"The Impact of Central Banks on Asset Prices"

European Central Bank workshop
Non-standard monetary policy measures
October 6, 2014

Keynote by Annette Vissing-Jorgensen, UC Berkeley

Background papers are at
http://faculty.haas.berkeley.edu/Vissing/

Three parts:

- **First, a new paper showing the impact of news from the US Federal Reserve on stock markets:**
  - May have accounted for the entire stock market risk premium in the US and the world over the last 20 years.
  - Suggests that there is a **risk premium for monetary policy news or for macro news coming from the Fed**.

``Stock returns over the FOMC cycle'' (2014 WP), Anna Cieslak, Adair Morse and Annette Vissing-Jorgensen

- **Second, a review of my work on US QE:**

The impact of US QE (private and public assets) on bond yields:
- Impact on bond yields of QE1, QE2, MEP, QE3.
- Channels

``The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy'', Brookings Papers on Economic Activity, Fall 2011, with Arvind Krishnamurthy

``The Ins and Outs of LSAPs", Jackson Hole paper, 2013, Arvind Krishnamurthy and Annette Vissing-Jorgensen

I hadn't planned on talking about this but I think there are some lessons we can learn that are relevant for thinking about current ECB policies (ABS, covered bonds, TLROs).

- **Third, if time permits:**

The impact of ECB policies involving govt. bond purchases on bond yields:
- Impact on bond yields of the SMP, OMT and (though not the ECB's objective) the LTROs.
- Channels

``ECB Policies Involving Government Bond Purchases: Impact and Channels'' (2014 WP), Arvind Krishnamurthy, Stefan Nagel and Annette Vissing-Jorgensen

There is one additional issue in the Eurozone context that is particularly scary: **Redenomination risk.**

- It's scary because it affects all borrowers in a country
- As part of our study of ECB policies we have some ideas for **how to monitor it going forward**, should we stop being in calm times….

This will hopefully never become useful for ECB policy!

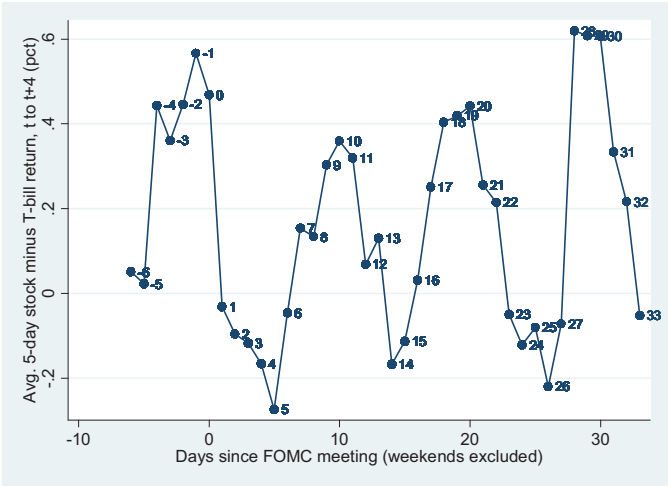
STOCK RETURNS OVER THE FOMC CYCLE

(Cieslak, Morse and Vissing-Jorgensen, 2014 WP)

Since 1994 **the US equity premium**

- Follows an **alternating weekly pattern measured in FOMC cycle time**, i.e. in time since the last FOMC meeting.
- Is earned **entirely in weeks 0, 2, 4, and 6 in FOMC cycle time** (with week 0 starting the day before a scheduled FOMC announcement day).

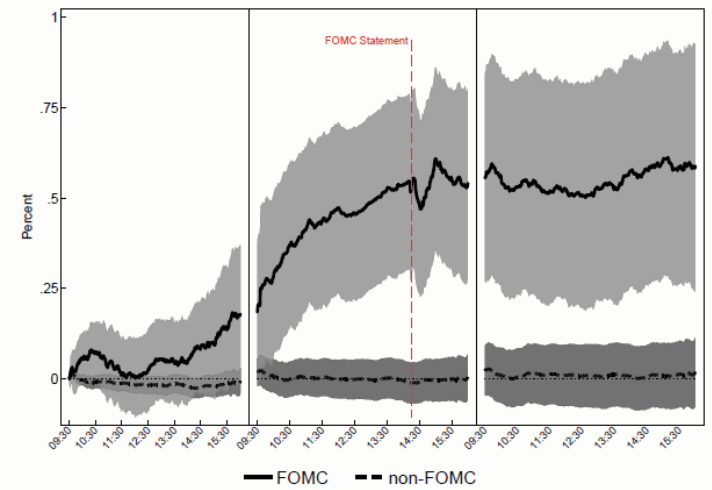
Figure 1. Stock returns over the FOMC cycle, 1994-2013
Panel A. Average 5-day stock return minus bill return over the FOMC cycle, percent



Based on 160 FOMC cycles (8 scheduled FOMC meetings per year). The numbers along the line indicate the value on the horizontal axis.

Note: If a given day is day -6 or closer to the next meeting, the 5-day (forward) return for this day is not used in the right part of the graph, so points to the right do not use any data for days -2 and later.

We got interested in the FOMC cycle because of Lucca and Moench's finding (JF, forthcoming): The stock market on average does well (50bps) the 24 hours from 2pm-2pm before the FOMC announcement



Statistical robustness: Each of the peaks is statistically significant

Let day 0 in event time by the date of the FOMC announcement.
Week -1: Days -6,…,-2
Week 0: Days -1,…,3
Week 1: Days 4,…,8
Week 2: Days 9,…,13
Week 3: Days 14,…,18
Week 4: Days 19,…,23
Week 5: Days 24,…,28
Week 6: Days 29,…,33

Test whether:

- Average excess return in even weeks in FOMC cycle time is statistically different from that in odd weeks in FOMC cycle time
- Average excess return is significantly positive in even weeks but not odd weeks in FOMC cycle time

Table 1. Regressions of daily excess stock returns on FOMC cycle dummies, 1994-2013
Panel A. Total US stock market

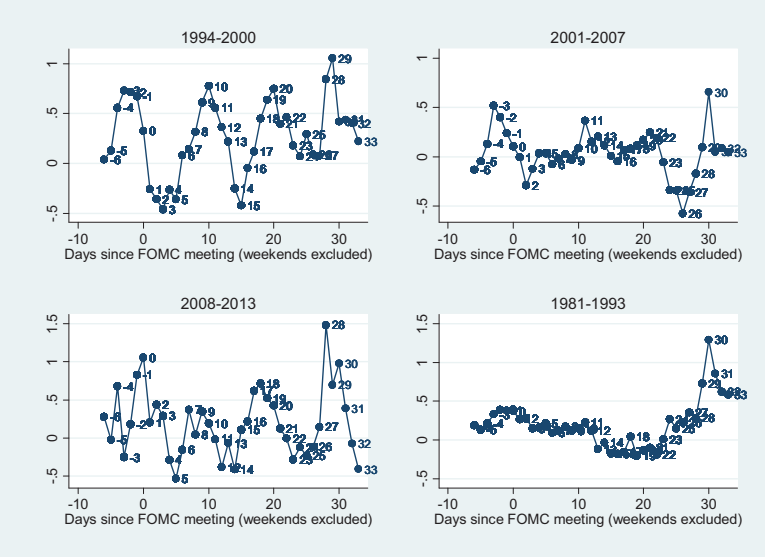
	Dependent variable: Excess return on stocks over T-bills			
	(1)	(2)	(3)	(4)
Dummy=1 in Week 0	0.136***	0.136***	0.115***	0.115***
	(2.76)	(2.76)	(2.59)	(2.59)
Dummy=1 in Week 2, 4, 6	**0.101*** **		**0.079*** **	
	(2.68)		**(2.59)**	
Dummy=1 in Week 2		**0.083* **		0.062
		(1.75)		(1.46)
Dummy=1 in Week 4		**0.108** **		0.086*
		(2.00)		(1.75)
Dummy=1 in Week 6		**0.179** **		0.157*
		(1.99)		(1.81)
Dummy=1 in Week -1, 1, 3, 5			-0.021	-0.021
			(-0.98)	(-0.98)
Constant	-0.021	-0.021		
	(-0.98)	(-0.98)		
N (days)	5214	5214	5214	5214

Note: t-statistics robust to heteroscedasticity in parenthesis. The left hand side variable is in percent, so (for example) 0.1 means 10 basis points per day. *** indicates significance at the 1 pct level, ** significance at the 5 pct level, and * significance at the 10 pct level.

- Average excess returns in each of the four even weeks in FOMC cycle time are sign. higher than average excess return in odd weeks at the 10 percent level or better.
- Equity premium is significantly positive only in even weeks.

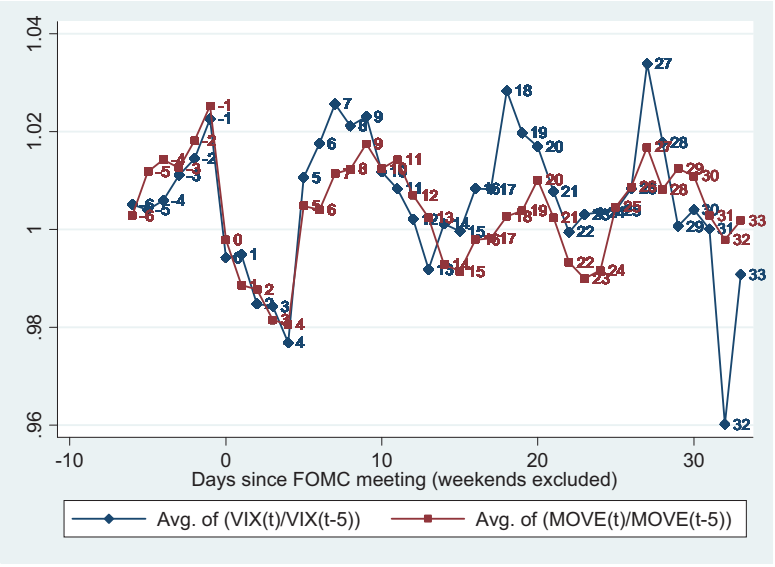
Robustness across sub-samples: Three sub-periods of 1994-2013

Figure 3. Stock returns over the FOMC cycle, by time period.
Average 5-day excess return, t to t+4 (percent)



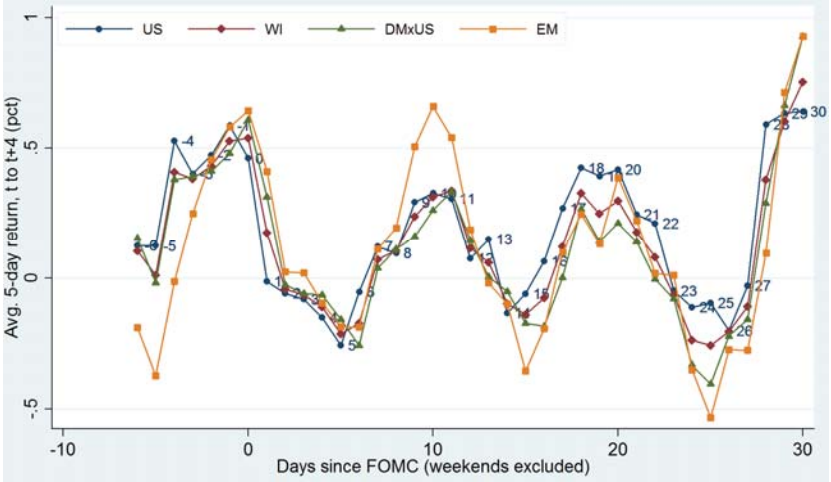
Patterns in implied volatility also confirm that our finding is not a statistical accident:

Implied volatility peaks just before high realized returns are observed and then falls during the even weeks (as uncertainty is resolved)



Same bi-weekly pattern in FOMC cycle time for non-US stocks

Figure 1. International stock returns over the FOMC cycle, percent, 1994-2013



Note: WI is the world index (Bloomberg ticker MXWD), DMxUS is the developed market index excluding US (MXWOU), EM is the emerging market index (MXEF). All indices are in USD. All returns, including US, are based on the MSCI indices obtained from Bloomberg.

Table 2. International stock returns over the FOMC cycle
Panel B. Dependent variable: One-day return on an MSCI equity index on day t+1

	WI	DMxUS	EM	UK	DE	FR	CH	JP
Dummy=1 in week 0	0.13***	0.15***	0.19***	0.13***	0.14**	0.13*	0.13***	0.11*
	(3.30)	(3.29)	(3.77)	(2.67)	(2.40)	(1.90)	(2.83)	(1.88)
Dummy=1 in week 2, 4, 6	0.092***	0.088***	0.18***	0.044	0.10**	0.053	0.10***	0.088**
	(3.09)	(2.66)	(4.75)	(1.25)	(2.28)	(1.17)	(2.89)	(2.15)
Constant	-0.025	-0.031	-0.065***	-0.014	-0.024	-0.011	-0.026	-0.036
	(-1.35)	(-1.52)	(-2.84)	(-0.65)	(-0.85)	(-0.38)	(-1.19)	(-1.41)
N (*days*)	5213	5213	5213	5213	5213	5213	5213	5213
Dummy=1 in week 0	0.13***	0.15***	0.19***	0.13***	0.14**	0.13*	0.13***	0.11*
	(3.29)	(3.29)	(3.77)	(2.67)	(2.40)	(1.90)	(2.83)	(1.88)
Dummy=1 in week 2	0.086**	0.081**	0.19***	0.029	0.14**	0.054	0.086*	0.098**
	(2.34)	(2.03)	(4.15)	(0.66)	(2.50)	(0.99)	(1.96)	(2.04)
Dummy=1 in week 4	0.084**	0.073	0.14***	0.036	0.050	0.017	0.11**	0.068
	(2.01)	(1.53)	(2.73)	(0.73)	(0.80)	(0.25)	(2.11)	(1.13)
Dummy=1 in week 6	0.18**	0.23***	0.26***	0.20**	0.16	0.28***	0.19**	0.15
	(2.51)	(2.71)	(3.33)	(2.30)	(1.60)	(2.71)	(2.21)	(1.18)
Constant	-0.025	-0.031	-0.065***	-0.014	-0.024	-0.011	-0.026	-0.036
	(-1.35)	(-1.52)	(-2.84)	(-0.65)	(-0.85)	(-0.38)	(-1.19)	(-1.41)
N (*days*)	5213	5213	5213	5213	5213	5213	5213	5213

Note: t-statistics robust to heteroscedasticity in parentheses. The dept. variable is the daily simple return to various MSCI equity indices (from Bloomberg), expressed in percent. To account for time zone differences, panels B reports returns realized on day t+1 relative to the dating of the FOMC cycle. Sample period is 1994:01-2013:12. Returns in columns (1)-(3) are in USD. Returns for individual countries are in local currency.

Economic significance: Trading strategies based on the FOMC cycle

Table 2. Profitability of various trading strategies, 1994-2013

Trading strategy:	Average annual excess return	Standard deviation of annual excess return	Sharpe ratio for annual returns
Standard buy and hold strategy			
A. Hold stocks all the time	**8.47**	**19.99**	**0.42**
Alternating FOMC week strategies for the overall stock market			
B. Hold stocks in weeks 0, 2, 4, 6 only	**11.58**	**13.92**	**0.83**
Hold stocks in week 0 only	4.76	9.06	0.53
Hold stocks in week 2 only	2.44	6.78	0.36
Hold stocks in week 4 only	3.02	6.69	0.45
Hold stocks in week 6 only	0.93	1.57	0.59
C. Hold stocks in weeks -1, 1, 3, 5 only	**-2.67**	**15.04**	**-0.18**
D. Long stocks in weeks 0, 2, 4, 6 and short stocks in weeks -1, 1, 3, 5 (strategy B minus strategy C)	14.24	21.78	0.65
Alternating FOMC week strategies for high beta stocks			
E. Hold high beta stocks in weeks 0, 2, 4, 6 only	16.51	21.87	0.75
F. Hold high beta stocks in weeks -1, 1, 3, 5 only	-1.99	19.06	-0.10
G. Long high beta stocks in weeks 0, 2, 4, 6 and short high beta stocks in weeks -1, 1, 3, 5 (strategy E minus strategy F)	18.28	28.34	0.65

Evidence that the new fact is driven by news from the Fed

Likely to reflect a **risk premium for news -- about monetary policy or the macro economy -- coming from the Federal Reserve**:

(1) The FOMC calendar is quite irregular and changes across sub-periods over which our finding is robust.

(2) Even weeks in FOMC cycle time do not line up with other macro releases or with reserve maintenance periods.

(3) It is well-documented that news about monetary policy mainly comes out between FOMC meetings, not at the FOMC announcement.

(4) Volatility in fed funds futures market and fed funds market (but not to the same extent in other markets) peaks during even weeks in FOMC cycle time.

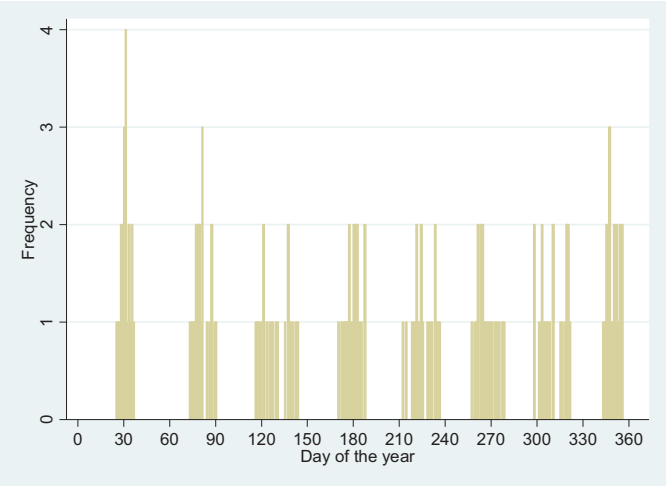
(5) Information processing/decision making within the Fed tends to happen bi-weekly in FOMC cycle time.

1) The FOMC calendar is quite irregular and changes across sub-periods over which our finding is robust

- The schedule of meetings for a particular year is announced ahead of time. The time between meetings varies across meetings and years – makes it much less likely that something other than the Fed is driving the main fact.

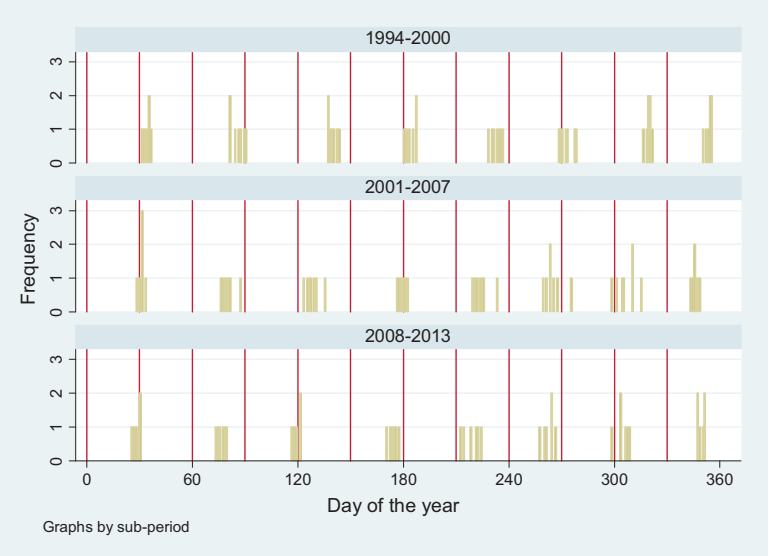
Figure 2. Timing of the eight FOMC meetings within the year

Panel A. Histogram of the day of the year on which FOMC meetings took place, 1994-2013



Note: For 2-day meetings, we set the FOMC meeting day equal to the second day.

