

The Effects of Quantitative Easing on Interest Rates

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Objective:

Evaluate the effect of the Federal Reserve's purchase of long-term Treasuries and other long-term bonds ("QE1" in 2008-2009 and "QE2" in 2010-2011) on interest rates.

- What are the effects on a variety of interest rates?
- What are the channels through which QE affects rates?

Understanding channels is important because:

- They determine whether all long rates react the same
- They determine whether it matters what is purchased

Novelty: More interest rates and derivatives data, analysis of both QE1 and QE2, intra-day data, but mainly analysis of channels.

Main findings -- using event-study methodology:

- Much larger effects of QE1 than QE2
- Large drop in nominal yields on long-term safe assets:
Treasuries, agency bonds, and highly-rated corporate bonds.
Unique clientele for long-term safe nominal assets.
- Some have pushed changes in duration risk premium as mechanism. We find **no support for a duration risk channel.**

Important since duration risk premium reduction would affect all long rates, while reduction in yield on safest asset do not.

- **Treasuries-only QE (QE2) does not lower MBS rates and possibly not expected returns on lower-grade corporate bonds**
 - Subtle: QE reduces CDS rates, thus lowering lower-grade corporate *yields*.
 - But this only reduces *expected returns* on such bonds (and thus cost of capital for new bonds) if due to reduction in default risk premium not just expected default.
- QE that buys MBS (QE1) lowers MBS rates via lower **MBS pre-payment risk premium** (market segmentation)
- Another key channel for QE is **increased expected inflation**, which lowers real rates

Implications:

(a) Inappropriate to focus only on Treasury rates as a policy target: QE works through several channels that affect particular assets differently

(b) Effects on particular assets depend critically on which assets are purchased. **Treasuries-only QE will not substantially affect many policy relevant securities (MBS, possibly lower-grade corporate bonds).**

Channels:

(1) Duration risk premium channel:

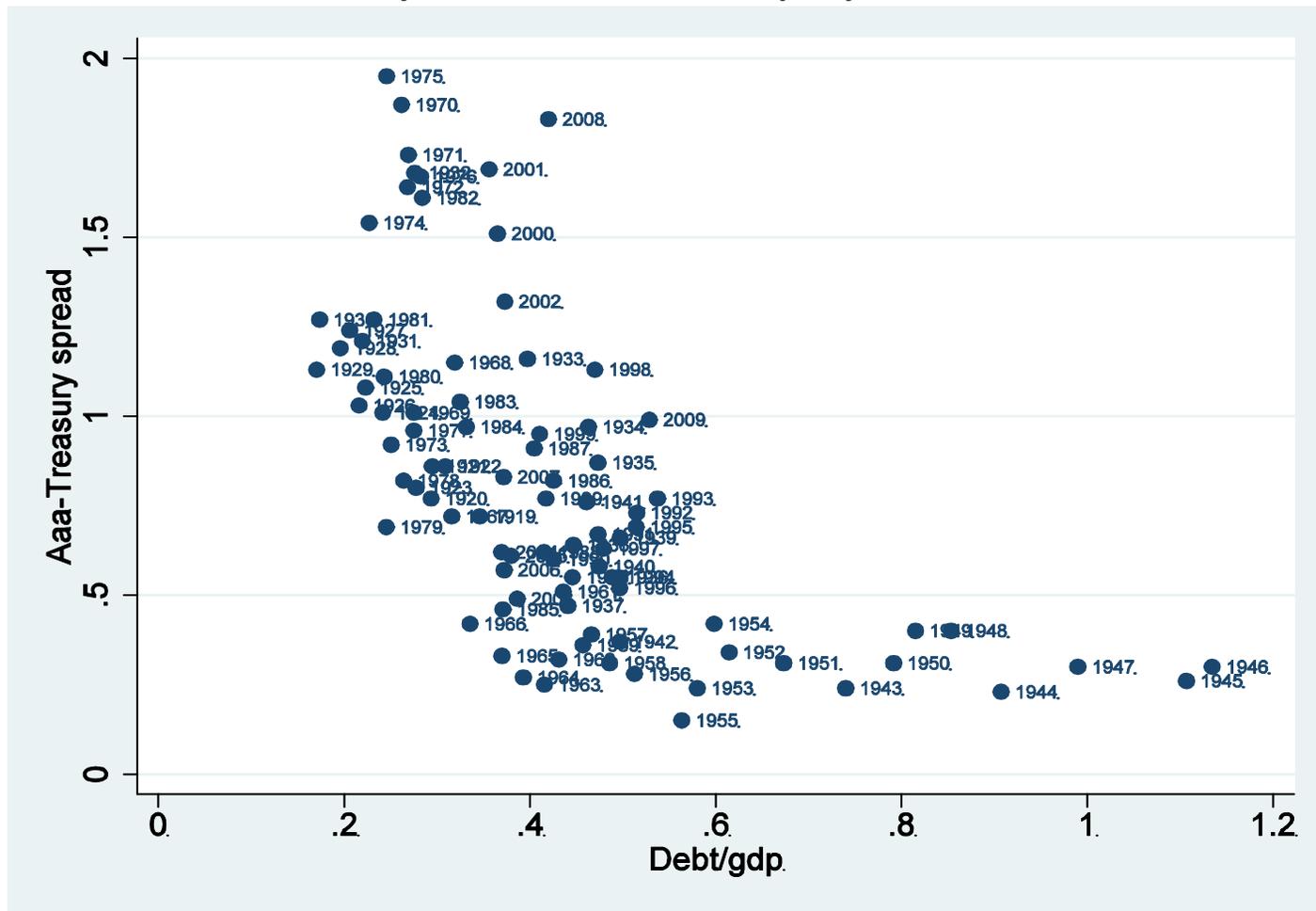
- In QE, government is buying long-duration assets from private sector → Reduction in market price of duration risk.
- Likely requires duration risk to be borne by subset of investors to get substantial effects, as in Vayanos and Vila (2010).
- Predictions:
 - i. QE decreases yields on all long-term nominal assets, including Treasuries, corporate bonds, and mortgages.
 - ii. The effects are proportional to the duration of a bond, with larger effects for longer duration assets.

