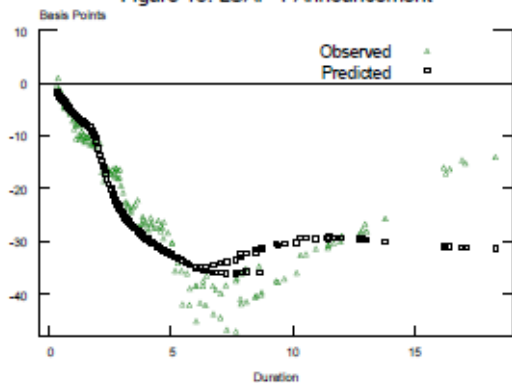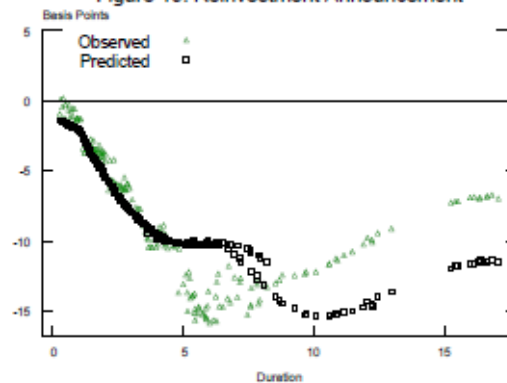## Figure 18. LSAP 1 Announcement

Figure 19. Reinvestment Announcement

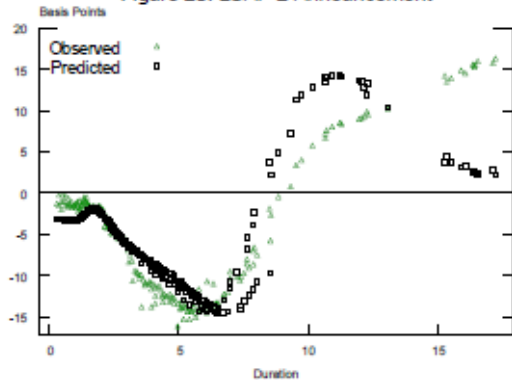## Figure 20. LSAP 2 Announcement

Figure 21. MEP Announcement

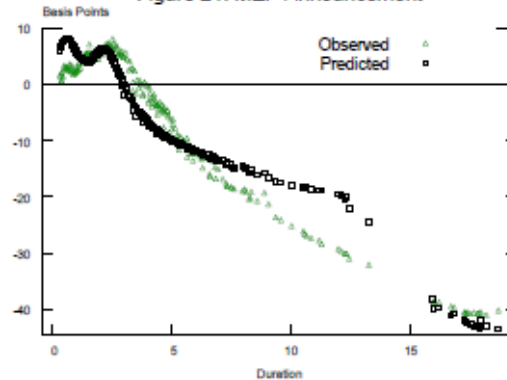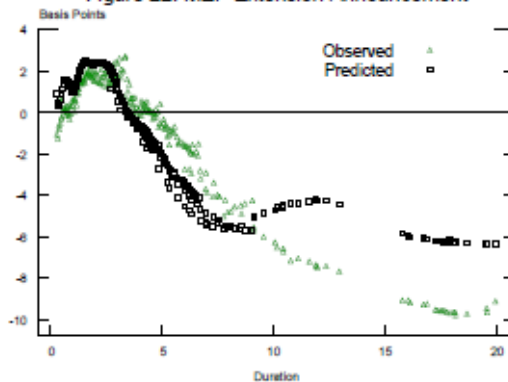## Figure 22. MEP Extension Announcement

Robustness to parameters' values

Table 8: Yield change regression results with variable window size, θ=0.769 and γ =0.095

	LSAP1	Reinvestment	LSAP2	MEP	MEP2	Pooled
			Two-day yield change regression			
Constant	-2.551	-1.399	-3.177	1.847	0.196	-0.624
	(-3.31)	(-4.27)	(-14.52)	(1.91)	(0.61)	(-2.44)
Duration risk shock	-1.375	1.638	0.065	-1.571	-0.314	-0.992
	(-17.37)	(6.97)	(0.56)	(-12.08)	(-5.01)	(-20.81)
Local supply shock	-0.680	-4.746	-2.003	-1.542	-0.539	-1.043
	(-18.61)	(-15.49)	(-68.93)	(-13.35)	(-11.69)	(-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. It is important to note that these t-statistics do not take into account the uncertainty about the parameters θ and γ.