Panel B. Histogram of the day of the year on which FOMC meetings took place, by sub-period



Note: Vertical lines are inserted every 60 days in order to facilitate comparisons across the three graphs.

2) Even weeks in FOMC cycle time do not line up with other macro releases or reserve maintenance periods

Macro releases: Controlling for the (importance-weighted) number of announcements doesn't change our results

Data for all non-FOMC macro announcements in Bloomberg for Nov 1996-Dec 2013.

- 16,396 non-Fed macro releases. Over 100 different types of macro data releases, with 91 types having at least 50 releases over the sample period.
- The data includes a "relevance" variable which is between 0 and 1 and measures how many Bloomberg users have set up ``alerts'' for that macro variable.

Non-Fed macro announcements have a clear weekly pattern in FOMC cycle time, not a bi-weekly pattern.

- Controlling for the number of announcements doesn't change our regression results much (even if you de-trend the series), see Table 4 below.
- Controlling for day of the month (dummies) also doesn't change our regression results much, see Table 4 below.

Nor does macro news explain the Lucca-Moench pre-FOMC effect:

- For the 2pm-2pm pre-FOMC period, we also tried dropping all 5-minute windows with any macro announcement (including overnight returns in case of announcements before the open).
- Reduces pre-FOMC effect (which is 50 bps) by about 15 bps, but also drops a bunch of minutes where macro news comes out but may not be the main driver of returns.

Figure 5. Number of macro announcements per day in FOMC cycle time, Bloomberg data 1996:11-2013:12.

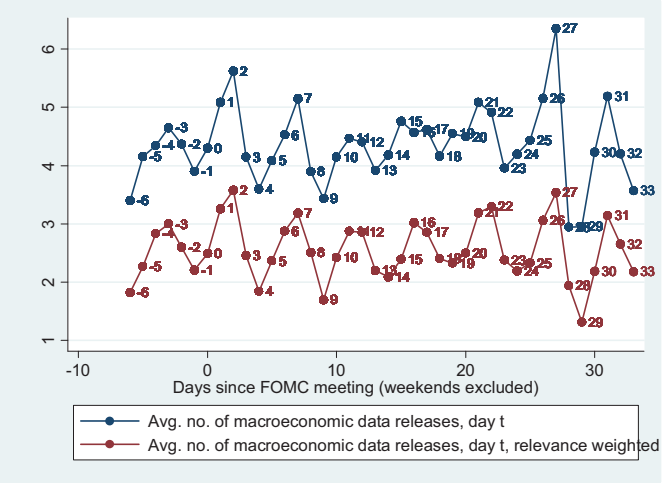


Table 4. Regressions of daily excess stock returns on FOMC cycle dummies with controls, 1994-2013

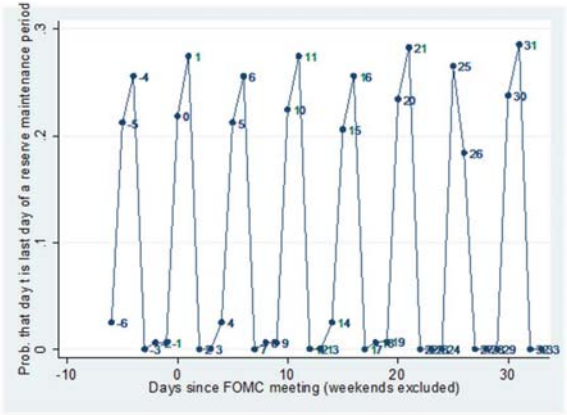
	Dependent variable: Excess return on stocks					
	(1), Baseline from Table 1	(2)	(3)	(4)	(5)	(6)
Dummy=1 in Week 0	0.136***	0.135***	0.147***	0.136***	0.13***	0.13***
	(2.76)	(2.70)	(2.60)	(2.75)	(2.74)	(2.66)
Dummy=1 in Week 2, 4, 6	0.101***	0.092***	0.108**	0.101***	0.099***	0.100***
	(2.68)	(2.40)	(2.50)	(2.67)	(2.65)	(2.61)
Number of macro data releases, relevance weighted			**0.019***			
			(1.94)			
Dummy for high payment flow day					0.074	
					(1.65)	
Number of corp. earnings announcements ($x10^4$)						0.35
						(0.20)
Fraction of positive corp. earnings surprises ($x10^4$)						-0.74
						(-0.08)
Day of the month dummies included	No	**Yes**	No	No	No	No
Dummies for day of the reserve maintenance period	No	No	No	**Yes**	No	No
Constant	-0.021	-0.018	-0.068**	-0.031	-0.033	-0.021
	(-0.98)	(-0.85)	(-2.1)	(-1.23)	(-1.45)	(-0.34)
N (days)	5214	5214	4475	5214	5214	5118

t-statistics robust to heteroscedasticity in parenthesis.
The left hand side variables is in percent, so (for example) 0.1 means 10 basis points per day.
*** means significant at the 1 pct level, ** signficant at the 5 pct level, and * significant at the 10 pct level.

Reserve maintenance periods: Controlling for day-of-the-RMP dummies doesn't affect our results

- Reserve maintenance periods in the US are two weeks long.
- Perhaps financial institution risk aversion varies with the RMP, driving our result?
  - No! RMPs are in calendar time, with no exceptions around holidays.
  - Because they are in calendar time and Fed calendar is not, the prob. that a given day in FOMC cycle time is the last day of an RMP has a weekly pattern, not bi-weekly.
  - Controlling for day of the RMP dummies doesn't change our regression results much, see Table 4 above.

Figure 3. Probability that a given day in FOMC cycle time is the end of a reserve maintenance period, 1994-2013



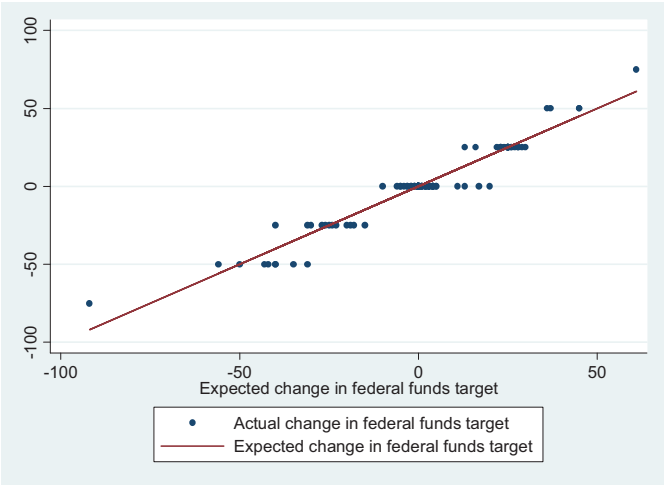
3) Well-documented that news about monetary policy mainly comes out in between meetings, not at the FOMC announcement

- Well known that when the Fed changes the fed funds target, this is to a large extent expected by the day before. Let's review this.
- Using Kuttner data, 1994-2008, on expected fed fund target changes extracted from Fed funds futures (116 FOMC meetings):

Table 3. Expected and surprise components of federal funds target changes in basis points, daily data, 1994-2008:06

Actual change	Number of changes	Avg. expected change	Avg. surprise	Avg. absolute value of surprise
-75	1	-92	17	17
-50	8	-42	-8	9
-25	12	-25	0	5
0	65	1	-1	2
25	25	25	0	2
50	4	41	9	9
75	1	61	14	14

Figure 4. Expected and actual changes in federal funds target rate, 1994-2008:06



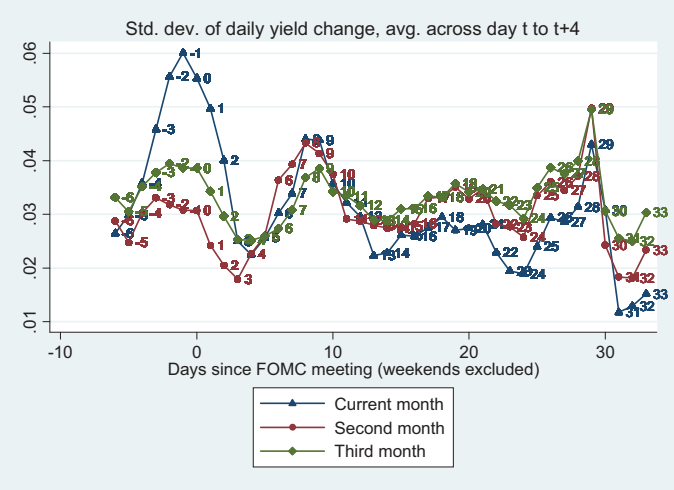
Note: The line is the 45 degree line.

- Regressing actual change in federal funds target on expected value of this change: Regression coefficient=1.02, t-statistic=41, R^2=0.94
  (for clarity the graph does not include the regression line).

4) Volatility in the fed funds futures market and the federal funds market (but not to the same extent in other markets) peaks during even weeks in FOMC cycle time

- Consider the first three federal funds futures contracts, each based on the average effective federal funds rate for a given calendar month.
- For each day in FOMC cycle time, calculate the yield change for a given futures contract as the change from day t-1 to t.
- Then calculate standard deviation of all available yield changes for that day in FOMC cycle time (so for day 0, for example, calculate std. dev. across 160 obs. of daily yield changes from day -1 to 0).
- Average these standard deviations across day t up to t+4 in FOMC cycle time.

Figure 5. Panel A. Volatility in federal funds futures yields over the FOMC cycle for the first, second and third month federal funds futures contracts, 1994-2013

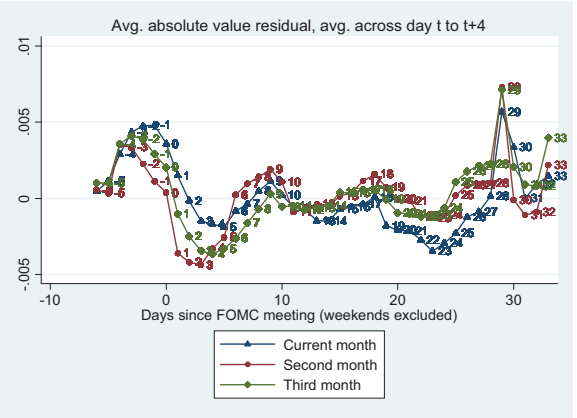


- Clear peaks in fed funds futures yield volatility in the even weeks in FOMC cycle time with volatility roughly twice as high in even as in odd weeks.

Issue: Futures contracts are based on calendar months.

- Yield changes are mechanically large on the first day of the new contracts.
- Contract month is mechanically closer in time as one proceeds within a month.
- Regress abs(daily futures yield change) on
  - Dummy for first trading day of the calendar month
  - Number of days left in the calendar month

Calculate average residuals by cycle day. Avg. over cycle day t to t+4.

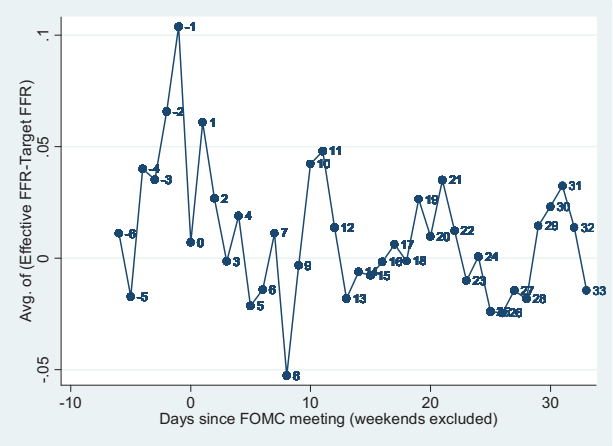


Changes in expected monetary policy may be reflected not only in futures contracts but also in the daily effective federal funds rate. Will be the case if:

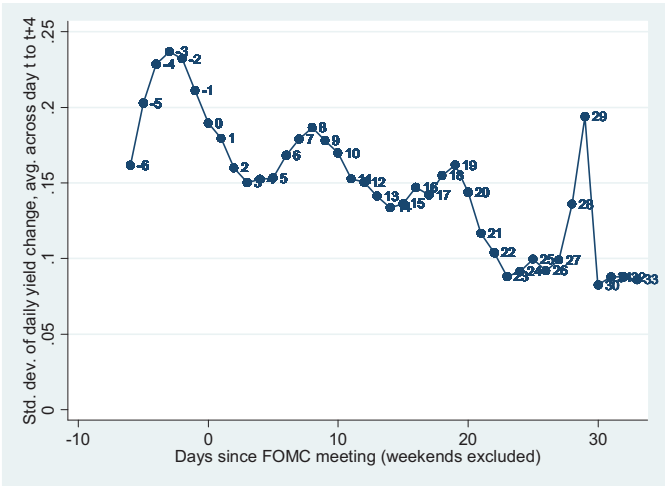
1) Financial institutions **adjust their demand** for federal funds in expectation of/in reaction to news about the future federal funds rate

2) The Fed's open markets desk **does not fully adjust its open markets operations** to keep the effective funds rate equal to the current target rate.

Extra graph: Average of Effective FFR-Target FFR over the cycle (this is about means, not about risk but if the effective rate was always at the target there could be no standard deviation between meetings):



Panel B. Volatility in the effective federal funds rate over the FOMC cycle, 1994-2013



- This volatility pattern is robust to controlling for the reserve maintenance period and what's called "high payment flow days".
- And it doesn't show up for stocks or bonds, suggesting that the news is really coming from the Fed funds market/Fed funds future market.

5) Information processing/decision making within the Fed tends to happen bi-weekly in FOMC cycle time.

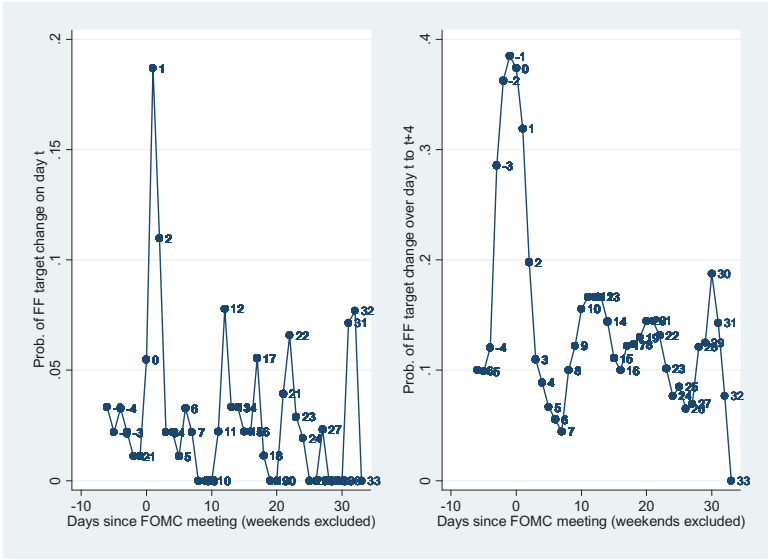
a) Federal funds target changes before 1994 tend to be bi-weekly in FOMC cycle time

Since 1994, Fed has mainly changed federal funds target at scheduled FOMC meetings: Only 7 of 60 changes over 1994-2013 were between meetings.

This differs from pre-1994 period when it was more common to change target in between meetings than at the meetings:

- From 1982:09 to 1993, 62 of 94 target rate changes were between meetings.
- So for pre-1994 period can use target change dates to learn about when information processing/decision making happens within the Fed.

Figure 12. Probability of an inter-meeting federal funds target change, 1982:09-1993



b) 6 of 7 federal funds target changes after 1994 were on the bi-weekly FOMC cycle

Table 6. Timing of the 7 intermeeting Federal funds rate changes from 1994-2013

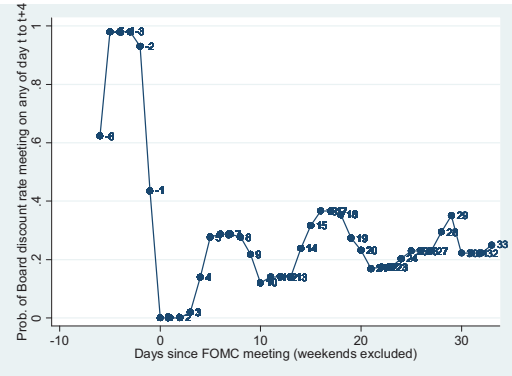
Date of intermeeting change in fed funds target	Date of prior board meeting	Fed funds target change	Day in FOMC cycle time
4/18/1994	Same day	0.25	**19**
10/15/1998	1 day before	-0.25	**12**
1/3/2001	1 day before	-0.5	**11**
4/18/2001	Same day and 2 days before	-0.5	**21**
9/17/2001	Same day	-0.5	**19**
1/22/2008	1 day before	-0.75	**-6 (30 of last cycle)**
10/8/2008	1 day before	-0.5	**16**

- 6 of 7 intermeeting Federal funds rate changes from 1994-2013 are on the bi-weekly FOMC cycle.
- Target change on 10/8/2008 appears to be a reaction to the 4% drop in the stock market on 10/6/2008 and the 5.8% drop on 10/7/2008.

c) Board of Governors board meetings tend to be bi-weekly in FOMC cycle time

Technically called the Board of Governors discount rate meetings. Minutes of these meetings are posted on the Federal Reserve's web page starting from May 2001.
In the process of using FOIA requests to obtain daily schedules for the Fed governors.

Figure 6. Probability of Board of Governors discount rate meeting on one of day t to t+4, 2001:06-2013:12



Note: We code cases of discount rate minutes, but no meeting, as a non-meeting.

Why would Fed board meetings tend to be bi-weekly in FOMC cycle time?

- Each regional fed's board/executive committee meet to decide on discount rate recommendations. Under the Federal Reserve Act of 1913, this happens at least every 2 weeks (in calendar time). Would make sense to schedule board meetings accordingly.

- The discount rate itself is not that important (pre-crisis borrowing was typically less than $1B). Instead: "While the Reserve Bank presidents are not part of the premeeting discussions at the Board, they have their own devices for influencing the policy discussion in between meetings. They do this specifically through requests to change the discount rate." (Larry Meyer (2004))

- Board meetings involve discussions of the views of the regional feds but also briefings by Fed staff. Most likely:

  (i) updates on national economic conditions and forecasting from Fed staff economists in charge of the Greenbook (now Tealbook)
  (ii) updates on from Monetary Affairs (on open markets operations etc.)
  (iii) updates on bank conditions from bank supervision economists in the Fed system.