(2) Liquidity channel:

- QE involves purchasing long-term securities and paying by increasing reserve balances which are likely more liquid → Reduction in price premium of liquid assets (yield increase).
- Predictions:
 - i. QE *raises* Treasury yields, rather than lowers them.
 - ii. QE produces large effects for liquid assets, and no effects for illiquid assets.

(3) Long-term safety channel:

- Krishnamurthy and Vissing-Jorgensen (2010): Evidence of a clientele-demand for long-term safe assets (1925-2009) -- investors value absolute certainty of nominal repayment



- Safety premium on bonds with near-zero default risk implies very steep relation between price and expected default rate near zero. Steeper with lower supply of long-term Treasuries.



Table III. Impact of Treasury Supply on Price of Safety, Price of Liquidity

	Panel A: Price of Safety			
	Assets with similar liquidity and different safety:			
	$S^{Baa-Aaa}$		S^{P2-P1}	
Period	1926-2008	1926-2008	1974-2007	1974-2007
$\log(Debt/GDP)$	-0.506		-0.879	
	[-3.42]		[-4.47]	
$\log(Debt > 10 \text{ year mat}/GDP)$, instr. by powers of $(Debt/GDP)$		-0.310		
		[-2.40]		
$\log(Debt \leq 1 \text{ year mat}/GDP)$ instr. by powers of $(Debt/GDP)$				-1.453
				[-2.94]
<i>Volatility</i>	5.070	6.311	0.321	0.029
	[6.53]	[6.66]	[0.38]	[0.03]
<i>Slope</i>	0.229	0.209	0.014	0.054
	[4.15]	[3.24]	[0.40]	[1.14]
<i>Constant</i>	0.660	0.241	-0.500	-2.662
	[4.52]	[0.648]	[-2.45]	[-2.56]
<i>N</i>	83	83	34	34
R^2	0.600		0.486	
Estimation method	OLS	IV	OLS	IV
Error term	AR(1)	AR(1)	AR(1)	AR(1)
Impact of -1σ supply		+41 bps		+26 bps

Table III. Impact of Treasury Supply on Price of Safety, Price of Liquidity

Panel B: Price of Liquidity		
Assets with similar safety and different liquidity:		
	$S_{FDIC\ insured\ CDs-Bills}$	$S_{Time\ \&\ Savings\ Accounts-Bills}$
Period	1984-2008	1935-1965
<i>log(Debt/GDP)</i>	-1.904 [-1.83]	-0.639 [-2.37]
<i>Slope</i>	0.137 [1.32]	1.013 [8.48]
<i>Constant</i>	-1.500 [-1.63]	-0.070 [-0.41]
<i>N</i>	25	31
<i>R</i> ²	0.271	0.720
Estimation method	OLS	OLS
Error term	i.i.d.	i.i.d.
Impact of -1 σ supply	+115 bps	

- QE decreases supply of long-term safe assets: Treasury and agency bonds (agency MBS has significant prepayment risk which means that it may not meet clientele safety demands)

- Predictions:
 - i. QE involving Treasuries and agencies lowers the yields on very safe assets.
 - ii. No effects on lower-grade debt such as Baa bonds or bonds with prepayment risk such as MBS.

(4) Prepayment risk premium channel:

- Gabaix, Krishnamurthy, and Vigneron (2007) present theory and evidence that mortgage prepayment risk carries a positive risk premium.
- Requires pre-payment risk to be borne by subset of investors to get substantial effects (segmented MBS market).
- Predictions:
 - i. QE1 lowers MBS yields relative to other bond market yields.
 - ii. QE2, which does not involve MBS purchases, does not affect MBS yields.

(5) Default risk channel:

- If QE succeeds in stimulating the economy, we can expect that the *default risk* of corporations will fall.
- Moreover, investor risk aversion may fall as the economy recovers, implying a lower *default risk premium*. Increasing health/capital in the intermediary sector can further lower the risk premium on default risk.