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 $\gamma =0.095$

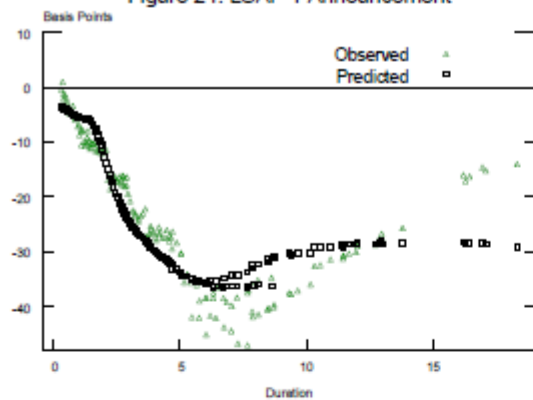|	LSAP1	Reinvestment	LSAP2	MEP	MEP2	Pooled
		Two-Day Yield Change Regression				
Total variation explained (R-squared)	0.85	0.76	0.96	0.94	0.87	0.79
of which, duration risk	0.40	0.26	0.04	0.47	0.41	0.27
of which, local supply	0.48	0.49	0.92	0.48	0.46	0.52

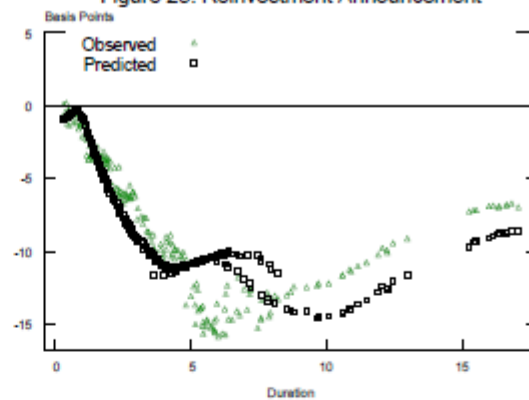Figure 24. LSAP 1 Announcement

Figure 25. Reinvestment Announcement

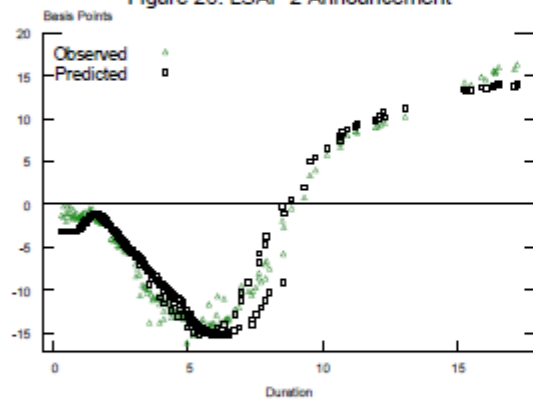Figure 26. LSAP 2 Announcement

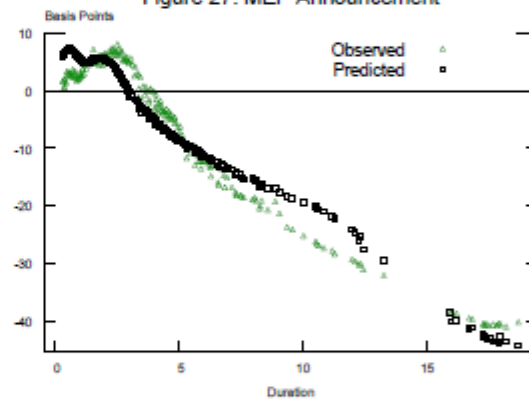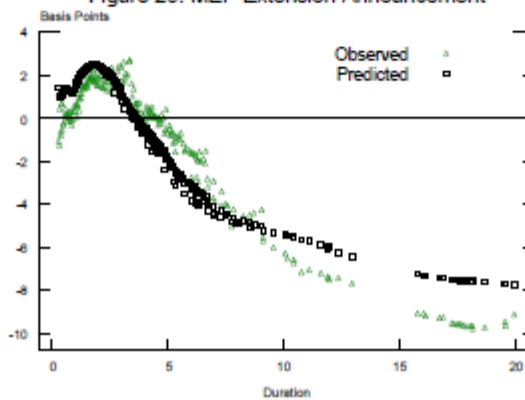Figure 27. MEP Announcement

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, θ=0.769 and γ=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, duration risk	-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, θ=0.769 and γ=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, duration risk	-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	-3.1313	-2.0322
	(2.58)	(-5.10)	(-5.917)
Duration risk shock	-2.2719	-0.6038	-1.3817
	(-9.77)	(-1.20)	(-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

Note: t-statistics in parenthesis.

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
  - Are 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 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 also 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.