- **Important caveat:** Before 2001, discount rate meetings tended to take place at a weekly frequency in FOMC cycle time, as opposed to a bi-weekly frequency (we did a FOIA request for discount rate minutes for 1994:01-2001:05).

  - Were some of the weekly meetings "formalities"? Would be consistent with the Fed subsequently changing to a bi-weekly meeting frequency in FOMC cycle time but this remains an open question.

Possible mechanisms for how information gets from the Fed to the market

- Signaling policy via open market operations

  Rule out that such signaling takes place post-1994. We have spoken with senior Federal Reserve officials who inform us that no such signaling via OMOs happens.

- Public communication by the Fed

  High-return weeks do not systematically line up with official information releases from the Federal Reserve or with the frequency of speeches by Fed officials

- Quiet policy communications and unintended information flows.

  Some indications of this. Much more work to be done.

Public information releases and public speeches by Federal Reserve officials? No: Line up with week 4 in FOMC cycle time, but not week 0, 2, 6.

FOMC statement: Doesn't explain high week 0 returns.

- Released publicly just after FOMC meeting, typically around 2.15pm.
- But as shown by Lucca and Moench (2013) the return in week 0 in FOMC cycle time is earned prior to the FOMC statement.

Beigebook:

- Summarizes economic conditions across the 12 regional fed districts.
- Made public 2 weeks *prior* to each scheduled FOMC meeting.

Minutes of FOMC meetings:

- Before Dec 2004, released on avg. 47 days after meeting (i.e. after next FOMC meeting). Since Dec 2004 released on average 21 days after the meeting.

Minutes of Board of Governors discount rate meetings:

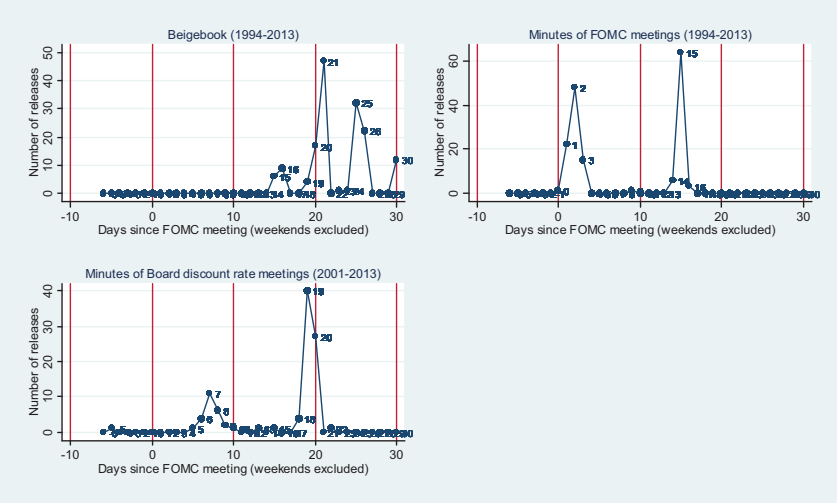
- Released in bunches 8 times per year, around 4 weeks after the FOMC meeting.

Green/Blue/Teal books and FOMC transcripts: Not public until 5 years later.

- Released **internally** within Fed a few days before FOMC meeting, more shortly.

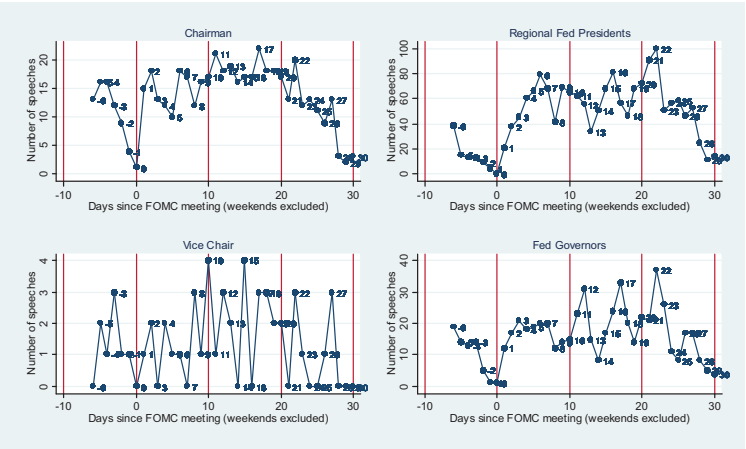
Figure 7. Releases of Federal Reserve documents over the FOMC cycle

Panel A. Public releases



- Beigebook and DR minutes line up with week 4 in FOMC cycle time.
- FOMC minutes don't line up with even week returns (remember that week 0 return is earned before the announcement on day 0).

Figure 8. Speeches by Federal Reserve officials over the FOMC cycle



Note: The figure displays the total number of speeches and testimonies given by Fed officials at each point of the FOMC cycle during the period 1994:01-2013:12. Data collected from Federal Reserve Board website and from websites of regional Feds.

- Peak in speech frequency of regional Fed pres's in week 4 in FOMC cycle time.

``Subtle" communication and unintended communication by the Fed

Might the Fed want to get information out as part of optimal policy?

- Long literature on the optimal amount of central bank communication. Survey by Blinder, Ehrmann, Fratzscher, de Haan and Jansen (2008).
- Communication guides market expectations about interest rates and inflation and for reduces uncertainty about policy rule.

But how should they get the information out?

Greenspan is known for his objections to full public disclosure and a preference for having flexibility in terms of policy and disclosure:

- Public disclosure is sometimes undesirable due to the risk of overreaction of market prices
- Public disclosure induces risk that the Fed's decision making would be less conditional due to the market's inability to fully understand contingencies in policy statements.

Greenspan's changes in policy were "subtly" communicated to the market:

- Prior to February 1994, the market had to infer policy changes from open market operations and from any "subtle" communication by the Fed.
- As part of Congressional hearings in 1993 (Gonzalez hearings) it became clear that from 1989 to May 1993 on 11 occasions, the essence of the FOMC directive to the open markets desk was made available to the Wall Street Journal within one week of the meeting (Belongia and Kliesen (1994)).
- Congressional dissatisfaction with this subtle communication lead to the Fed conceeding to release its fed funds target decision right after the FOMC meeting and to make transcripts of FOMC meetings available with a 5-year lag.

Perhaps Fed has had a continued preference for "making changes either quite publicly or more subtly, as conditions warrant"

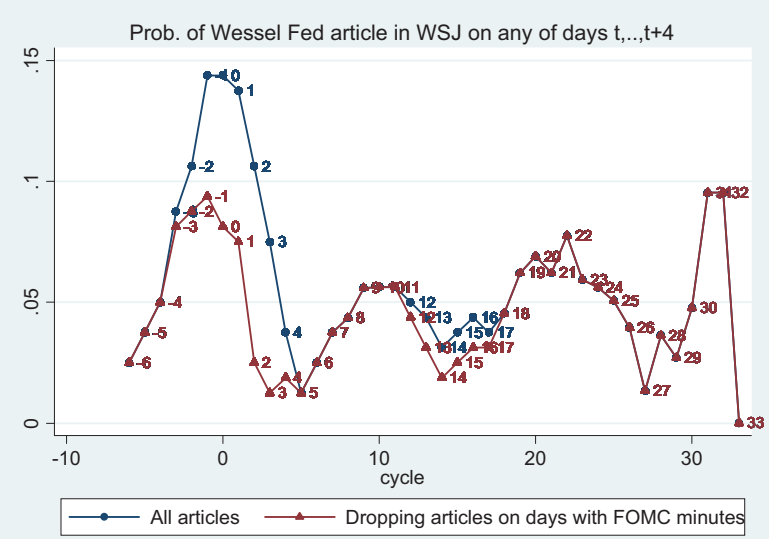
- Observation: The change in disclosure in 1994 lines up with the Fed's change from making quite frequent intermeeting changes to the target to making almost no intermeeting changes after 1994.
- Given that target changes are now immediately public it has reduced its use of intermeeting changes of the fed funds target.

What direct evidence is there for continued use of subtle communication?

- Appendix B, Part 1 list twelve *samples* of "subtle" information coming from Fed. Except for the first item, these articles concern information coming out aligned with the board meetings.

Example: Item number 7 is a **David Wessel article from 12/18/2000** that according to an article the next day in the Wall Street Journal "sent blue chips soaring" (see item 8):

> *But Fed insiders say there is discussion of doing more; although not yet any firm consensus. Both private and Fed staff forecasts have been marked down in the past several months; and there is some concern inside the Fed that the U.S. economy's momentum is slowing more rapidly than desired. Incoming data is mixed; but a slew of companies have reported surprisingly abrupt drops in sales and orders; and consumer confidence has fallen sharply. Fed officials welcome a slowdown; but differ on how much of a slowdown -- and how much of an increase in unemployment -- is desirable…Members of the Federal Reserve Board in Washington are scheduled to meet with staff economists for an important review of the outlook today.*



- Based on articles in the WSJ from 1994-2013 by David Wessel which contains any of the words "FOMC" or "federal open market committee"or "fed board". 75 articles total.

More directly, Larry Meyer discusses the Fed's "signal corps":

"The use of reporters as part of the Fed's signal corps is not official Board or FOMC doctrine. The public affairs staff and the Chairman like to pretend it doesn't happen. I expect that the Chairman generally expects reporters to read between the lines or somehow sense the signal in his body language. He generally relies on a small group of reporters for this purpose. John Berry, longtime reporter for *The Washington Post* and now at Bloomberg is the more widely recognized in this role. But *The Wall Street Journal* reporter covering the Fed – it was **David Wessel**, then Jake Schlesinger, and most recently Greg Ip during my term – was also a regular member of the signal corp."

Meyer (2004), page 98

``I was surprised, then, one Monday before an FOMC meeting, to pass John Berry coming out of the Chairman's office.''

Meyer (2004), page 99

Beyond intentional releases of information: Private parties on occasion obtain insights from the information aggregation process inside the Fed. Some examples (from Appendix B part 2):

- Larry Meyer's book (2004) states that the Greenbook is rather "leaky," and thus there has been resistance to include the update from the trading desk in the written copy. Timing lines up with week 0 if leaks take a couple of days.

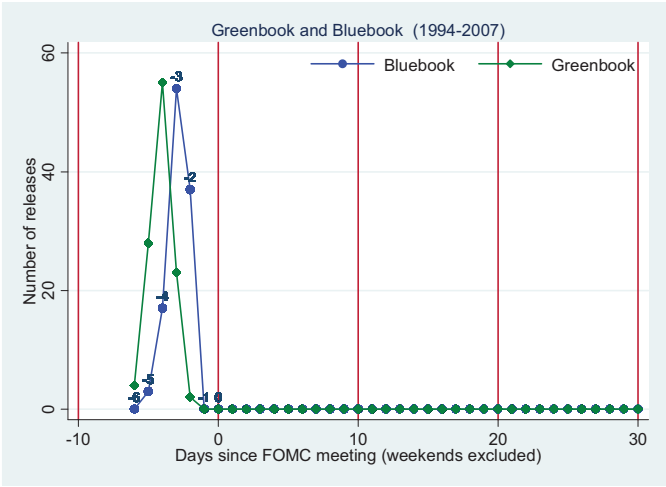
  An example of PIMCO's Bill Gross knowing the Greenbook content on a day 0 (before the FOMC announcement) is at:

  http://www.zerohedge.com/article/did-bill-gross-just-confirm-live-tv-he-has-advance-look-non-public-fed-data

- A Reuters report by Cooke, da Costa and Flitter (2010) discusses how Larry Meyer and other former employees have access to the Fed Board facilities.

  Describes how Larry Meyer, who provides macroeconomic/ monetary policy updates to private sector clients for an annual subscription price of $75,000, had the details of the August 2010 FOMC meeting weeks before the information was to emerge publicly.

Figure 14, Panel B. Releases of documents internally within the Federal Reserve



Summary:

- *Since 1994 the US equity premium is earned entirely in weeks 0, 2, 4 and 6 in FOMC cycle time*
- Likely reflects a risk premium for news (about monetary policy or the macro economy) coming from the Federal Reserve
- How the information gets from the Fed to asset markets remains the main unresolved issue:
  - Not signaling via OMOs and (except week 4) even weeks do not systematically line up with official information releases from the Fed or with frequency of speeches by Fed officials.
  - Possible role for quiet policy communication and unintended information flows.

THE EFFECTS OF QUANTITATIVE EASING ON INTEREST RATES: CHANNELS AND IMPLICATIONS FOR POLICY

(Krishnamurthy and Vissing-Jorgensen,
Brookings Papers on Economic Activity, Fall 2011)

THE INS AND OUTS OF LSAPS

(Krishnamurthy and Vissing-Jorgensen, Jackson Hole paper, 2013)

Did we learn anything from studying US QE that may be useful for thinking about current/potential future ECB policies?

- A key lesson from the US is that **it matters what you buy**:
  - The assets purchased move more in yield than those not purchased (across and within bond categories).
  - While there are "general" channels, the "specific" channels seem very important.

This highlights the potential of the ECB's ABS, covered bond and TLTRO policies for affecting private sector borrowing costs.

- **Buying government bonds in calm times has limited effect on private sector yields beyond a signaling effect** (impact on perceived policy rate path) which might be achievable with forward guidance/have already been achieved with the guidance given.

This is perhaps consistent with the ECB's reluctance to do broad-based government bond QE in the current environment.

- **Buying private sector assets (MBS in the US) affects private sector yields in both crisis and calmer times, but the channels differ:**
  - In crisis times, capital constraints and **reductions in risk premia appear central.**
  - There is an additional **on the specific securities purchased, via a ``scarcity" effect**: By paying more for particular securities (those based on newly originated loans) you can get banks to sell them to you and (hopefully) get them to originate more. This effect is a large part of the impact **in calmer times.**

This suggests that targeting flows (buying newly issued ABS) may be particularly important for the ECB's current ABS and covered bond programs:

Even if the ECB doesn't buy the lower tranches, if it's willing to pay more than others for the safer tranches that will still make it more profitable for banks to originate loans.

This idea is **quite related to the ECB's design of the TLROs:** Focus on lending only if banks increase lending.

Here is a summary of how we reached these conclusions

Objective of our Brookings paper:

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:

- They determine whether it matters what is purchased.
- They determine whether/how much some off the QE effect may have been achievable with forward guidance to keep Fed funds rate low, without balance sheet risk.

QE1 purchase magnitudes and 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 of longer-term Treasuries.

Focus on two-day changes for QE1 (very illiquid period).

Liquid assets (Treasuries, Agencies): One-day changes similar.

Illiquid assets (corporate, MBS): One-day changes smaller.

QE2 purchase magnitudes and 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.

- August 4, 2010 Fed MBS holdings: $1,118B
  August 3, 2011 Fed MBS holdings: $897B, i.e. 19.7% lower.
- Thus, reinvesting MBS principal in Treasuries implies Treasury purchase of about $220B over next year, and $396B over next two years (from announcement).

2. September 21, 2010: FOMC statement
   ''maintain its existing policy of reinvesting principal payments''
   "The Committee will continue to monitor the economic outlook and financial developments and is prepared to provide *additional* accommodation if needed to support the economic recovery […]" (emphasis added)

   The "additional" was read by many market participants as indicating new stimulus by the Fed, and particularly an expansion of its purchases of long-term Treasuries (e.g. Goldman Sachs commentary on 9/21/2010).

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.

   Focus on one-day changes for QE2 (more liquid period).

Changes in yields using event-study methodology:

QE1, 2-day changes, sum across 5 event dates

Treasuries yields					Agency yields				Agency MBS	
30 yr	10 yr	5 yr	3 yr	1 yr	30 yr	10 yr	5 yr	3 yr	30 yr	15
-73	-107	-74	-39	-25	-144	-200	-150	-123	-107	-88

Corporate yields						
	Aaa	Aa	A	Baa	Ba	B
Long	-77	-83	-93	-81	-60	-43
Intermediate	-88	-93	-92	-76	-82	-130

QE2, 1-day changes, sum across 2 event dates

Treasuries yields					Agency yields				Agency MBS	
30 yr	10 yr	5 yr	3 yr	1 yr	30 yr	10 yr	5 yr	3 yr	30 yr	15
-9	-18	-17	-8	-1	-9	-17	-17	-10	-9	-12

Corporate yields						
	Aaa	Aa	A	Baa	Ba	B
Long	-9	-6	-8	-7	-10	-7
Intermediate	-13	-11	-12	-13	-4	3

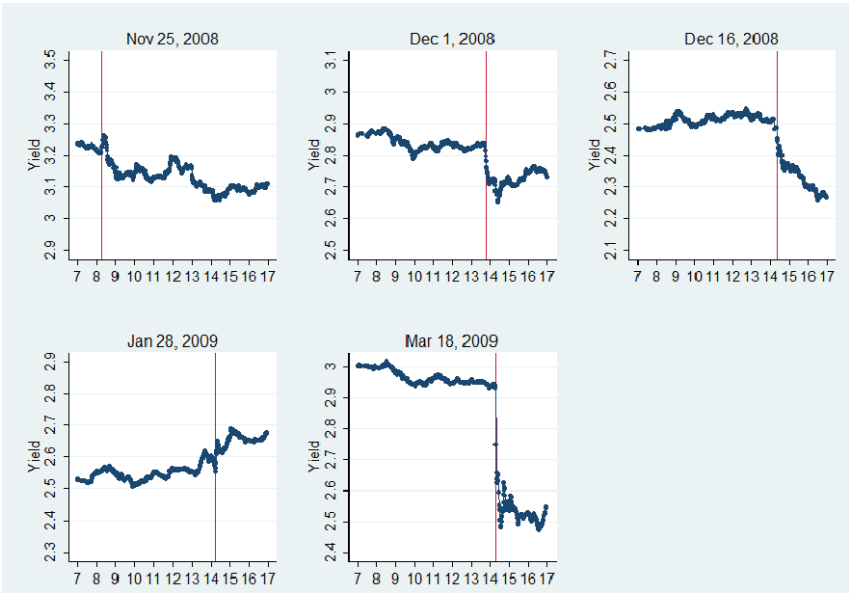
Statistical significance in paper (regressions using daily data for 2008-2011:Q3).
See also my comment on Chodorow-Reich (Brookings, 2014) regarding standard errors.

Is it causal? Intra-day changes in on-the-run 10-year Treasury yields and trading volume

- Vertical lines indicate the minute of the announcement (minute of the first article covering the announcement in Factiva).
- Trading volume graphs suggests that QE was important news on each day.
- QE1: Intra-day yield moves on all but 1/28/2009 suggests announcements contained news and were important for daily yield moves.
- QE2: Intra-day yield move on 11/3/2010 consistent with QE2 already being priced in.