(6) Inflation channel:

- To the extent that QE is expansionary or signals central bank willingness to stimulate, it *increases inflation expectations*. This can be expected to have a positive effect on nominal interest rates.
- QE may also either increase or decrease *inflation uncertainty*.
- Predictions:
 - i. QE increases the rate on inflation swaps as well inflation expectations as measured by the difference between nominal bond yields and TIPS.
 - ii. QE may increase or decrease interest rate uncertainty as measured by the implied volatility on swaptions.

Event study of QE1:

Event dates:

1. November 25, 2008: Initial LSAP announcement
Buy up to \$100B of agency debt, up to \$500B of agency MBS
2. December 1, 2008: Bernanke speech
3. December 16, 2008: FOMC statement
4. January 28, 2009: FOMC statement
Fed may expand agency and agency MBS purchases and is evaluating Treasury purchases
5. March 18, 2009: FOMC statement
Increase agency purchases up to \$200B, agency MBS up to \$1.25T, and buy up to \$300B on longer-term Treasuries.

QE1: Focus on two-day changes (for liquid assets, Treasuries and Agencies one day-changes are similar. For illiquid assets such as corporate bonds and MBS one-day changes are generally smaller.

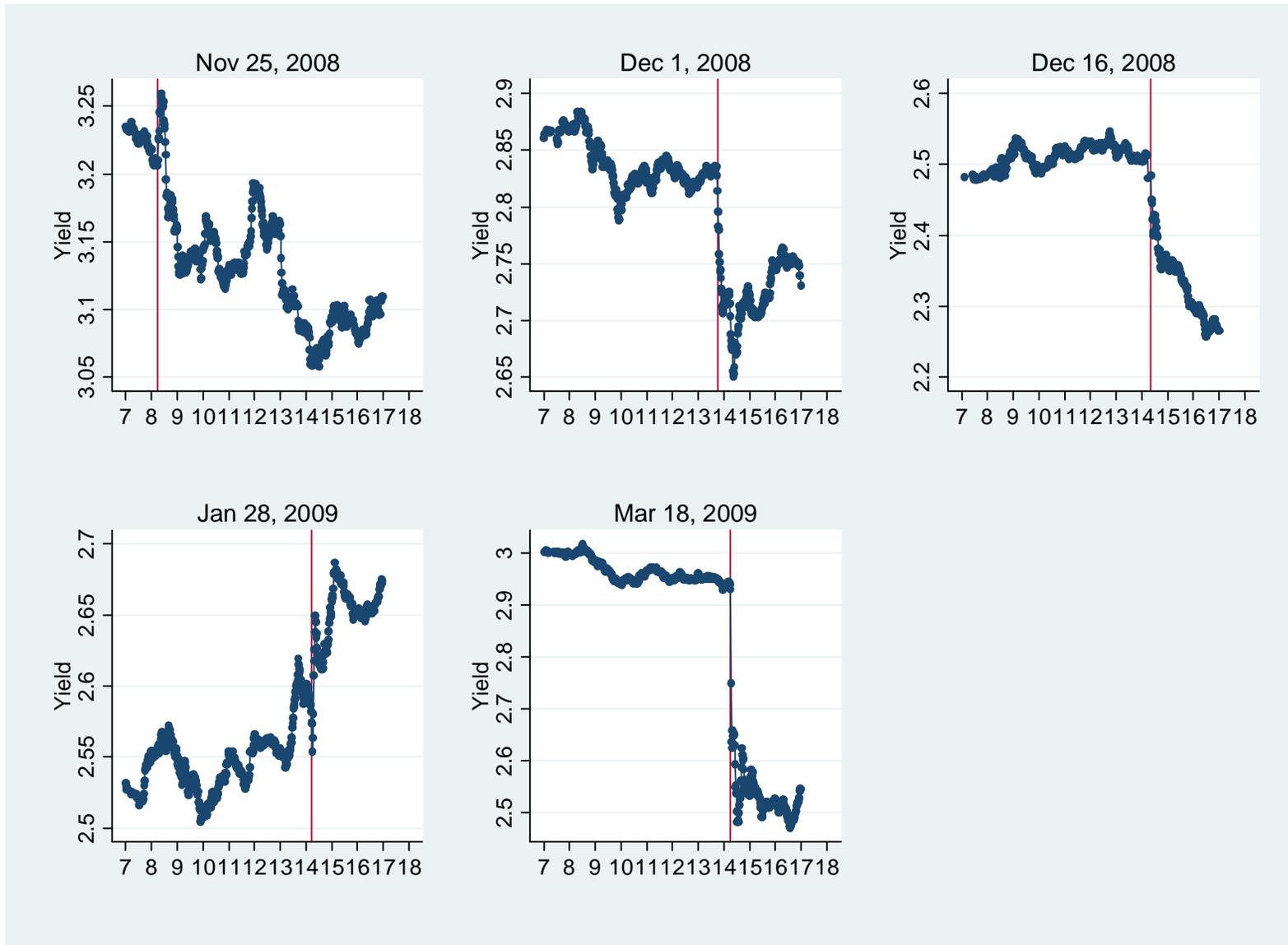
QE2: More liquid period. Focus on one-day changes, but show both.

First, use **intra-day data** to increase confidence that QE announcements were the dominant news on the event dates we study.