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

Panel A. Yields



Panel B. Trading Volume

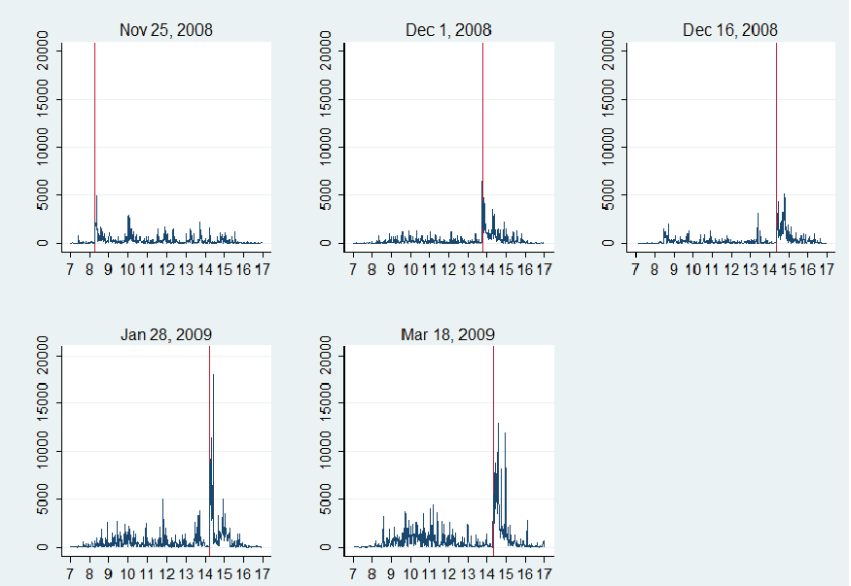
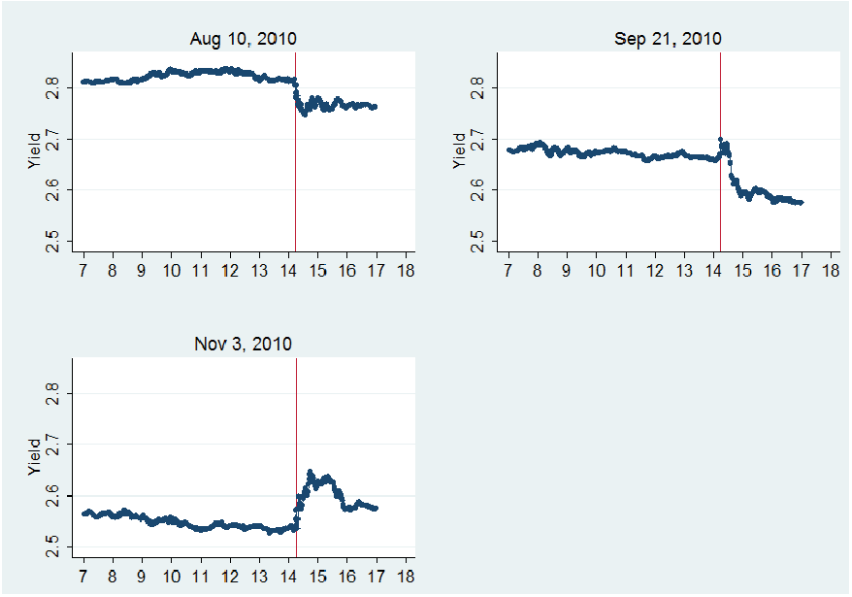
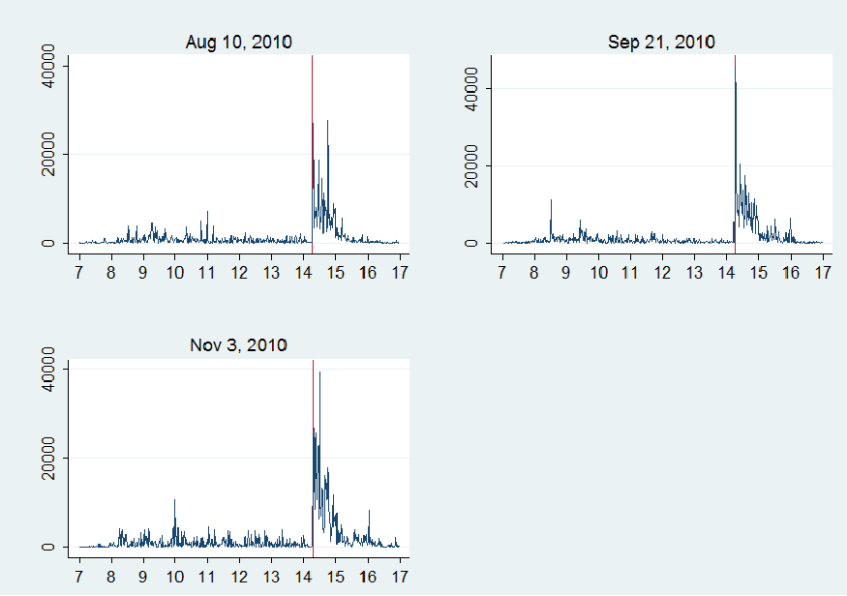


Figure 4. Intra-day Yields and Trading Volume on QE2 Event Days

Panel A. Yields



Panel B. Trading Volume



Channels:

- Previous work has emphasized two channels:
  (1) QE signals lower future fed funds rate
  (2) A ``portfolio rebalancing'' channel: Securities that are ``similar'' to those purchased will move in price.

  Some Fed officials have focused on a particular version of (2): A reduction in the duration risk premium.

- We consider signaling in more detail and several portfolio rebalancing channels (similarity along duration risk, prepayment risk, default risk, degree of extreme safety, liquidity), and effects of policy on expected inflation.

- Our basic approach is to think of a given interest rate as driven by a host of components and then compare different interest rates and derivatives prices to isolate each component.

$$
\begin{aligned}
& r_{long-term} \\
& = E\left[i_{safe,\, liq\,,short-term}\right] \\
& \quad + Duration \times P_{DurationRisk} \\
& \quad + DefaultRisk \times P_{DefaultRisk} \\
& \quad + PrepaymentRisk \times P_{PrepaymentRisk} \\
& \quad - Degree\ of\ extreme\ safety \times P_{Safety} \\
& \quad - Liquidity \times P_{Liquidity} \\
& \quad - \pi^{e}
\end{aligned}
$$

(r=real, i=nominal)

(1) Signaling channel:

- Possible mechanism for QE announcements to affect expected future short rate:
  - Some of QE statements **directly address** FF target (lowered on 12/16/2008 plus forward guidance on several dates).
  - Perhaps QE made these statements **extra credible**: If Fed raises rates, it takes a loss on assets purchased.
  - Perhaps QE announcement even without any explicit forward guidance is taken as a **signal about policy preferences** (e.g. that the doves are winning the argument).

- Approach 1: Look at changes in longest Fed funds futures. Assume they apply to all medium and long rates.

- Approach 2: Use schedule of Fed funds futures to work out how much the Fed funds rate cycle shifted forward in time. Calculate implied effect on each maturity bond via impact on average short rate.

Table 4. Federal Funds Futures Yield Changes

QE1, 2-day changes, sum across 5 event dates

Fed Funds Futures, Contract Maturity			
3rd month	6th month	12th month	24th month
-28	-27	-33	-40

QE2, 1-day changes, sum across 2 event dates

Fed Funds Futures, Contract Maturity			
3rd month	6th month	12th month	24th month
0	-1	-4	-11

- Approach 1:
  QE1, 2-day: 40 bps of decline at mat≥2 years due to signaling.
  QE2, 1-day: 11 bps of decline at mat≥2 years due to signaling.

Figure 3. Yield Curves from Fed Funds Futures, pre- and post QE1 Event Days

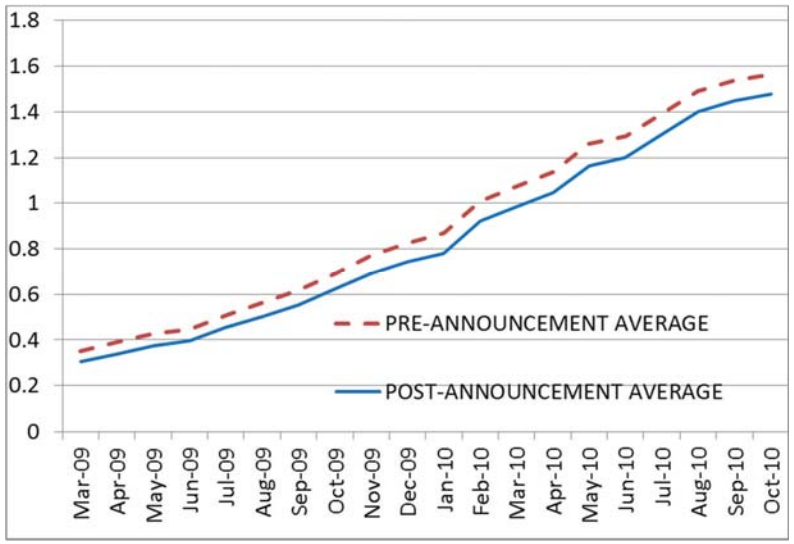
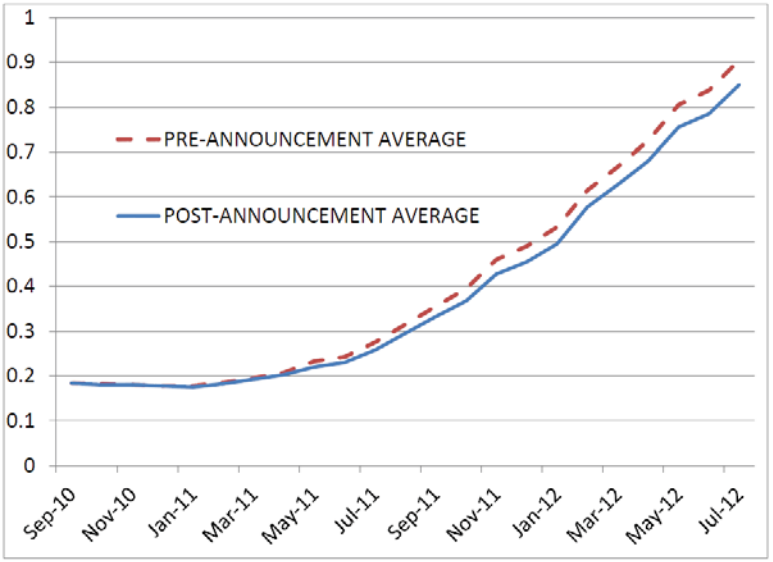


Figure 5. Yield Curves from Fed Funds Futures, pre- and post QE2 Event Days



- Approach 2: Forward shift in rate cycle=[(Vertical shift in avg yield curve)/Slope of initial average yield curve]*[# event dates]

  QE1: 6.3 months (evaluated from March 2010 point)
  QE2: 2.1 months (evaluated from July 2011 point)
  3.2 months (evaluated from July 2012 point)

  QE1 signaling effects:
  30 bps for 5-yr bond, 20 bps for 10-yr bond, 7 bps for 30-yr bond

  QE2 signaling effects:
  Using 2.1 months: 11 bps for 5-yr, 7 bps for 10-yr, 2 bps for 30-yr bond.
  Using 3.2 months: 16 bps for 5-yr, 11 bps for 10-yr, 4 bps for 30-yr bond

- In sum, signaling accounts for:

  QE1: 20-40 bps at the 10 year horizon, 30-40 bps at 5 year horizon
  QE2: 7-11 bps at the 10 year horizon, 11-16 bps at 5 year horizon

- **So perhaps some of the QE effect on yields may have been achievable with forward guidance, without balance sheet risk.**

- Qualifier: These numbers may be a little too high.

  Effect of Fed funds futures changes on predicted future realized Fed fund rates is a bit less than 1-for-1 because Fed funds futures rates contain a risk premium (Piazzesi and Swanson, 2008) which varies with the level of short rates and the business cycle.

A few examples that **forward guidance without associated QE** is able to move yields:

Aug 9, 2011: ``… exceptionally low levels for the federal funds rate at least through mid-2013''.
Jan 25, 2012: ``… exceptionally low levels for the federal funds rate at least through late 2014.

- 1-day changes in Treasuries:

	30-yr	10-yr	5-yr	3-yr
Aug 9, 2011:	-12 bps	-20 bps	-20 bps	-12 bps
Jan 25, 2012:	-2 bps	-7 bps	-11 bps	-5 bps

- 1-day changes in Fed Funds futures:

	2-yr	1-yr
Aug 9, 2011:	-22 bps	-4 bps
Jan 25, 2012:	-4 bps	-0.5 bps

(2) 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).

- Prediction:
  QE decreases yields on all long-term nominal assets, including Treasuries, corporate bonds, and mortgages.

- Use corporate bonds to isolate duration risk channel. **Lower grade bonds particularly informative (no safety, liquidity, or MBS prepayment effects).** Adjust yield changes for CDS changes+signaling.

QE1, 2-day changes

Corporate yields	Aaa	Aa	A	Baa	Ba	B
Long	-77	-83	-93	-81	-60	-43
Intermediate	-88	-93	-92	-76	-82	-130
Credit default swaps						
	Aaa	Aa	A	Baa	Ba	B
10 yr	-7	-14	-32	-40	-78	-1354
5 yr	-6	-17	-33	-51	-98	-991
Corporate yields, minus effect of CDS						
	Aaa	Aa	A	Baa	Ba	B
Long	-70	-69	-61	-41	18	1311
Intermediate	-82	-76	-59	-25	16	861

QE2, 1-day changes

Corporate yields	Aaa	Aa	A	Baa	Ba	B
Long	-9	-6	-8	-7	-10	-7
Intermediate	-13	-11	-12	-13	-4	3
Credit default swaps						
	Aaa	Aa	A	Baa	Ba	B
10 yr	2	2	2	2	6	8
5 yr	0	4	3	4	9	13
Corporate yields, minus effect of CDS						
	Aaa	Aa	A	Baa	Ba	B
Long	-11	-8	-10	-9	-16	-15
Intermediate	-13	-15	-15	-17	-13	-10

We construct CDS indices by rating (using Datastream, FISD, TRACE):

- Sort firms into ratings categories using value-weighted average rating on debt with remaining maturity >1 year.
- For each QE date, calculate value-weighted average of firm level CDS changes (1-day or 2-day).

QE1: No clear evidence of duration risk premium effect

- Essentially no change in CDS-adj. yields of Baa and lower bonds.
  Signaling enough to explain reduction for Baa, and nothing left to explain for lower than Ba and B.

QE2: No clear evidence of duration risk premium effect

- CDS-adj. yields of Baa and lower bonds down and MBS down by about the amount of the signaling effect
  (Exception: Ba, B long CDS adjusted are down more)

(3) MBS pre-payment risk premium channel:

- Gabaix, Krishnamurthy, and Vigneron (2007): 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. In QE1 MBS rates fall by more than the signaling effect
  ii. In QE2, which does not involve MBS purchases, MBS rates fall only by the signaling effect.

- Note: We'll consider other channels below. These don't affect MBS (default risk, long-term safety, liquidity).

QE1, 2-day changes, sum across 5 event dates

Treasuries yields					Agency yields				Agency MBS	
30 yr	10 yr	5 yr	3 yr	1 yr	30 yr	10 yr	5 yr	3 yr	30 yr	15
-73	-107	-74	-39	-25	-144	-200	-150	-123	-107	-88

Corporate yields	Aaa	Aa	A	Baa	Ba	B
Long	-77	-83	-93	-81	-60	-43
Intermediate	-88	-93	-92	-76	-82	-130

QE2, 1-day changes, sum across 2 event dates

Treasuries yields					Agency yields				Agency MBS	
30 yr	10 yr	5 yr	3 yr	1 yr	30 yr	10 yr	5 yr	3 yr	30 yr	15
-9	-18	-17	-8	-1	-9	-17	-17	-10	-9	-12

Corporate yields	Aaa	Aa	A	Baa	Ba	B
Long	-9	-6	-8	-7	-10	-7
Intermediate	-13	-11	-12	-13	-4	3

- Suppose 15 yr MBS has duration around 5 years, and 30 yr MBS has duration around 10 years. Then:

  QE1: Pre-payment risk premium channel is:
  At least 88 bps-40 bps=48 bps for the 15 yr MBS
  At least 107 bps-40 bps=67 bps for the 30 yr MBS.

  Pre-payment risk interpretation is consistent w/30-year MBS down more than 15-year MBS (more pre-payment risk in 30-year MBS than 15-year MBS).

  QE2: Pre-payment risk premium channel is zero, as expected.

(4) Default risk channel:

- **Default risk:** If QE succeeds in **stimulating the economy**, we can expect that the *default risk* of corporations will fall.

  Default risk premium: Also, investor **risk aversion may fall** as economy recovers, implying a lower *default risk premium*. Increasing **health/capital in the intermediary sector** can further lower risk premium on default risk.

- Prediction: Credit default swap rates for corporate bonds will fall.

- QE1: A lot of decline in yields for lower grade corporates is due to reduced credit risk!

- QE2: CDS rates didn't go down. QE2 didn't succeed in reducing credit risk. This could suggest that the MBS purchases in QE1 were crucial for stimulating the economy!

QE1, 2-day changes

Corporate yields	Aaa	Aa	A	Baa	Ba	B
Long	-77	-83	-93	-81	-60	-43
Intermediate	-88	-93	-92	-76	-82	-130
Credit default swaps						
	Aaa	Aa	A	Baa	Ba	B
10 yr	-7	-14	-32	-40	-78	-1354
5 yr	-6	-17	-33	-51	-98	-991
Corporate yields, minus effect of CDS						
	Aaa	Aa	A	Baa	Ba	B
Long	-70	-69	-61	-41	18	1311
Intermediate	-82	-76	-59	-25	16	861

QE2, 1-day changes

Corporate yields	Aaa	Aa	A	Baa	Ba	B
Long	-9	-6	-8	-7	-10	-7
Intermediate	-13	-11	-12	-13	-4	3
Credit default swaps						
	Aaa	Aa	A	Baa	Ba	B
10 yr	2	2	2	2	6	8
5 yr	0	4	3	4	9	13
Corporate yields, minus effect of CDS						
	Aaa	Aa	A	Baa	Ba	B
Long	-11	-8	-10	-9	-16	-15
Intermediate	-13	-15	-15	-17	-13	-10

Aside: We didn't study stocks in the QE paper, but let's check if they give the same message as CDS.

		1/2 hour return	Daily return	2-day return
QE1	11/25/2008	2.60	0.97	4.87
	12/1/2008	-0.30	-8.99	-5.55
	12/16/2008	0.62	5.31	4.79
	1/28/2009	-0.40	3.38	-0.03
	3/18/2009	1.89	2.23	1.40
	Sum	4.41	2.89	5.48
QE2	8/10/2010	0.75	-0.81	-3.74
	9/21/2010	0.79	-0.32	-0.84
	Sum	1.54	-1.13	-4.58

Out of sample evidence supporting that it really does matter what you buy – it's not just about duration risk premia. See our Jackson Hole paper.