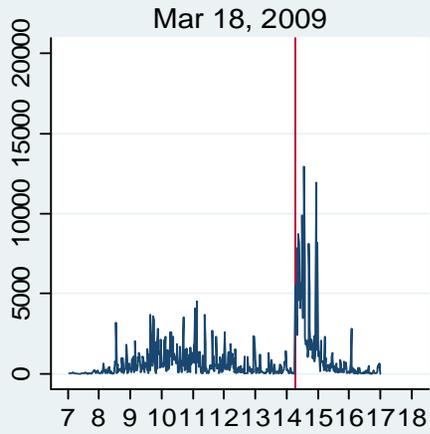
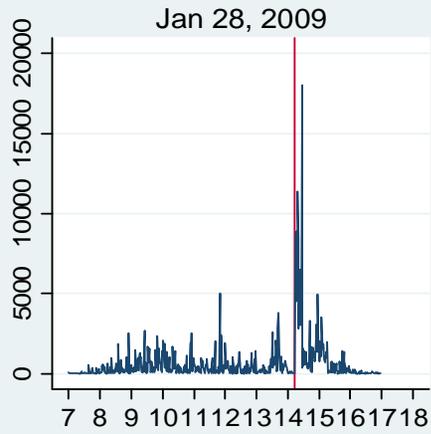
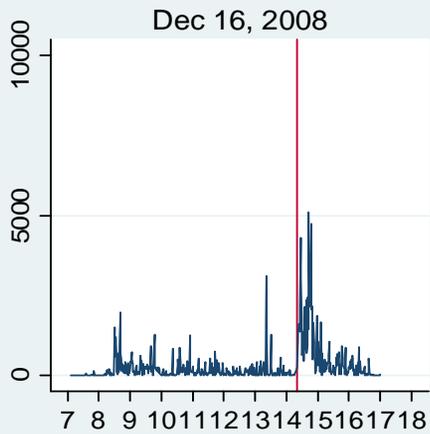
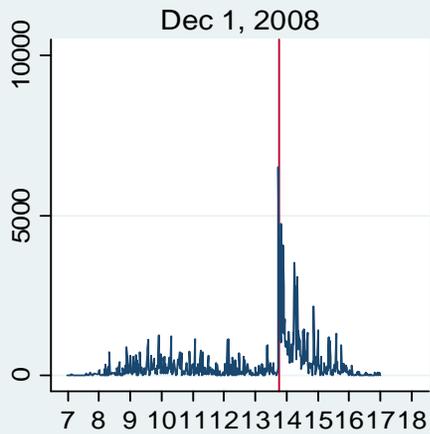
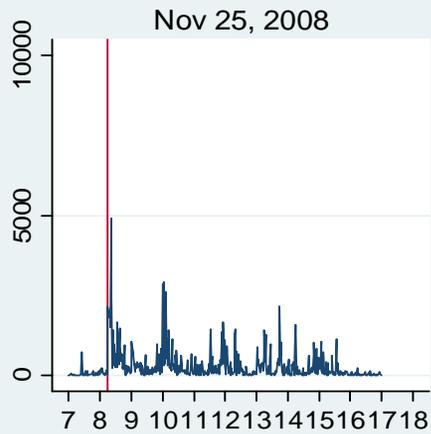
- Data from BG Cantor for the **on-the-run 10 year Treasury bond** at each date.
- Yields graphed are averages by the minute and trading volume graphed is total volume by minute.
- Vertical lines indicate the minute of the announcement (minute of the first article covering the announcement in Factiva).

Figure 2. Intra-day Yields and Trading Volume on QE1 Event Days

Panel A. Yields



Panel B. Trading Volume



- The announcements do appear to be the main piece of news on 12/1/2008, 12/16/2008 and 3/18/2009.
- For 11/25/2008 and 1/28/2009, the trading volume graphs also suggests that the announcements are the main events, with more mixed evidence from the yield graphs for those days.

Turning to two-day changes: **Across the five event dates, interest rates fell on long-term bonds, consistent with a contraction of supply effect.**

- But amounts differed across assets and what were the channels through which the supply effect may have worked.

Table 1. Treasury, Agency and Agency MBS yields on QE1 Event Dates
Two-day changes (in basis points)

<u>Date</u>	<u>Event</u>	Treasuries yields (constant maturity)				Agency yields			Agency MBS yields	
		30 year	10 year	5 year	1 year	10 year	5 year	3 year	30 year	15 year
11/25/2008	Initial announcement	-24	-36	-23	-2	-76	-57	-42	-75	-147
12/1/2008	Bernanke speech	-27	-25	-28	-13	-67	-50	-28	-10	58
12/16/2008	FOMC statement	-32	-33	-15	-5	-39	-26	-28	-30	-7
1/28/2009	FOMC statement	31	28	28	4	28	27	16	6	16
3/18/2009	FOMC statement	-21	-41	-36	-9	-45	-44	-38	-19	-18
Above 5 dates	Above 5 events	-73	-107	-74	-25	-199	-150	-120	-128	-98

Note: The Treasury yields are from FRED (the constant maturity series). The agency yields are for FNMA bonds and the MBS yields are for the current coupon GNMA. Both are from Bloomberg.

(1) Duration risk premium channel: Is not operational

- Long-term safety-channel affect long Treasury and agency bond yields more than short ones
- Reduction in pre-payment risk premium affecting long MBS more.
- So use corporate bonds to isolate duration risk channel. Lower grade bonds particularly informative (no safety effects).
- Adjust yield changes using CDS changes to isolate duration risk premium effects.

Evidence against duration risk premium channel:

- Only small change in CDS-adj. yields of Baa and lower bonds.
- And no apparent pattern across long and intermediate maturities in the changes in CDS-adjusted corporate bond yields.
(Note: We don't have CDS ratings indices by maturity within each rating, but firm level CDS data show no tenor effect in CDs rates).

Table 2. Corporate Yields and Corporate Yields Adjusted by CDS on QE1 Event Dates

Two-day changes (in basis points)

<u>Date</u>	<u>Event</u>	Corporate yields											
		Aaa long	Aa long	A long	Baa long	Ba long	B long	Aaa int	Aa int	A int	Baa int	Ba int	B int
11/25/2008	Initial ann.	-28	-18	-23	-19	-4	4	-17	-15	-18	-18	1	-47
12/1/2008	Bernanke speech	-24	-24	-21	-17	-13	28	-21	-15	-18	-8	-5	6
12/16/2008	FOMC statement	-43	-37	-45	-39	1	-11	-19	-21	-24	-27	-28	-42
1/28/2009	FOMC statement	34	17	17	14	-16	-25	12	8	7	3	-32	-25
3/18/2009	FOMC statement	-16	-21	-21	-20	-28	-39	-43	-50	-39	-26	-18	-22
Above 5 dates	Above 5 events	-77	-83	-93	-81	-60	-43	-88	-93	-92	-76	-82	-130

Credit default swaps (5 year tenor)						Corporate yields-Credit default swaps											
Aaa	Aa	A	Baa	Ba	B	Aaa	Aa	A	Baa	Ba	B	Aaa	Aa	A	Baa	Ba	B
						long	long	long	long	long	long	int	int	int	int	int	int
3	-1	-5	-19	-35	-32	-31	-17	-18	0	31	36	-20	-14	-13	1	36	-15
2	7	12	1	0	124	-26	-31	-33	-18	-13	-96	-23	-22	-30	-9	-5	-118
5	-4	-5	-17	-15	13	-48	-33	-40	-22	16	-24	-24	-17	-19	-10	-13	-55
-3	-5	-8	-9	-17	-118	37	22	25	23	1	93	15	13	15	12	-15	93
-1	-2	-4	-7	-14	-45	-15	-19	-17	-13	-14	6	-42	-48	-35	-19	-4	23
6	-5	-10	-50	-81	-58	-83	-78	-83	-31	21	15	-94	-88	-82	-26	-1	-72

Note: The corporate yield indices are from Barclay's and downloaded from Datastream. The CDS rates by ratings are Moody's indices.

Table 3. CDS Rates on QE1 Event Dates, by Quintile of Credit Risk and Tenor. Two-day changes (in basis points)

QE1 event day	Tenor	Mean 2-day change, by quintile of 5-year CDS rate (level) as of day before the particular QE1 event day				
		Q1 (lowest)	Q2	Q3	Q4	Q5 (highest)
11/25/2008	10 years	-3	-8	-14	-23	-182
	5 years	-3	-8	-14	-24	-157
12/1/2008	10 years	3	6	8	8	-149
	5 years	2	6	10	11	-102
12/16/2008	10 years	-5	-8	-13	-27	-184
	5 years	-4	-8	-13	-30	-187
1/28/2009	10 years	0	-7	-11	-26	-37
	5 years	1	-5	-11	-25	-38
3/18/2009	10 years	-2	-4	-9	-15	-88
	5 years	-2	-3	-10	-18	-106
All 5 days	10 years	-7	-22	-38	-84	-640
All 5 days	5 years	-6	-18	-39	-86	-591
		Mean 5-year CDS rate level, day prior to QE1 event day:				
		Q1 (lowest)	Q2	Q3	Q4	Q5 (highest)
All 5 days		82	159	318	669	3395

Note: The CDS rates are obtained from Datastream. The number of firms covered is around 440 for each of the five event dates.

(2) Liquidity channel: QE increases supply of liquidity. Causes substantial *increase* in yields on more liquid assets relative to less liquid assets

- Yields on Treasuries (more liquid) fall less than yields on agencies (less liquid)
- 10 year Agency-Treasury spread falls by $199-107=92$ basis points.

(3) Long-term safety channel: One of the dominant channels for QE

- Fall in Agency yields isolate this effect (no default risk during QE period). 10 year Agency yields fall 199 bps!
- Corporate bond evidence also consistent with a safety effect. Aaa bonds (CDS-adj.) are fall 83 bps.
- Larger fall in agencies than Aaa consistent with safety channel since agencies are safer than Aaa corporate bonds (even with CDS protection).

- Close to no effect on non-investment grade bonds: Even with CDS protection these bonds are not close to riskless (counterparty risk in CDS).