9/13/2012 FOMC announcement: QE3 all in MBS

``To support a stronger economic recovery and to help ensure that inflation, over time, is at the rate most consistent with its dual mandate, the Committee agreed today to increase policy accommodation by **purchasing additional agency mortgage-backed securities at a pace of $40 billion per month**.''

What should happen if it matters what you buy?

- MBS yields should go down more than Treasury yields.

9/21/2011 FOMC announcement: MEP (twist+more MBS)

Operation Twist:

``To support a stronger economic recovery and to help ensure that inflation, over time, is at levels consistent with the dual mandate, the Committee decided today to extend the average maturity of its holdings of securities. The Committee intends to **purchase, by the end of June 2012, $400 billion of Treasury securities with remaining maturities of 6 years to 30 years** and to **sell an equal amount of Treasury securities with remaining maturities of 3 years or less**. …"

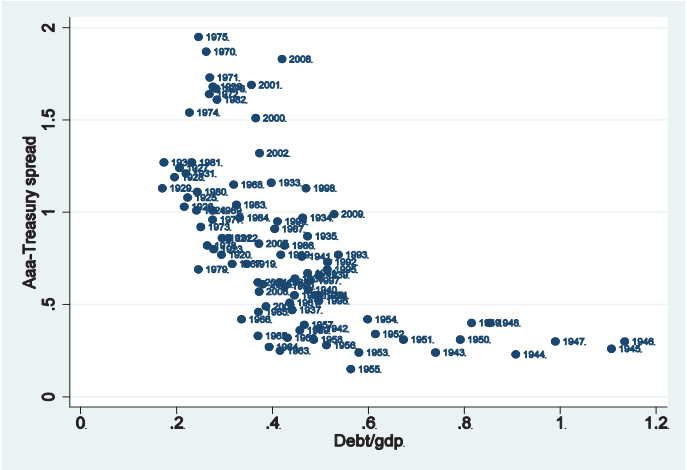
More MBS:

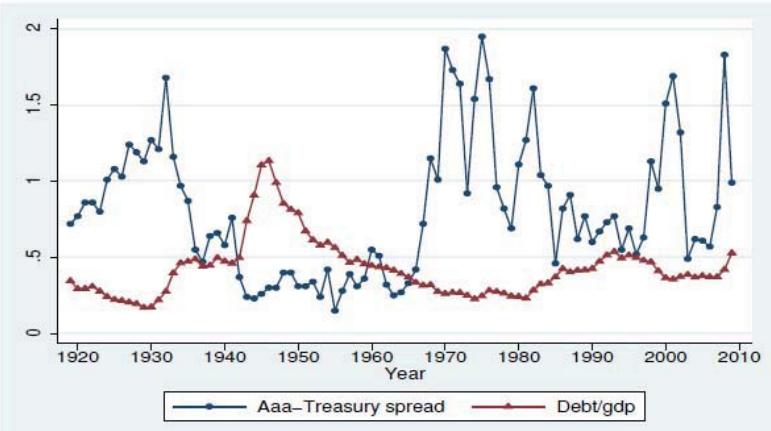
"To help support conditions in mortgage markets, the Committee will now **reinvest principal payments from its holdings of agency debt and agency mortgage-backed securities in agency mortgage-backed securities**."

	QE1	QE2	MEP	QE3
	MBS & Treasury	Treasury only	MBS & Treasury	MBS only
Treasury Yields				
5-year	-74	-17	+3	-6
10-year	-107	-18	-7	-3
30-year	-73	-9	-17	1
Corporate Bonds				
Aaa	-77	-9	-16	4
Baa	-81	-7	-15	0
IG CDS 10 year			+9	0
Agency MBS				
15-year	-88	-9	-7	-16
30-year	-107	-12	-23	-16
Fed Funds Futures				
12th month	-33	-4	0	0
24th month	-40	-11	-1	-3
Implied Signaling Effect				
5-year	-35	-18	0	-1
10-year	-20	-12	0	-1

(5) Long-term safety channel:

- Krishnamurthy and Vissing-Jorgensen (2012): 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.

- **QE decreases supply of long-term safe assets:** Treasury and agency bonds (agency MBS has significant prepayment risk which means that it is unlikely to meet clientele safety demands)

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

Best place to isolate this effect: Agency bonds - these must be mainly affected by signaling and safety effect
- o Duration risk effect was small.
- o Pre-payment risk not relevant: Use non-callable agency bonds
- o Default risk tiny: Fannie & Freddie taken over by govt. pre-QE1
- o Liquidity smaller issue than for Treasuries.

QE1, 2-day changes, sum across 5 event dates

Treasuries yields					Agency yields				Agency MBS	
30 yr	10 yr	5 yr	3 yr	1 yr	30 yr	10 yr	5 yr	3 yr	30 yr	15
-73	-107	-74	-39	-25	-144	-200	-150	-123	-107	-88

Corporate yields	Aaa	Aa	A	Baa	Ba	B
Long	-77	-83	-93	-81	-60	-43
Intermediate	-88	-93	-92	-76	-82	-130

QE2, 1-day changes, sum across 2 event dates

Treasuries yields					Agency yields				Agency MBS	
30 yr	10 yr	5 yr	3 yr	1 yr	30 yr	10 yr	5 yr	3 yr	30 yr	15
-9	-18	-17	-8	-1	-9	-17	-17	-10	-9	-12

Corporate yields	Aaa	Aa	A	Baa	Ba	B
Long	-9	-6	-8	-7	-10	-7
Intermediate	-13	-11	-12	-13	-4	3

Agency yield reduction due to safety effect (netting out signaling):

QE1:
At least 200 bps-40 bps=160 bps for the 10 yr agency
At least 150 bps-40 bps=110 bps for the 5 yr agency
QE2:
At least 17 bps-11 bps=6 bps for the 10 yr agency
At least 17 bps-16 bps=1 bps for the 5 yr agency

Same safety effect on Treasuries, but these are also affected by liquidity issues (more shortly), so not a good place to look to isolate the safety effect.

QE1 evidence for corporate bonds also consistent with a safety-effect for higher-grade corporate bonds. Aaa, Aa and A-rated bonds CDS-adjusted fall by about 75 bps, i.e. more than can be explained by signaling, and more than for lower-grade corporates.

Why couldn't non-investment grade bonds+CDS satisfy safety demand?

- Even with CDS protection these bonds are not close to riskless due to counterparty risk in CDS
- Also, you cannot post a bond+CDS as collateral.

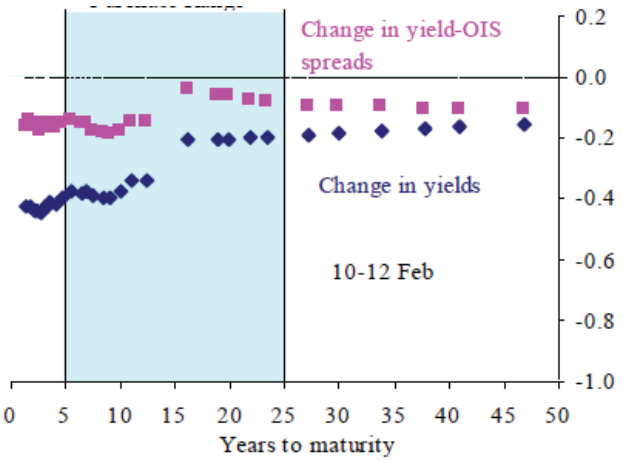
Digression: UK QE evidence provides evidence of safety effects even within an asset class

Two first QE event dates for the UK, from Joyce et al 2010:

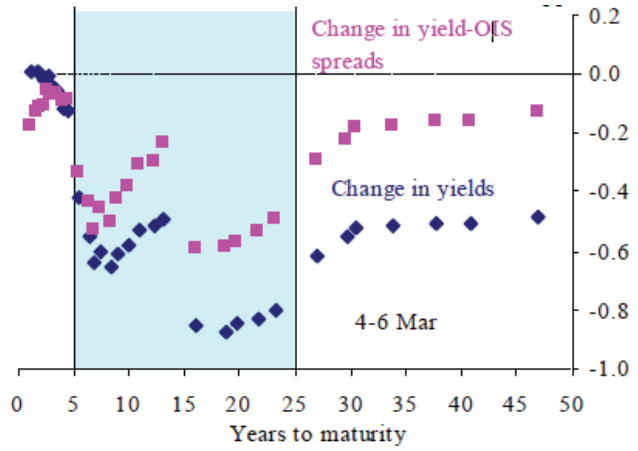
Table A: Key QE announcement dates

Announcement	*Decision on QE*	*Other information*
11 February 2009	February *Inflation Report* and the associated press conference gave strong indication that QE asset purchases were likely.	
5 March 2009	The MPC announced that it would purchase £75 billion of assets over three months funded by central bank reserves, with conventional bonds likely to constitute the majority of purchases. Gilt purchases were to be restricted to bonds with a residual maturity of between 5 and 25 years.	Bank Rate reduced from 1% to 0.5%.

Yield changes by maturity, Feb 10 to Feb 12:



Yield changes by maturity, Mar 4 to Mar 6:



(6) 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).
- Prediction: The liquidity effect raises yields on liquid assets

QE1: Strong liquidity effect

- Yields on Treasuries (more liquid) fall less than yields on agencies (less liquid). 10 yr Agency-Treasury spread falls 200-107=93 bps

QE2: No liquidity effect

- Yields on Treasuries and agencies fall the same.
- Plausible: Liquidity premia were quite low in late 2010 (almost same yields on 1-week and 3-month T-bills and on T-bills and Tier 1 CP). Reserves ↑ about $750B, T-bills ↑ about $290B from QE1 to QE2.

	Yield (basis points)	
Maturity	Treasury bill	Tier 1 nonfinancial commercial paper
1 week	13	20
1 month	15	19
3 month	15	27

(7) 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.

- **Important: If operative, this means that *real* rate declines were larger than *nominal* rate declines.**

- What nominal yield should be compared to TIPS? Something with the same safety-demand, so probably not Treasuries or agencies. We'll show results for Aaa corp and Baa corp (CDS-adjusted)

QE1, 2-day changes

Corporate yields, minus effect of CDS changes								
		Aaa	Aa	A	Baa	Ba	B	
Long		-70	-69	-61	-41	18	1311	
Intermediate		-82	-76	-59	-25	16	861	
Inflation swaps				TIPS real yields			Interest rate volatility	
30 yr	10 yr	5 yr	1 yr	20 yr	10 yr	5 yr		
35	96	38	41	-135	-187	-160		-38

QE2, 1-day changes

Corporate yields, minus effect of CDS changes								
		Aaa	Aa	A	Baa	Ba	B	
Long		-11	-8	-10	-9	-16	-15	
Intermediate		-13	-15	-15	-17	-13	-10	
Inflation swaps				TIPS real yields			Interest rate volatility	
30 yr	10 yr	5 yr	1 yr	30 yr	10 yr	5 yr		
11	5	3	-1	-20	-25	-22		-3

QE1: Expected inflation up by…

- Using inflation swaps: 35 to 96 bps.
- Using Aaa (CDS-adj)-TIPS:
  10-year: -70-(-187)=117 bps. 5-year: -82-(-160)=78 bps
- Using Baa (CDS-adj)-TIPS:
  10-year: -41-(-187)=146 bps. 5-year: -25-(-160)=135 bps.

QE2: Expected inflation up by…

- Using inflation swaps: -1 to 11 bps.
- Using Aaa (CDS-adj)-TIPS:
  10-year: -11-(-25)=14 bps. 5-year: -13-(-22)=9 bps
- Using Baa (CDS-adj)-TIPS:
  10-year: -9-(-25)=16 bps. 5-year: -17-(-22)=5 bps.

Inflation uncertainty: Implied vol from interest rate swaptions falls 38 bps in QE1 (avg. vol. over QE1 time period=104 bps), 3 bps in QE2.

Summary:

General channels:

Signaling channel (general channel):

- QE1: 20-40 bps at the 10 yr horizon, 30-40 bps at 5 yr horizon
- QE2: 7-11 bps at the 10 yr horizon, 11-16 bps at 5 yr horizon

Duration risk premium channel (general channel): Doesn't seem important

Inflation channel:

- QE1: 10-year expected inflation up 96-146 bps
- QE2: 10-year expected inflation up 5-16 bps

Specific channels:

Pre-payment risk premium channel: For MBS, but only for QE1

- QE1: At least 48 bps for the 15 yr MBS, 67 bps for the 30 yr MBS.
- QE2: Pre-payment risk premium channel is zero, as expected.

Default risk channel: For corporates, but only for QE1

- QE1: 7 bps (Aaa) to 78 bps (Ba)
- QE2: CDS rates go up!

Safety channel: For agencies and Treasuries

- QE1: At least 160 bps for the 10 yrs, 110 bps for the 5 yrs
- QE2: At least 6 bps for the 10 yrs, 1 bps for the 5 yrs

Liquidity channel: For Treasuries, but only for QE1

- QE1: 93 bps, pushing yields up
- QE2: No liquidity effect

Why is this useful for thinking about current/potential future ECB policies?

1) A key lesson is that **it matters what you buy**:

- The assets purchased move more in yield than those not purchased (across and within bond categories).
- While there are "general" channels (signaling, duration risk, inflation), the "specific" channels seem very important (MBS pre-payment risk, Treasury safety, default risk)
- MBS purchases in QE1 and QE3 and MEP (reinvestment part) crucial for lowering MBS rates and likely driver of lower corporate credit risk and thus corporate yields.
- Treasuries-only QE in QE2 had disproportional effect on Treasuries and agencies relative to MBS and corporates.

This highlights the potential of the ECB's ABS, covered bond and TLTRO policies for affecting private sector borrowing costs.

2) A second lesson is that **buying government bonds in calm times has limited effect on private sector yields beyond a signaling effect** (impact on perceived policy rate path), which might be achievable with forward guidance/have already been achieved with the guidance given.

This is perhaps consistent with the ECB's reluctance to do broad-based government bond QE in the current environment.

Is there room to signal? Less than pre-QE2 in the US.

- Euro forward rate at 5-year maturity: Around 1%.
- US forward rate at 5-year maturity pre-QE2 (August 2010): Around 3.3%

And default risk/risk premia are also quite small:

- Spain and Italy 10-year government yields about 120bps above bunds
- So some room for effects via lower sovr. default risk (and associated macro spillovers), but nothing like during the SMP/OMT/LTRO period.

What exactly do we mean by pre-payment risk effects for MBS?

An obvious one is **capital constraints for speculators**:

- MBS is a complex asset class: You need sophisticated pre-payment models.
- This limits who can invest (banks, dealers, asset managers).
- In the fall of 2008 many such investors had wealth losses.
- Suppose that a fraction of the MBS investors are in distress and have to sell off their assets. The remaining investors will have to absorb these sales with their limited capital. This drives prices down and risk premia (and thus yields) up.

This effect on MBS yields should be strong when capital among sophisticated investors is scarce.

This seems likely for QE1/QE2, but not MEP and QE3.

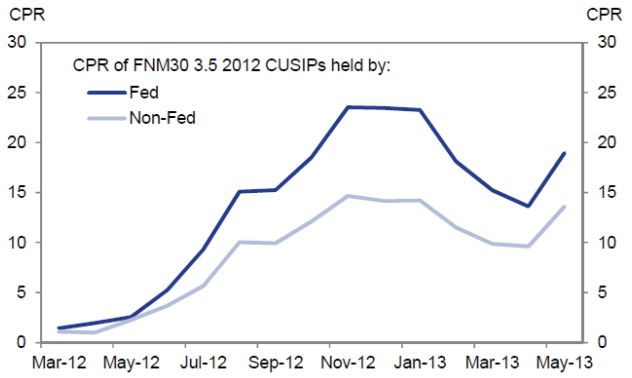
An additional channel could be **``MBS current-coupon scarcity''**:

- The Fed buys mainly the current coupon MBS (the one used to fund currently issued mortgages).
- This happens in what's called the ``to-be-announced'' (TBA) market (a forward market in which all securities sell at the same price, with the identity of exactly what's being delivered only revealed 48 hours before the settlement of the forward contract).
- Suppose originators sell the best (least-prepaying) mortgages in the TBA market and keep the rest.
- The more the Fed wants to buy, the better securities it will then have to attract into the TBA market. Thus the price in the TBA market goes up, and the yield goes down.

This seems more likely to be the right story for the MEP and QE3 (where markets had rebounded).

Here is a graph from Himmelberg, Young, Shan and Henson (2013) showing that mortgages purchased by the Fed are in fact worse than others from the same vintage:

Exhibit 3: Fed holdings prepay faster than comparable securities not held by the Fed
CPR of Fannie Mae 30-year 3.5% coupon 2012 vintage mortgages by Fed holding status

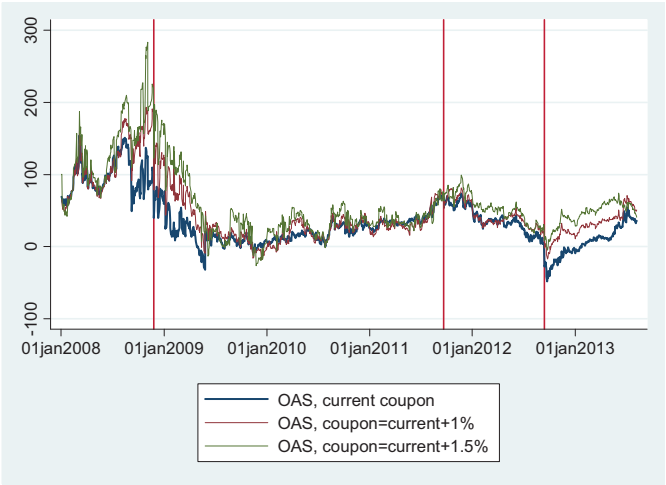


Can we test which MBS channel is more relevant when? Yes, to some extent.

- If capital constraints are important you'd expect:
  - All MBSs (current coupon or not) to have high risk premia, especially the ones with more pre-payment risk (non-current coupon).
  - And QE purchases should lower risk premia on all MBS.

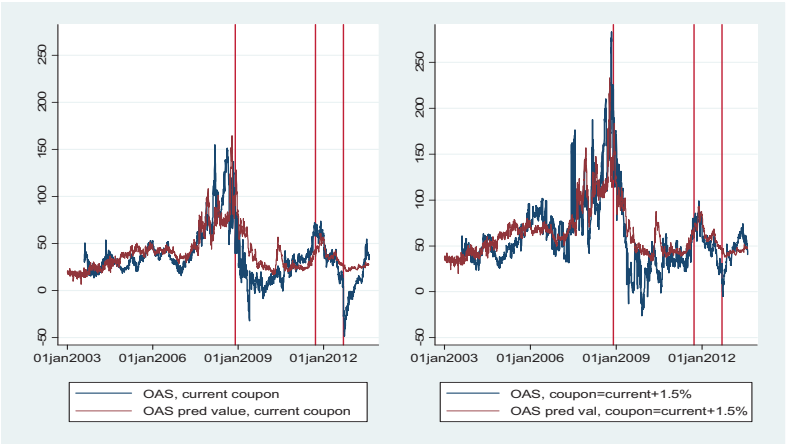
- If MBS current coupon scarcity is instead important, you'd expect:
  - MBS risk premia need not be very high.
  - QE purchases mainly lower risk premia for the current coupon MBS.