(4) Prepayment risk channel: One of the dominant channels for QE if QE buys mortgages!

- 30-year agency MBS yields fall by 128 for 30-year bonds and 98 bps for 15-year bonds.
- Unlikely to be due to safety effect, due to substantial pre-payment risk
- More likely to be due to pre-payment risk being priced (via market segmentation). Consistent w/30-year down more (more pre-payment risk in 30-year MBS than 15-year MBS).

(5) Default risk channel: Large effect for lower grade corporate bonds.

- Not possible to determine whether expected default drops or default risk premium drops
- This matters for impact of cost of capital for new projects -- only falls if default effect is due to lower default risk premium.

(6) Inflation channel: Large increase in expected inflation due to QE1. And inflation uncertainty falls substantially.

- Inflation swaps: Exp. infl. up between 36 and 95 bps.
- Comparing TIPS to CDS-adj. corporates (not Treasuries due their higher liquidity):
 - 10-year: Baa ↓ 31 bps. TIPS ↓ 187 bps --> Exp. infl. up 156 bps.
 - 5-year: Baa ↓ 26 bps. TIPS ↓ 159 bps --> Exp. infl. up 133 bps.
- Inflation uncertainty: Implied volatilities from interest rate swaptions fall 37 bps (avg. vol. over QE1 time period is 103 bps).

Table 4. Inflation Swaps, TIPS, and Implied Interest Rate Volatility on QE1 Event Dates. Two-day changes (in basis points)

<u>Date</u>	<u>Event</u>	Inflation swaps				TIPS real yields (constant maturity)			Interest rate volatility
		30 year	10 year	5 year	1 year	20 year	10 year	5 year	
11/25/2008	Initial ann.	1	-6	-28	48	-22	-43	5	1
12/1/2008	Bernanke speech	15	27	11	-40	-38	-34	-51	-7
12/16/2008	FOMC statement	4	37	35	-17	-45	-57	-83	-20
1/28/2009	FOMC statement	14	15	-6	5	15	6	13	0
3/18/2009	FOMC statement	2	22	24	45	-45	-59	-43	-11
Above 5 dates	Above 5 events	36	95	36	41	-135	-187	-159	-37

Note: Inflation swap rates and interest rate volatility (ticker BBOX) is from Bloomberg. TIPS yields are from FRED.

QE1 summary:

- **Strong safety-effect** lead QE1 to reduce Treasuries, Agencies and highly-rated corporate bonds, with liquidity effects working in the opposite direction.
- There is **no evidence for the duration risk premium channel**.
- For riskier bonds such as Baa corporate bonds or MBS, QE1 had effects through a **reduction in default risk/default risk premia** and a **reduced prepayment risk premium**.
- QE1 **increased inflation expectations**, and **reduced inflation uncertainty**.

Perspective: The QE1 period is an unusual financial-crisis period. Demand for safe assets was heightened, segmented market effects were apparent across many markets, and intermediaries suffered from serious financing problems. In such an environment, supply changes should be expected to have a large effect on interest rates.

Event study of QE2:

Event dates:

1. August 10, 2010: FOMC statement

"the Committee will keep constant the Federal Reserve's holdings of securities at their current level by reinvesting principal payments from agency debt and agency mortgage-backed securities in longer-term Treasury securities."

Prior to this announcement, market expectations were that the Fed would let its MBS portfolio run off.

Back-of-the-envelope: Suppose prepayment rate for next year on \$1.1T of MBS was 20% (a typical rate) and reinvestment policy in place for 1 year. Then announcement indicated Fed purchase \$220B of Treasuries over next year.

2. September 21, 2010: FOMC statement
"maintain its existing policy of reinvesting principal payments"
3. November 3, 2010: FOMC statement
"maintain its existing policy of reinvesting principal payments
.... In addition, the Committee intends to purchase a further
\$600 billion of longer-term Treasury securities"

This was widely anticipated, so little expected effect of 11/3.
We aggregate across the 8/10 and 9/21 events.