Evidence based on option-adjusted spreads, OAS (a measure of risk premia):

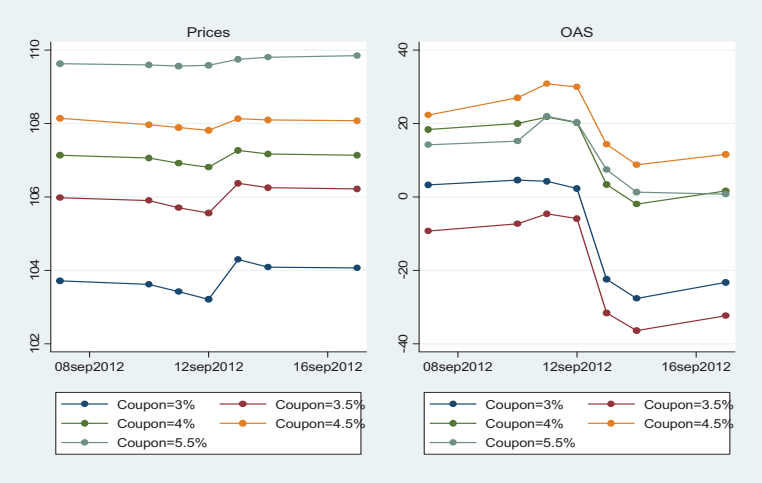


- Looks like our intuition for what mattered when holds up.

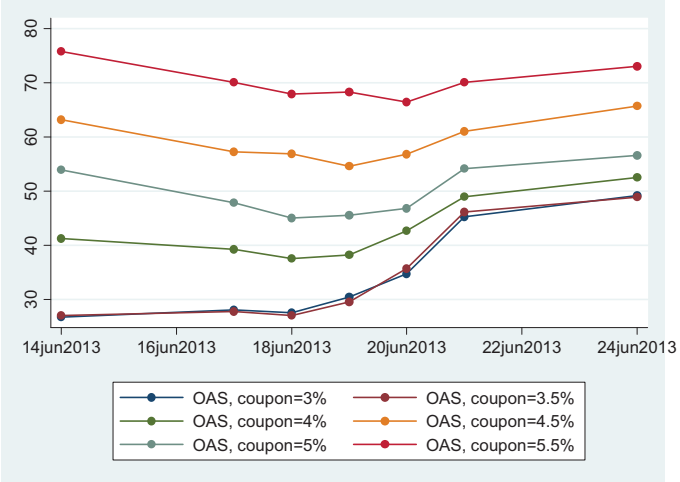
- OAS's (risk premia on MBS) tend to move with other risk premia. Comparing actual OASs to predicted values from OAS on (Interest rate swap-Treasury yield) show the MBS current coupon scarcity effects clearly for QE3.



- Here is a zoom-in on the period around the QE3 date (Sept 13, 2012):



- And here is a zoom-in on the period around the date Bernanke hinted at exit (June 19, 2013):



Why is this useful for thinking about current/potential future ECB policies?

3) A third lesson is that **buying private sector assets (MBS in the US) affects private sector yields in both crisis and calmer times, but the channels differ:**

- In crisis times, capital constraints and **reductions in risk premia appear central.**
- There is an additional **on the specific securities purchased, via a ``scarcity" effect**: By paying more for particular securities (those based on newly originated loans) you can get banks to sell them to you and (hopefully) get them to originate more.
  This effect is a large part of the impact **in calmer times.**

This suggests that:

Targeting stocks (buying already outstanding ABS) will work well if both:

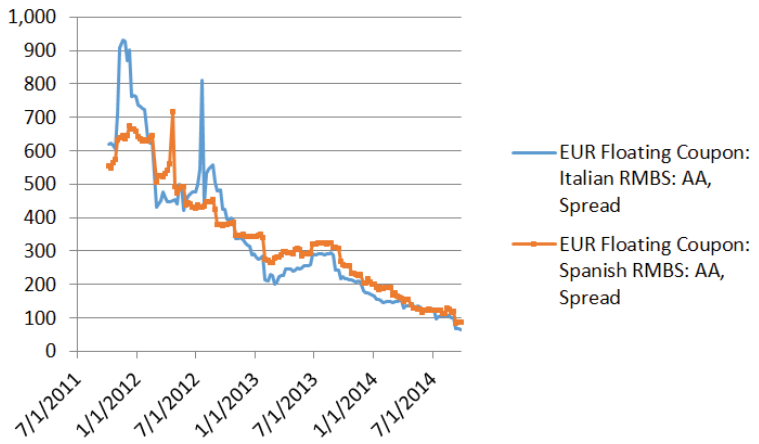
- Banks/insurance companies holding these are **using a lot of regulatory capital** on this to the detriment of new lending/investing.
- The ECB **buys ABS with high capital requirements**, i.e. less effect for buying safer tranches.

Targeting flows (buying newly issued ABS) may be particularly important for the ECB's current ABS and covered bond programs:

- **Even if the ECB doesn't buy the lower tranches**, if it's willing to pay more than others for the safer tranches that will still make it more profitable for banks to sell loans and, hopefully, originate more loans.

Are European ABS spreads currently suggesting that the capital constraints channel is large?

- I'm not the right person to assess this, but based on a few series from Barclays, spreads had already come down a lot prior to the June 2014 announcement of ABS purchases.



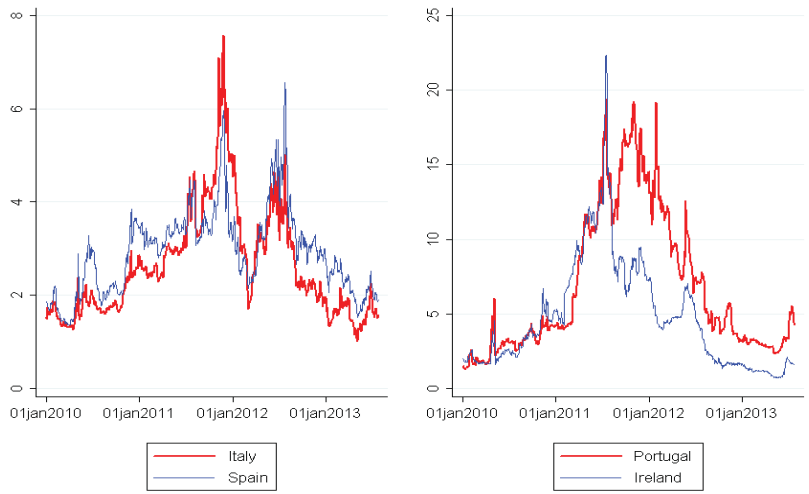
ECB POLICIES INVOLVING GOVERNMENT BOND PURCHASES: IMPACTS AND CHANNELS

(Krishnamurthy, Nagel and Vissing-Jorgensen, 2014 WP)

Objective

- During the European debt crisis GIIPS countries faced **large increases in govt. yields**.

Figure 1. 2-Year Government Bond Yields, Jan 2010 to July 2013



- ECB introduced **policies to help lower yields** by direct ECB government bond purchase or by lending to banks in expectation that they would buy govt. bonds.

Q1: **Did policies succeed** in lowering government bond yields?
Q2: **How** did the policies lower government bond yields?
Q3: Did policies have **positive spillovers** to the economies more broadly?

ECB policies involving government bond purchases (directly or indirectly via loans to banks)

Securities Markets Programme (SMP):

- May 10, 2010:

  ``In view of the current exceptional circumstances prevailing in the market, the Governing Council decided [….] To conduct interventions in the euro area public and private debt securities markets (Securities Markets Programme) to ensure depth and liquidity in those market segments which are dysfunctional. The objective of this programme is to address the malfunctioning of securities markets and restore an appropriate monetary policy transmission mechanism. ''

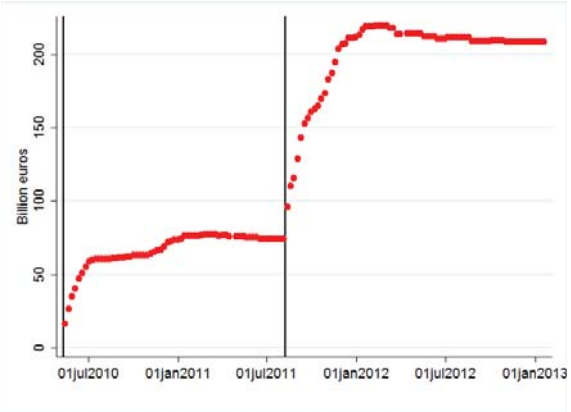
- Aug 7, 2011:

  ``The Governing Council of the European Central Bank (ECB) welcomes the announcements made by the governments of Italy and Spain concerning new measures and reforms in the areas of fiscal and structural policies.
  [….]
  It is on the basis of the above assessments that the ECB will actively implement its Securities Markets Programme. This programme has been designed to help restoring a better transmission of our monetary policy decisions – taking account of dysfunctional market segments – and therefore to ensure price stability in the euro area.''

- ``Dysfunction'' mentioned repeatedly. Sounds like ECB perceived problem to be some type of mispricing/market segmentation.

- Holdings of bonds purchased under the SMP peak **above 200 billion euros.**

Figure 2. ECB bond holdings under the Securities Markets Programme (SMP)



- Only government bonds were purchased.
- It's our understanding that up to 2nd announcement purchases were of Greece, Portugal, and Ireland bonds.

Outright Monetary Transactions (OMT): Replacement for the SMP, emphasizes conditionality

- July 26, 2012:
  Draghi statement at a conference that ``Within our mandate, the ECB is ready to do whatever it takes to preserve the euro. And believe me, it will be enough.''

- August 2, 2012 (ECB press conference):
  ``The Governing Council, within its mandate to maintain price stability over the medium term and in observance of its independence in determining monetary policy, may undertake outright open market operations of a size adequate to reach its objective. […] Furthermore, the Governing Council may consider undertaking further non-standard monetary policy measures according to what is required to repair monetary policy transmission. Over the coming weeks, we will design the appropriate modalities for such policy measures.''

- September 6, 2012: Details announced regarding the OMT:
  "Transactions will be focused on the shorter part of the yield curve, and in particular on sovereign bonds with a maturity of between one and three years."
  "No ex ante quantitative limits are set on the size of Outright Monetary Transactions."

- As of today, no bonds purchased yet under the OMT program.

- OMT was motivated by perceived redenomination risk:
  Draghi on OMT, Dec 6, 2012:
  "we said that the main aim of the OMT is to remove tail risk to overcome monetary and financial fragmentation of the euro area that would stem from a redenomination risk"

3-year Longer-Term Refinancing Operations (LTROs):

- **The ECB did not intend for banks to use the LTRO money to buy government bonds. But since they to some extent did, it's relevant to study this aspect of the LTRO in our context.**

- December 1, 2011: Draghi speech to the European Parliament

  "we are aware of the scarcity of eligible collateral" [for banks] and suggests that the "the most important thing for the ECB is to repair the credit channel."

  The Financial Times reports that markets interpreted the Draghi speech to indicate an expansion of SMP or a three-year LTRO.

- December 8, 2011: ECB announcement

  ``The Governing Council of the European Central Bank (ECB) has today decided on additional enhanced credit support measures to support bank lending and liquidity in the euro area money market. In particular, the Governing Council has decided:

  To conduct two longer-term refinancing operations (LTROs) with a maturity of 36 months and the option of early repayment after one year. ''

- Terms: Full allotment with realized loan rate=realized average MRO rate over loan period.

  New: The commitment to lend over a long period. The ECB had already in Oct 2008 moved to fixed rate full allotment for its regular lending operations.

- 1st allotment date (Dec. 21, 2011):
  335 billion euros borrowed (by banks, from the ECB)

- 2nd allotment date (Feb. 29, 2012)
  448 billion euros borrowed (by banks, from the ECB)

FT: (Dec 9, 2011)

French President Nicolas Sarkozy said the ECB's increased provision of funds meant governments in countries like Italy and Spain could look to their countries' banks to buy their bonds. "This means that each state can turn to its banks, which will have liquidity at their disposal," Sarkozy told reporters at the summit in Brussels.

WSJ: (Feb 29, 2012)

Quotes Intesa's Chairman Andrea Beltratti, "The new funds, which come with a 1% interest rate, will be used in part for a profitable trading strategy regarding Italian government bonds." He said the bank would mainly purchase Italian government bonds with maturities of three years or less, so that they match with the three-year duration of the ECB loans.''

- Estimate of amounts of sovereign bond purchases by banks using 3-year LTRO money: Around **86 billion euros for Italy, 66 billion euros for Spain**, not much (if any) for Ireland and Greece and no 2012 data to sort this out for Portugal.

Panel B. Changes in resident bank holdings of GIIPS sovr. bonds during period of 3-year LTRO loans, billion euros

	Residents, total	Resident Banks	Central Bank	Other Public Institutions	Other Resi-dents	Non-Residents	Total
			ITALY				
2010:Q1	735	224	62		449	774	1,509
2011:Q3	813	268	81		464	778	1,591
2011:Q4	883	265	89		528	722	1,605
2012:Q2	983	354	94		535	676	1,659
2012:Q2-2011:Q3	**170**	**86 billion: 5% of total**	**12**	**0**	**71**	**-102**	**68**
			SPAIN				
2010:Q1	306	142	16	54	94	260	566
2011:Q3	390	165	25	65	134	259	649
2011:Q4	427	197	28	63	139	245	672
2012:Q2	464	232	29	62	142	195	659
2012:Q2-2011:Q3	**74**	**66 billion: 10% of total**	**3**	**-3**	**8**	**-64**	**10**

	Residents, total	Resident Banks	Central Bank	Other Public Institutions	Other Resi-dents	Non-Residents	Total
			IRELAND				
2010:Q1	12	8		0	4	69	81
2011:Q3	18	15		1	2	71	90
2011:Q4	19	16		1	2	66	85
2012:Q2	22	20		1	2	61	83
2012:Q2-2011:Q3	**4**	**5 billion: 5% of total**	**0**	**0**	**-1**	**-10**	**-6**
			PORTUGAL				
2009	35	19	0		16	105	140
2010	58	35	1		22	103	161
2011	61	37	2		22	123	184
2012	69	41	1		27	135	205
2012-2010	11	**6 billion: 5% of total**	0		5	32	44
			GREECE				
2010:Q1	76	39	4	26	7	202	278
2011:Q3	62	33	4	16	9	93	155
2011:Q4	46	27	3	11	6	62	108
2012:Q2	25	13	6	5	2	39	64
2012:Q2-2011:Q3	**-37**	**-20 billion**	**1**	**-11**	**-7**	**-55**	**-91**

Sources: Bruegel database of sovereign bond holdings. Holdings are at principal values for Italy, Portugal and Ireland and at market values for Spain. For Greece they are market value up to 2012:Q1 and principal value after that.

Facts about policy impact

Event study approach: We will look at 2-day changes (end of day before to end of day after) in asset prices around these event dates.

Table 2. Impacts of policies on sovereign bond yields, by policy and country, 2-day changes

Policy	Ann. date	Avg. yield	6mo	2yr	5yr	10yr	Avg. yield	6mo	2yr	5yr	10yr
		ITALY					**SPAIN**				
SMP	May 10, 2010	**-47**	-15	**-80**	**-55**	**-31**	**-62**	ND	**-87**	**-75**	**-51**
	Aug 7, 2011	**-84**	-26	**-103**	**-107**	**-92**	**-92**	ND	**-115**	**-112**	**-98**
	Total	**-131**	-41	**-183**	**-162**	**-123**	**-154**	ND	**-202**	**-187**	**-149**
OMT	Jul 26, 2012	**-72**	**-48**	**-116**	**-77**	**-48**	**-89**	**-69**	**-113**	**-89**	**-63**
	Aug 2, 2012	-23	-30	**-64**	-29	11	**-41**	-37	**-98**	**-36**	12
	Sep 6, 2012	**-31**	-15	-21	**-42**	**-46**	**-54**	-7	-37	**-67**	**-78**
	Total	**-126**	**-93**	**-201**	**-148**	**-83**	**-184**	**-113**	**-248**	**-192**	**-129**
3-year LTROs	Dec 1, 2011	**-46**	-25	**-46**	**-69**	**-34**	**-61**	-19	**-79**	**-72**	**-58**
	Dec 8, 2011	**35**	10	30	**47**	**35**	30	36	28	34	32
	Total	-11	-15	-16	-22	1	-31	17	-51	-38	-26

Avg. yields are from Barclay's indices. 2, 5, and 10-year yields are mid-yields from Bloomberg. ND=No data.
Bold indicates significance at the 5% level.

Policy	Ann. date	Avg. yield	6mo	2yr	5yr	10yr	Avg. yield	6mo	2yr	5yr	10yr
		PORTUGAL					**IRELAND**				
SMP	May 10, 2010	**-219**	**-92**	**-378**	**-268**	**-176**	ND	ND	**-289**	ND	**-127**
	Aug 7, 2011	**-120**	0	**-172**	**-188**	-52	ND	ND	**-281**	**-102**	**-49**
	Total	**-339**	-92	**-550**	**-456**	**-228**	ND	ND	**-570**	ND	**-176**
OMT	Jul 26, 2012	ND	0	12	-3	-12	ND	ND	-57	-26	ND
	Aug 2, 2012	ND	-5	-21	-42	-8	ND	ND	-13	-7	ND
	Sep 6, 2012	ND	4	-65	**-107**	**-98**	ND	ND	5	-49	ND
	Total	ND	-1	-74	**-152**	**-118**	ND	ND	-65	-82	ND
3-year LTROs	Dec 1, 2011	ND	4	-30	-6	-3	ND	ND	-29	-27	-127
	Dec 8, 2011	ND	7	108	24	5	ND	ND	11	-2	-49
	Total	ND	11	78	18	2	ND	ND	-18	-29	ND

- Very large impacts of SMP and OMT on GIIPS sovereign bond yields. Small impacts of LTROs.

Policy	Ann. date	Avg. yield	6mo	2yr	5yr	10yr
				GREECE		
SMP	May 10, 2010	ND	**-430**	**-1123**	**-698**	**-500**
	Aug 7, 2011	ND	ND	93	8	-3
	Total	ND	ND	**-1030**	**-690**	**-503**
OMT	Jul 26, 2012	ND	ND	ND	ND	-78
	Aug 2, 2012	ND	ND	ND	ND	-67
	Sep 6, 2012	ND	ND	ND	ND	-36
	Total	ND	ND	ND	ND	-181
3-year LTROs	Dec 1, 2011	ND	ND	500	175	-147
	Dec 8, 2011	ND	ND	499	80	90
	Total	ND	ND	999	**255**	-57

Channels for policy impact on GIIPS government yields

$$r_T^c = \frac{1}{T}\int_0^T E[i_t]dt + TermPremium_T$$
$$+ P_{DEF,T}^c\left(1 - \lambda_{DEF,T}^c\right) + P_{RED,T}^c\left(1 - \lambda_{RED,T}^c\right) + SEG_T^c$$

Two **broad channels** that affects all euro countries the same:

1) **Signaling:** Announcements regarding ECB government bond purchases may be taken as a signal of a more accommodating stance of the ECB in general, including the future path of the policy rate
Was important for impact of US quantitative easing programs.