Figure 3. Intra-day Yields and Trading Volume on QE2 Event Days

Panel A. Yields



Panel B. Trading Volume

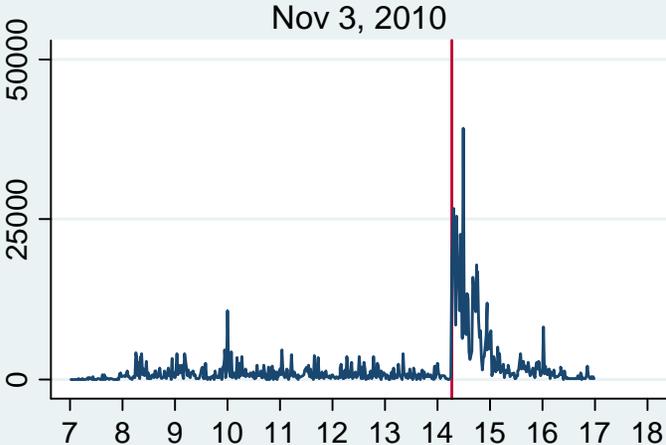
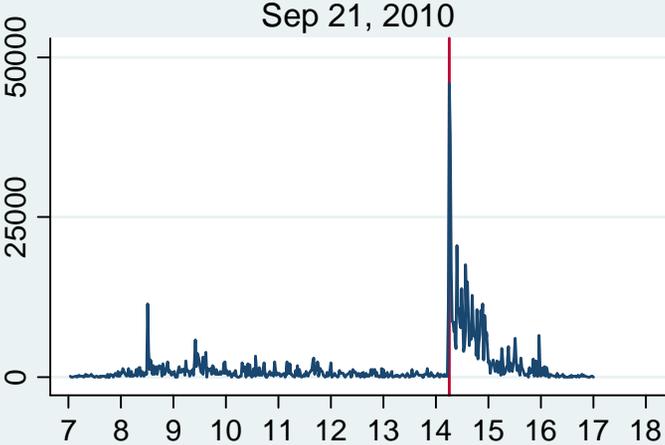
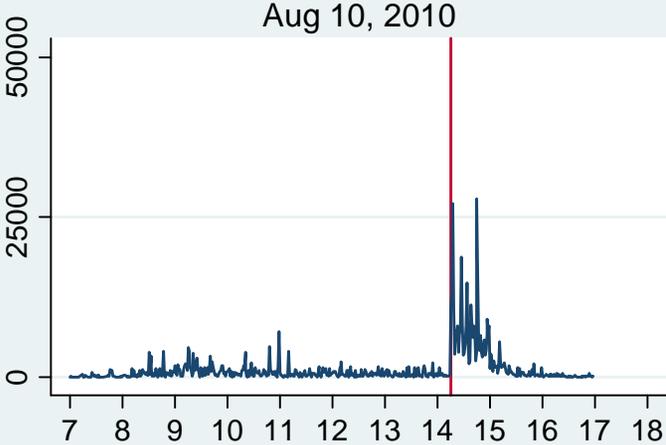


Table 5. Treasury, Agency and Agency MBS Yields on QE2 Event Dates. One and two-day changes (in basis points)

<u>Date</u>	<u>Event</u>	<u>Changes</u>	Treasuries yields (constant maturity)				Agency yields		Agency MBS yields	
			30 year	10 year	5 year	1 year	10 year	5 year	30 year	15 year
8/9/2010 to 11/4/2010			3	-33	-50	-5	-41	-53	-36	-26
8/10/2010	FOMC stmt.	1-day	-1	-7	-8	-1	-7	-9	1	-5
		2-day	-8	-14	-10	-1	-13	-9	-8	-4
9/21/2010	FOMC stmt.	1-day	-8	-11	-9	0	-11	-9	-7	1
		2-day	-13	-16	-10	-1	-16	-10	4	5
11/3/2010	FOMC stmt.	1-day	16	4	-4	0	5	-5	-5	-2
		2-day	11	-10	-11	-1	-10	-14	-13	-3
8/10/2010 and 9/21/2010		1-day	-9	-18	-17	-1	-18	-18	-6	-4
		2-day	-21	-30	-20	-2	-29	-19	-4	1

Table 6. Corporate Yields, and Corporate Yields Adjusted by CDS on QE2 Event Dates. One and two-day changes (in basis points)

<u>Date</u>	<u>Event</u>	<u>Changes</u>	Corporate yields				CDS		Corporate yields-CDS			
			Inv. grade long	Inv. grade int.	High yield long	High yield int.	Inv. grade	High yield	Inv. grade long	Inv. grade int.	High yield long	High yield int.
8/9/2010 to 11/4/2010			-11	-51	-58	-120	-13	-70	2	-38	12	-50
8/10/2010	FOMC stmt.	1-day	2	-3	-5	3	-2	-11	4	-1	6	14
		2-day	-6	-6	-3	17	1	2	-7	-7	-5	15
9/21/2010	FOMC stmt.	1-day	-9	-9	-5	-3	3	-10	-12	-12	5	7
		2-day	-13	-10	-10	0	4	-4	-17	-14	-6	4
11/3/2010	FOMC stmt.	1-day	11	-2	17	-4	-2	-6	13	0	23	2
		2-day	2	-13	10	-19	-3	-15	5	-10	25	-4
8/10/2010 and 9/21/2010		1-day	-7	-12	-10	0	0	-21	-7	-12	11	21
		2-day	-19	-16	-13	17	5	-2	-24	-21	-11	19

Note: The corporate yield indices are from Barclay's and downloaded from Datastream. The CDS rates are from the Financial Times and are for 5-year tenor.

Table 7. Inflation Swaps, TIPS, and Implied Interest Rate Volatility on QE2 Event Dates. One and two-day changes (in basis points)

<u>Date</u>	<u>Event</u>	<u>Change</u>	Inflation swaps				TIPS real			10 year interest rate volatility
			30 year	10 year	5 year	1 year	20 year	10 year	5 year	
8/9/2010 to 11/4/2010			37	17	16	19	-53	-60	-54	-1
8/10/2010	FOMC stmt.	1-day	5	-1	-3	0	-10	-9	-8	-2
		2-day	-2	0	-3	-4	-6	-9	-5	-3
9/21/2010	FOMC stmt.	1-day	6	6	6	-1	-14	-16	-14	-1
		2-day	6	4	7	9	-17	-20	-18	-2
11/3/2010	FOMC stmt.	1-day	6	-3	2	1	4	1	-6	-2
		2-day	1	-10	4	14	2	-5	-14	-3
8/10/2010 and 9/21/2010		1-day	11	5	3	-1	-24	-25	-22	-3
		2-day	4	4	4	5	-23	-29	-23	-5

Note: Data sources are as for QE1.