2) **Duration risk:** Removal of a fraction of the medium term bond supply may lower duration risk premia in general.

We treat these as **observable**, in sum, using changes in Euro swap rate (EONIA OIS).
$S_T^c = \frac{1}{T}\int_0^T E[i_t]dt + TermPremium_T$

Table 4. Impacts of policies on euro swap (EONIA OIS), 2-day changes

Policy	Ann. date	2yr	5yr	10yr
SMP	May 10, 2010	1	5	**15**
	Aug 7, 2011	**-21**	**-15**	**-16**
	Total	**-20**	-10	-1
OMT	Jul 26, 2012	-9	4	12
	Aug 2, 2012	4	6	5
	Sep 6, 2012	3	6	8
	Total	-2	16	**25**
3-year LTROs	Dec 1, 2011	-4	-5	-6
	Dec 8, 2011	-1	6	2
	Total	-5	1	-4

- Swap rates don't move much on policy dates. Thus the **signaling and duration risk channels are not substantial.**

Three more narrow channels: Default, redenomination, market segmentation

- Note that default and redenomination terms include both expected losses and risk premium effects.

3) **Default risk:** Bond purchases may lower default risk/default risk premia. Why?

a) **Multiple equilibria**: Policy may ``pick'' the good equilibrium
b) Could be a signal of **future fiscal transfers**
c) Any yield change via the **other channels** will lower borrowing costs and thus default risk.

4) **Redenomination risk:** Bond purchases may lower target countries' borrowing costs sufficiently to affect the risk that they will need to redenominate their currency, with this risk reduction feeding back into borrowing costs.

5) **Market segmentation:** Violations of standard pricing relations due to some people selling/buying and others not seeking to arbitrage away deviations. Policy may alleviate positive segmentation or cause negative segmentation.

(Safety and liquidity effects less relevant here and it's hard to study country-level inflation effects.)

We treat these three components as **latent variables**.

- Uncover through a Kalman filter.
- Focus on Italy, Spain, Portugal for data reasons.

Why use Kalman filtering? Illiquidity

- **Measurement error** likely
- Some yields may only **react with a lag** to underlying latent variables

First, the setup with measurement errors but no lags, then we'll add lags.

Observables:

- Vector y_t of various yields and CDS rates (domestic sovereign swap-rate adj. bond yield is first element)

Latent components: x_t. Follow 1st order (restricted and heteroscedastic) VAR.

$$x_t = a + Fx_{t-1} + u_t, \quad u_t = Q_t^{1/2}\varepsilon_t$$

- *F*: Diagonal matrix
- ε_t: Vector of mutually uncorrelated standard normal disturbances
- $Q_t = Qy_{1,t-1}$, i.e., cond. variances and covariances are proportional to domestic bond yield (see, e.g. Feldhütter and Lando (2008) for a related specification).

Relation between observables and latent variables:

- Observed yields and CDS rates are linear combinations of the latent components plus heteroscedastic measurement error

$$y_t = Hx_t + w_t, \quad w_t = V_t^{1/2}\eta_t$$

H: Known matrix
η_t: Vector of mutually uncorrelated standard normal disturbances
$V_t = Vy_{1,t-1}$ with diagonal *V*.

Adding lags: Allowing for lags allows us to **effectively adjust the event window** to a greater width depending on the degree to which an asset is prone to delayed reaction.

- State vector is expanded to include *q* lags of the latent components in addition to the *k* unobservable components that we are interested in extracting:

$$\begin{pmatrix} x_t \\ x_{t-1} \\ \vdots \\ x_{t-q} \end{pmatrix} = \begin{pmatrix} a \\ 0_{k\times 1} \\ \vdots \\ 0_{k\times 1} \end{pmatrix} + \begin{pmatrix} F & 0_{k\times k(q-1)} & 0_{k\times k} \\ & I_{kq\times kq} & 0_{kq\times k} \end{pmatrix} \begin{pmatrix} x_{t-1} \\ x_{t-2} \\ \vdots \\ x_{t-q-1} \end{pmatrix} + \begin{pmatrix} u_t \\ 0_{k\times 1} \\ \vdots \\ 0_{k\times 1} \end{pmatrix},$$

with *F* and *u* as before.

- Observation equation is now specified as

$$y_t = \begin{pmatrix} L_1 \otimes H_1 \\ L_2 \otimes H_2 \\ \vdots \\ L_k \otimes H_k \end{pmatrix} \begin{pmatrix} x_t \\ x_{t-1} \\ \vdots \\ x_{t-q} \end{pmatrix} + w_t,$$

L_i are row vectors, (1, g_i, sgn(g_i)$|g_i|^2$,… , sgn(g_i)$|g_i|^q$), that contain geometrically decaying weights, truncated after lag *q*, rescaled so that elements sum to one.

- The degree of reaction delay is the same for each unobserved component, but it is allowed to differ across assets.

Identification is about the elements of *y* and the matrix *H*.

Table 2. Identification of default, redenomination and domestic sovereign segm.
Panel A. The basic idea (y and H)

	Sovereign default	Redeno-mination	Domestic sovereign segmentation
Sovereign EUR Yield – Swap	1	1	1
Sovereign USD Yield - USD Swap	1	0	0
A measure of redenomination risk from corporate non-financial bonds	0	1	0

- ***Foreign-law sovereign bonds cannot be redenominated*** → Sov. USD Yield-USD Swap identifies default component of sovereign bond yield.

- ***Redenomination affects all securities issued in a given country under the country's local law equally*** → Can use euro-denominated local-law corporate bonds (or loans) to identify redenomination risk.

- Sov. EUR yield-swap then identifies Domestic sovereign segmentation.

Important:

1) **We assume that domestic law and foreign law sovereign bonds have the same amount of default risk**
   - Reinhart and Rogoff (2011): In post WWII period up to 2010 no clear pattern in terms of whether foreign debt or domestic debt holders do better in terms of incidence of default.
   - In Greek default: Same loss imposed on local and foreign bonds, although some holders of foreign-law debt who did not participate in the restructuring were eventually paid in full (Zettelmeyer, Trebesch and Gulati 2013).

2) **We assume the USD bonds do not load on the sovereign segmentation**
   - ECB only purchased EUR bonds so it is crucial to allow for purchases to potentially cause negative segmentation of EUR bonds.

3) **We don't use sovereign CDS to measure default**
   - Issues in Fall 2011/Winter 2012 of whether CDS would be triggered
   - ECB purchases may distort CDS rates so they don't reflect true default risk but hard to assess magnitude of any such distortion.

Identification of redenomination differs between Italy and non-Italy countries.

- We **need to use corporate CDS rates** since we cannot find EUR-USD matches for corporate non-financials.

- ISDA Master Agreement for CDS contracts:
  CDS contracts must pay if there is …. ``any change in the currency or composition of any payment of interest or principal to any currency which is not a Permitted Currency. …. ``Permitted currency'' means (1) the legal tender of any Group of 7 country….or (2) the legal tender of any country which ….has a local currency long-term debt rating of either Aaa or higher…''

- **Italy is G7. Therefore, for Italy, CDS contracts don't cover redenomination.**
  This was also the common perception in the market.

Panel B. Baseline implementation (method (i))

	Sovereign default	Corporate default	Redeno-mination	Dom. sovereign segmentation
ITALY				
Sovereign EUR Yield-EUR Swap	1	0	1	1
Sovereign USD Yield-USD Swap	1	0	0	0
ENI EUR Yield-EUR Swap	0	1	1	0
ENI CDS Rate	0	1	0	0
SPAIN				
Sovereign EUR Yield-EUR Swap	1	0	1	1
Sovereign USD Yield - USD Swap	1	0	0	0
Telefonica USD Yield - USD Swap	0	1	0	0
Telefonica CDS Rate	0	1	1	0
PORTUGAL				
Sovereign EUR Yield-EUR Swap	1	0	1	1
Sovereign USD Yield - USD Swap	1	0	0	0
EDP GBP Yield - GBP Swap	0	1	0	0
EDP CDS Rate	0	1	1	0

Notice that:

1) Spain/Portugal: We checked that the corporations on which the CDS contracts are written (Telefonica and EDP) have euro-denominated local debt (bonds/loans).

2) There are other components to CDS-bond basis than redenomination (e.g. Bai and Dufresne (2011)).

   - CDS is "too low" in crisis", so baseline approach will overestimate redenomination risk *level* for Italy and underestimate it for Spain/Portugal
   - CDS-bond basis may change on ECB announcement days for reasons unrelated to ECB announcements and in ways not fully understood.

   ➔ Alternative approach: Use the yield on a euro-denominated local law bond or, for Spain and Portugal, the CDS rate of a reasonably safe corporation as upper bound on redenomination risk.

Panel C. Alternative implementation (method (ii))

	Sovereign default	Corporate default	Redeno-mination	Domestic sovereign segmentation
	ITALY			
Sovereign EUR Yield-EUR Swap	1	0	1	1
Sovereign USD Yield - USD Swap	1	0	0	0
ENI EUR Yield-EUR Swap	0	0	1	0
	SPAIN			
Sovereign EUR Yield-EUR Swap	1	0	1	1
Sovereign USD Yield - USD Swap	1	0	0	0
Endesa CDS	0	0	1	0
	PORTUGAL			
Sovereign EUR Yield-EUR Swap	1	0	1	1
Sovereign USD Yield - USD Swap	1	0	0	0
EDP CDS	0	0	1	0

We also consider a robustness check with separate segmentation component for USD bonds

- E.g. due to tax effects, clienteles, or illiquidity (illiquidity premium could change on ECB announcement dates).
- Assume this comp is shared between sovereign USD and corporate USD bonds.

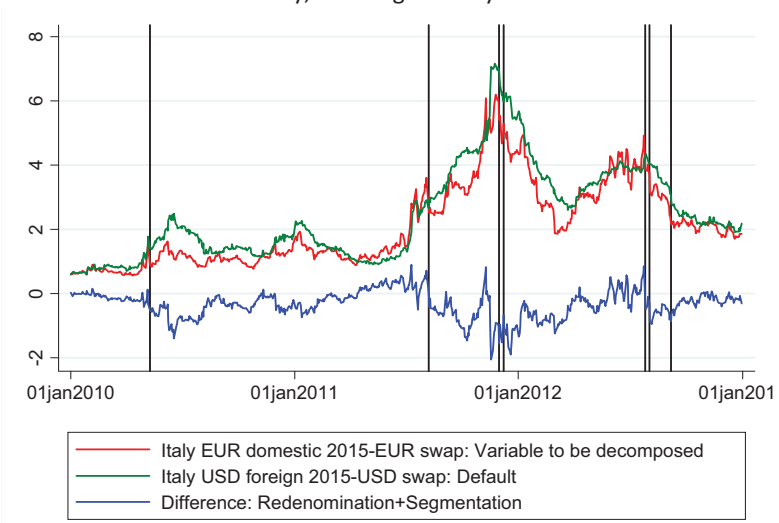
Panel D. Robustness check allowing for foreign segmentation (method (iii))

	Sov. Default	Corp. Default	Redenom.	Domestic Sov. Seg.	Foreign Mkt. Seg.
	ITALY				
Sovereign EUR Yield-EUR Swap	1	0	1	1	0
Sovereign USD Yield - USD Swap	1	0	0	0	1
ENI Yield - Swap	0	1	1	0	0
ENI USD Yield – USD Swap	0	1	0	0	1
ENI CDS Rate	0	1	0	0	0
	SPAIN				
Sovereign EUR Yield-EUR Swap	1	0	1	1	0
Sovereign USD Yield - USD Swap	1	0	0	0	1
Telefonica USD Yield - USD Swap	0	1	0	0	1
Telefonica CDS Rate	0	1	1	0	0
Endesa CDS Rate	0	0	1	0	0
	PORTUGAL				
Sovereign EUR Yield-EUR Swap	1	0	1	1	0
Sovereign USD Yield - USD Swap	1	0	0	0	1
EDP GBP Yield - GBP Swap	0	0	0	0	1
EDP CDS Rate	0	0	1	0	0

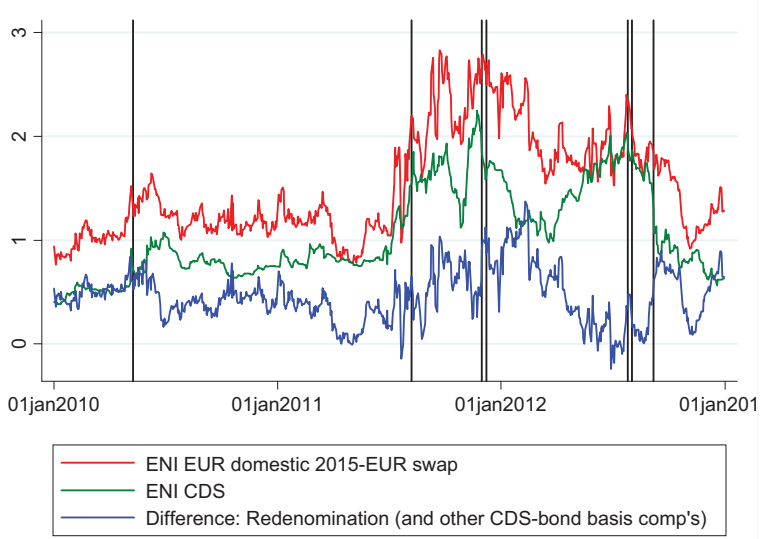
ITALY

Figure 3. Bond yield decomposition for Italy

A. Italy, sovereign bond yields



B. Italy, corporate non-financial bond yields and CDS



C. Italy, Kalman filtering results (baseline)

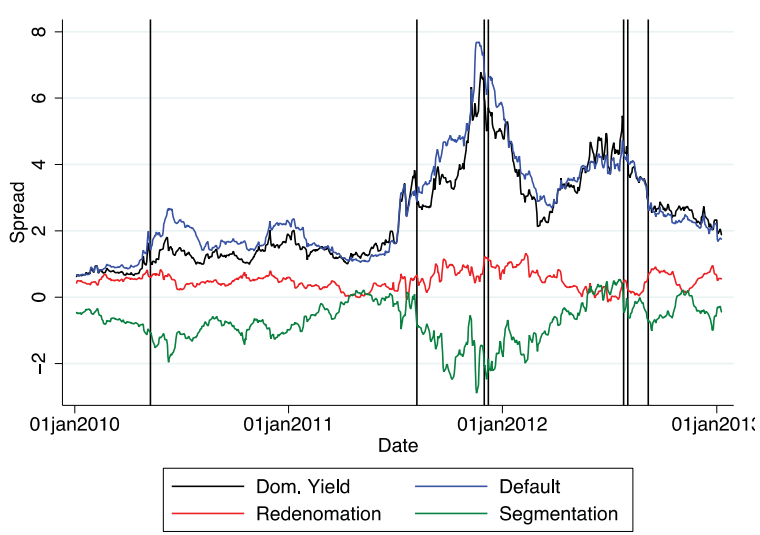


Table 6. Latent yield components, 2-day changes (bps)

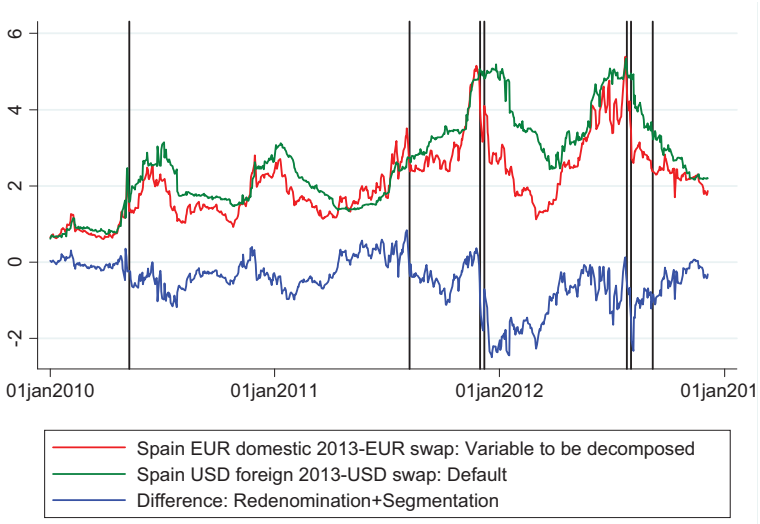
		ITALY								
		Default risk			Redenomination Risk			Domestic Sovereign Segmentation		
Policy	Ann. date	(i)	(ii)	(iii)	(i)	(ii)	(iii)	(i)	(ii)	(iii)
SMP	May 10, 2010	**-53**	**-47**	**-43**	-3	**-27**	-4	-9	9	-17
	Aug 7, 2011	-14	-14	-4	-2	3	-6	**-75**	**-80**	**-80**
	Total	**-67**	-61	**-47**	-5	-24	-10	**-84**	**-71**	**-97**
OMT	Jul 26, 2012	**-45**	**-44**	**-47**	9	-16	7	**-61**	**-37**	**-55**
	Aug 2, 2012	**-8**	-11	-16	-9	-13	-10	**-47**	**-41**	**-40**
	Sep 6, 2012	**-42**	**-32**	**-61**	15	-19	14	-7	17	13
	Total	**-96**	**-88**	**-124**	15	**-48**	11	**-114**	**-60**	**-81**
3-yr	Dec 1, 2011	**-54**	**-55**	**-51**	**27**	12	**24**	**-36**	-19	**-36**
LTROs	Dec 8, 2011	35	34	19	-9	4	-6	12	0	23
	Total	-19	-22	-32	18	16	18	**-24**	-19	-13

- SMP, OMT: Large effects on default risk and domestic sovereign segmentation. Little effect on redenomination (method ii is the upper bound).
- LTROs have little effect on any components.

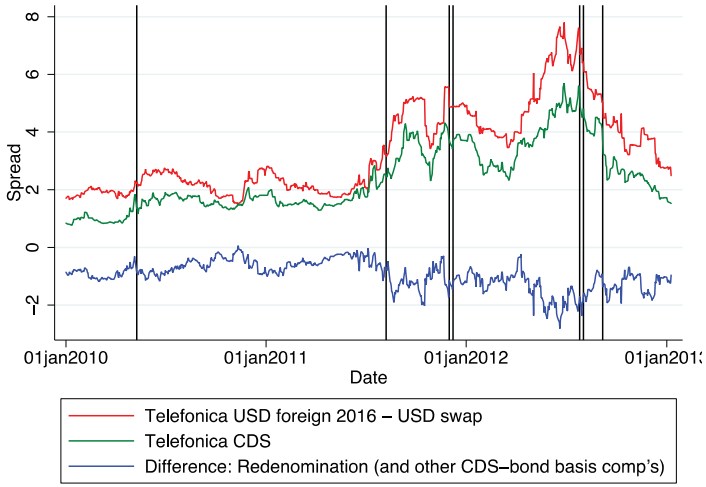
SPAIN

Figure 4. Bond yield decomposition for Spain.