- **Substantial long-term safety channel:**

- Treasury and agency yields down about 18 bps.
- CDS-adj. investment grade corporates down about 10 bps.

- **No duration risk premium channel:**

- Longer-term yields do not systematically move more than shorter term yields.
- And while CDS-adjusted inv. grade corporate bond yield falls, that of the high yield corporate bond rises.

- **No liquidity channel:**

- Treasury and Agency yields fall by nearly the same amounts.
- Plausible, since liquidity premia generally were quite low in late 2010 (almost identical yields on 1-week and 3-month T-bills and on T-bills and Tier 1 CP).

- **Almost no effects on MBS:** With no MBS purchases, we shouldn't see a fall in pre-payment risk premium.
- **Some evidence for a credit risk channel:** High yield CDS falls 21 bps.
- **Inflation expectations rise with QE2:**
 - 10 year inflation swap rises by 5 bps.
 - Comparing 10-year TIPS to CDS-adjusted high-yield bonds to TIPS: Corporate \uparrow 11 bps. TIPS \downarrow 25 bps \rightarrow Exp. infl. up 36 bps.

Implied volatility on swaptions falls by 3 bps, indicating a slight decrease in inflation uncertainty.

QE2 summary: The primary channels for the Treasuries-only policy are the safety-channel and increased inflation expectations. Nominal MBS and (CDS-adj.) lower-grade corporates did not fall much/at all.

Conclusion:

Important to look at a variety of asset market data to assess the effects of QE. Derivatives useful (CDS, inflation swaps, implied vol).

- QE1 effect on **long term safety-premium** reduced yields on safest assets (Treasuries, agencies) by more than 100 bps. QE2 effect is 18 bps.
- Impact of QE on lower-grade corporate bonds work mainly via **default effects**, with small default-adjusted yield changes.
- Impact of QE on MBS rates is large when QE involves MBS purchases (QE1), but not when it involves only Treasury purchases (QE2): Changes in **pre-payment risk premium**.
- **Expected inflation** up a lot due to QE1, modestly due to QE2.

Regression analysis of the safety channel

Possible drawbacks of event-study approach:

- Event dates chosen may not capture all of the effect of expectation changes due to policy -- think about Nov. 3, 2010 announcement for QE2.
- Results may be particular to period studied.

Consider the following regression approach to evaluate the predicted impact of Treasuries-only QE, on average using annual data for 1949-2008. Builds on Krishnamurthy and Vissing-Jorgensen (2010a).

$$\begin{aligned} \text{Baa} - \text{Treasury yield spread}_t &= \text{Default controls}_t \\ &+ \beta \ln(\text{Long Treasury supply}_t / \text{GDP}_t) + \epsilon_t \end{aligned}$$

Evaluate the term $\beta \ln(\text{Long Treasury supply} / \text{GDP})$ at the pre-QE and post-QE values of long Treasury supply.

- Baa-Treasury spread reflects both liquidity premium and safety premium. Consider also Baa-Aaa spread: Captures safety premium only, but not fully.

Estimation:

- Long Treasury supply: 10-year equivalents
Compute market value of each Treasury issue*(Duration/10).
Sum across Treasury issues with remaining maturity ≥ 2 years.
- Instrument by (Total Treasury supply)/GDP, and squares and cubes of (Total Treasury supply)/GDP.
- Default controls: Stock market volatility (std. dev. of weekly stock returns over preceding year), slope of yield curve (10 year minus 3-month Treasury yield).
- Estimate by OLS. Adjust std. errors assuming AR(1) error term.

Estimates for QE1:

11 bps using Baa-Treasury spread. 4 bps using Baa-Aaa spread.

- Purchases of \$242B of Treasuries and agencies in 10-year equivalents from Gagnon et al (2010).
(Regression evidence suggests that Baa and Agency-MBS moves similar in response to Treasury supply --> Agency-MBS supply does not drive safety premium.)
- Small relative to safety effect estimates from QE1 event study.
- Suggests that changes in Treasury supply have much larger impact on safety premium in times of unusually high safety demand than in average times
(CDS-adjusted Baa spread minus the CDS-adjusted Aaa spread averages 1.87% in the sample from 11/25/08 to 3/23/09).

Estimates for QE2:

21 bps using Baa-Treasury spread. 7 bps using Baa-Aaa spread.

- Using purchase of \$600bn of Treasuries and rolling over maturing MBS into long-term Treasuries (about \$220bn over the next year).
- \$820B of Treasuries= \$511B of 10-year equivalents, based on the planned maturity breakdown provided by the Federal Reserve Bank of New York.
- These numbers seem in line with those from the event study.