A. Spain, sovereign bond yields



B. Spain, corporate non-financial bond yields and CDS



C. Spain, Kalman filtering results (baseline)

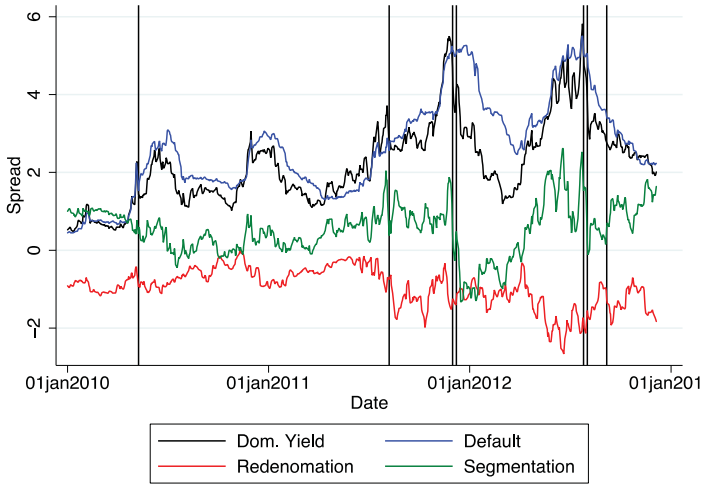


Table 6. Latent yield components, 2-day changes (bps)

		SPAIN								
		Default risk			Redenomination Risk			Domestic Sovereign Segmentation		
Policy	Ann. date	(i)	(ii)	(iii)	(i)	(ii)	(iii)	(i)	(ii)	(iii)
SMP	May 10, 2010	**-39**	**-41**	**-35**	**-29**	**-37**	**-35**	-18	-8	-17
	Aug 7, 2011	-18	-16	-12	-1	-5	-4	**-71**	**-68**	**-74**
	Total	**-56**	**-58**	**-47**	-31	**-41**	**-39**	**-89**	**-76**	**-91**
OMT	Jul 26, 2012	**-36**	**-34**	**-38**	-25	-17	**-22**	-24	**-34**	-27
	Aug 2, 2012	**-36**	**-35**	-18	6	-7	-6	**-89**	**-77**	**-94**
	Sep 6, 2012	-14	-13	-26	**-33**	**-19**	**-26**	38	22	**43**
	Total	**-86**	**-82**	**-82**	**-53**	**-43**	**-54**	**-75**	**-89**	**-78**
3-yr	Dec 1, 2011	-13	-11	15	18	-7	-5	**-112**	**-90**	**-117**
LTROs	Dec 8, 2011	9	9	21	**30**	16	**20**	-10	3	-12
	Total	-4	-2	35	**47**	9	15	**-123**	**-88**	**-128**

- A bit more role for redenomination risk as a channel for SMP, OMT.
  But still smallest of the 3 channels
- Substantial effect of LTROs via domestic sovereign segmentation. Consistent with larger purchases by Spanish banks as pct. of Spanish government bond total.

- Domestic sovereign segmentation effects:

  Potentially consistent with the ECB stating "dysfunctional'' markets as a central motivation for the SMP

  But the fact that the market segmentation component turns negative could indicate that the ECB policies lead to a "negative" segmentation effect:
  Domestic yields temporarily depressed due to "excess demand" for domestic bonds from the ECB or domestic banks.

PORTUGAL

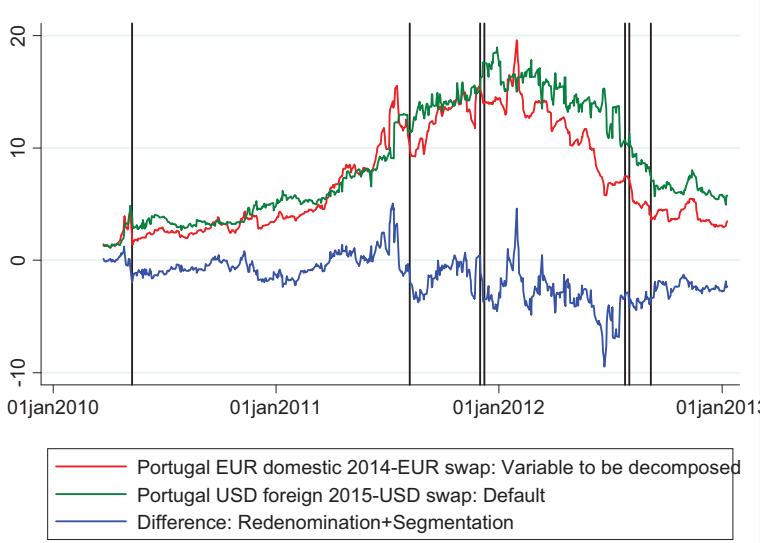
Table 6. Latent yield components, 2-day changes (bps)

PORTUGAL										
		Default risk			Redenomination Risk			Domestic Sovereign Segmentation		
Policy	Ann. date	(i)	(ii)	(iii)	(i)	(ii)	(iii)	(i)	(ii)	(iii)
SMP	May 10, 2010	**-96**	**-77**	**-65**	**-82**	**-93**	**-113**	**-112**	-41	**-112**
	Aug 7, 2011	9	5	**-64**	**-84**	-19	-10	-41	**-92**	-41
	Total	**-87**	**-72**	**-130**	**-165**	**-112**	**-122**	**-153**	**-133**	**-153**
OMT	Jul 26, 2012	-35	-30	4	-23	-58	**-63**	35	72	35
	Aug 2, 2012	-13	-11	19	9	-19	-23	-36	-16	-36
	Sep 6, 2012	**-100**	**-90**	-33	9	-48	**-58**	-1	68	-1
	Total	**-148**	**-130**	-10	-5	**-125**	**-144**	-2	124	-1
3-yr	Dec 1, 2011	-34	-25	-18	-4	-12	-21	-32	-25	-32
LTROs	Dec 8, 2011	44	32	32	**50**	57	**62**	36	1	36
	Total	10	7	14	46	46	41	4	-23	4

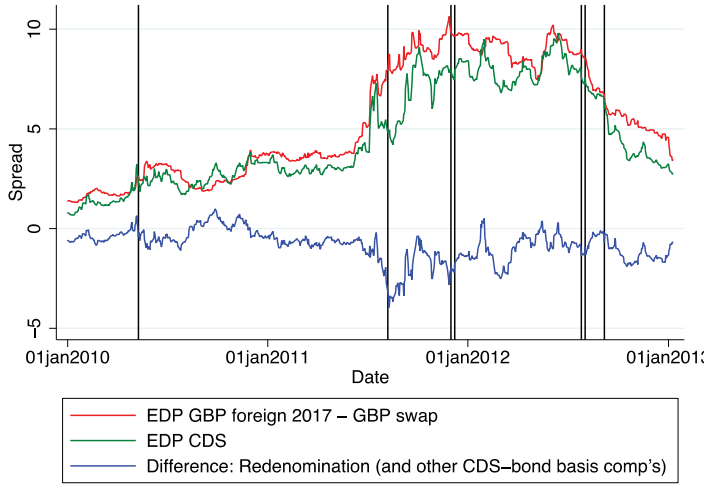
- SMP, OMT: Large effects on default risk and domestic sovereign segmentation. Substantial role for redenomination risk, especially for the SMP.
- LTROs have little effect on any components.

Figure 5. Bond yield decomposition for Portugal

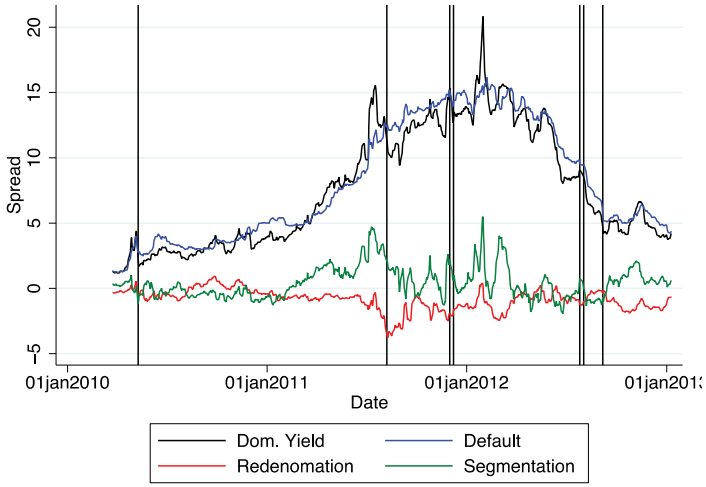
A. Portugal, sovereign bond yields



B. Portugal, corporate non-financial bond yields and CDS



C. Portugal, Kalman filtering results (baseline)



Summary of results on channels:

$$r_T^C = \frac{1}{T}\int_0^T E[i_t]dt + TermPremium_T$$
$$+ P_{DEF,T}^C\left(1 - \lambda_{DEF,T}^C\right) + P_{RED,T}^C\left(1 - \lambda_{RED,T}^C\right) + SEG_T^C$$

- **Little impact on signaling and term premium term**.
- **Reduced default risk**, **sovereign bond segmentation**: **Dominant channels** for SMP and the OMT to affect sovereign bond yields of Italy and Spain
- **Reduced redenomination risk**: May have been a third policy channel for the SMP and OMT for Spain and Portugal, but **not for Italy**.
- Effects of the **LTROs on sovereign yields generally small except for Spain**. LTROs appear to have reduced sov. yields via the market segmentation channel.

What about broader policy effects and welfare effects?

Table 7. Impact of ECB policies on stock market values. 2-day returns

Panel A. All stocks

			GIIPS			
Policy	Ann. date	Italy	Spain	Portugal	Ireland	Greece
SMP	May 10, 2010	**10.64**	**11.31**	**8.40**	**8.45**	6.65
	Aug 7, 2011	-1.96	-2.56	**-3.99**	-0.25	-6.41
	Total	**8.68**	**8.75**	4.41	**8.20**	0.24
OMT	Jul 26, 2012	**8.85**	**10.75**	**5.00**	3.14	-0.38
	Aug 2, 2012	1.80	0.61	0.00	0.66	-0.09
	Sep 6, 2012	**6.55**	**5.55**	**5.30**	2.55	-1.14
	Total	**17.20**	**16.91**	**10.30**	6.35	-1.61
3-year	Dec 1, 2011	1.20	1.41	0.88	-0.87	1.13
LTROs	Dec 8, 2011	-0.96	0.07	-1.20	-2.12	-1.66
	Total	0.24	1.48	-0.32	-2.99	-0.53

Source: MSCI indices from Bloomberg. Non-financial indices calculated by us based on total country indices and financial indices. ND=no data. Bold indicates significance at the 5% level.

		Core						EMU
Policy	Ann. date	Ger-many	France	Nether-lands	Bel-gium	Austria	Finland	
SMP	May 10, 2010	**5.73**	**8.52**	**7.21**	**8.32**	**8.44**	**6.05**	**8.25**
	Aug 7, 2011	**-5.00**	-3.18	**-3.49**	-1.61	**-6.26**	0.34	-3.44
	Total	0.73	5.34	3.72	**6.71**	2.18	**6.39**	4.81
OMT	Jul 26, 2012	**4.29**	**6.06**	**4.34**	**4.19**	**5.01**	**5.51**	**5.81**
	Aug 2, 2012	1.62	1.55	0.84	0.70	0.61	0.63	1.35
	Sep 6, 2012	3.51	3.22	2.44	1.42	4.59	4.19	3.75
	Total	**9.42**	**10.83**	**7.62**	**6.31**	**10.21**	**10.33**	**10.91**
3-year	Dec 1, 2011	-0.12	0.26	0.25	0.33	0.59	-1.33	0.31
LTROs	Dec 8, 2011	-0.25	-0.28	-0.04	-0.79	-1.43	-2.23	-0.38
	Total	-0.37	-0.02	0.21	-0.46	-0.84	-3.56	-0.07

- Large impact of the SMP and OMT on stocks, not much impact of LTROs.

Panel B. Financial sector stocks

		GIIPS				
Policy	Ann. date	Italy	Spain	Portugal	Ireland	Greece
SMP	Total	**15.41**	**16.01**	**11.18**	ND	4.80
OMT	Total	**22.43**	**22.96**	**18.69**	ND	ND
3-yr LTROs	Total	1.57	2.85	**14.18**	ND	-4.82

Panel C. Non-financial sector stocks

		GIIPS				
Policy	Ann. date	Italy	Spain	Portugal	Ireland	Greece
SMP	Total	**6.50**	5.22	3.98	**8.22**	ND
OMT	Total	**16.17**	**14.65**	**10.11**	6.56	ND
3-yr LTROs	Total	-0.08	0.95	-0.69	-3.09	ND

- Financial sector stocks did the best, but even non-financial stock returns are high for the SMP and OMT event dates. Suggests spillovers of policies into the broader economy.

Panel B. Financial sector stocks

		Core					
Policy	Ann. date	Germany	France	Netherlands	Belgium	Austria	Finland
SMP	Total	3.79	**13.56**	**13.11**	**13.37**	3.62	**8.41**
OMT	Total	**13.99**	**19.27**	**17.74**	**11.47**	**13.72**	**8.75**
3-yr LTROs	Total	2.27	2.27	1.82	2.55	0.68	0.31

Panel C. Non-financial sector stocks

		Core					
Policy	Ann. date	Germany	France	Netherlands	Belgium	Austria	Finland
SMP	Total	0.22	3.85	2.24	**5.18**	0.98	6.11
OMT	Total	**8.83**	**9.66**	**6.15**	**5.64**	**7.60**	**10.85**
3-yr LTROs	Total	-0.73	-0.33	-0.05	-0.86	-1.62	-4.42

Table 8. How much of bank stock returns can be explained by gains on GIIPS sovereign bond holdings? 2-day returns

			GIIPS					Core					
Policy	Ann. date		Italy	Spain	Portugal	Ireland	Greece	Ger-many	France	Nether-lands	Bel-gium	Austria	Fin-land
			Market-capitalization weighted average bank stock return										
SMP	Total	Actual	15.9	10.5	9.9	19.5	10.9	3.7	13.4	11.1	14.4	-0.9	-1.4
		Implied	5.5	2.0	19.5	4.3	53.7	15.5	5.8	1.6	41.7	0.0	0.0
OMT	Total	Actual	22.5	24.2	18.1	4.7	6.1	20.8	26.5	19.9	18.4	14.5	10.4
		Implied	6.5	1.9	13.4	0.3	7.8	8.9	4.3	1.6	49.6	0.0	0.0
3-yr LTROs	Total	Actual	-2.3	3.1	6.9	4.9	-0.5	3.9	3.4	2.3	13.0	-5.5	0.8
		Implied	0.3	0.4	-3.5	0.1	-5.7	1.1	0.2	0.2	13.5	0.0	0.0

Note: The table is based on banks that both provided data to the EBA's 2011 stress tests and were publicly traded on the particular event date. The number of banks varies between 34 and 37 across event dates. We calculate implied stock returns based on reported holdings of each of the GIIPS countries' sovereign bonds by maturity bucket, along with our documented yield changes by maturity from Table 2.

- For many countries, **only a small fraction of the large financial sector returns** can be explained by the increase in market value of GIIPS sovereign bonds held by financial institutions. Exceptions are Portugal, Greece, Germany and Belgium.

- In the sample of banks and event dates, the implied return has little explanatory power for actual returns. Instead, **returns are much better explained by the bank's Beta** on the Eurostoxx index (SXXT, a fairly broad index with about 300 firms included) multiplied by the realized 2-day return on this index around the particular event date.
- Thus, financial sector stock returns are more likely to be driven by a **more general macro impact of policies**. This is consistent with even non-financial stocks going up.

Table 9. Impacts of policies on corporate bond yields, by policy and country, 2-day changes

Policy	Ann. date	Italy	Spain	Portugal	Ireland	Greece
SMP	May 10, 2010	-3	-16	**-43**	ND	ND
	Aug 7, 2011	15	16	-20	ND	ND
	Total	12	0	**-63**	ND	ND
OMT	Jul 26, 2012	-4	**-26**	ND	ND	ND
	Aug 2, 2012	-6	-7	ND	ND	ND
	Sep 6, 2012	**-30**	**-58**	ND	ND	ND
	Total	**-40**	**-91**	ND	ND	ND
3-year LTROs	Dec 1, 2011	**-40**	**-30**	-35	ND	ND
	Dec 8, 2011	12	7	28	ND	ND
	Total	-28	-23	-7	ND	ND

Source: Barclay's corporate bond indices obtained from Datastream. Average corporate bond durations are around 4 years for Italy, Spain and Portugal.

- Some spillovers to corporate bonds, but much smaller effects than for sovereigns.

So let's try to do a few simple calculations on potential **welfare effects of SMP, OMT** via impacts on sovereign bonds and stock markets.

Table 10. Increase in total market value of GIIPS sovereign bonds and EMU stocks on SMP and OMT event dates, 2-day changes

	Italy		Spain		Portugal		Ireland		Greece		GIIPS total		EMU
	Stocks	Govt Bonds	Stocks	Govt Bonds	Stocks	Govt Bonds	Stocks	Govt Bonds	Stocks	Govt Bonds	Stocks	Govt Bonds	Stocks
SMP	34.9	54.5	36.8	44.1	2.3	14.4	3.8	9.9	1.2	40.2	79.1	163.1	200.2
OMT	56.7	52.9	57.1	31.5	4.1	2.2	2.8	0.1	-0.4	1.4	120.3	88.1	549.8
Total	91.6	107.4	93.9	75.6	6.4	16.6	6.6	10.0	0.9	41.6	199.4	**251.2**	**749.9**

Policy benefits: At least €917B based on market value increase in GIIPS govt bonds and EMU stocks

- Some double counting via a fraction f of GIIPS sovereign bonds owned by GIIPS or core publicly traded banks:
  We adjust for this using data for f from Bruege/EBA stress test. f is around 1/3.

  Overall market value increase: **(1- f)*€251 billion + €750 billion=€917 billion**.

  Add to this any market value changes for corporate debt and non-publicly traded firms, along with wage gains via reduced economic contraction.

Policy cost to ECB/Taxpayers: At most €251B

- If the fundamental problem is solvency risk:
  - Upper bound on cost (from ECB ``over-paying'' for the bonds or decisions being perceived as signal about future fiscal transfers from core countries):
    The increase in market value of GIIPS govt debt, which was **€251B.**

- If underlying problem is multiple equilibria or market segmentation:
  - Zero for OMT (they won't need to buy if they are credible)
  - <0 for SMP, as ECB makes a profit on purchases

Qualifiers to this large net welfare benefit:

- We're not accounting for any potential subsidy to **future** debt (i.e. debt not currently issued).
- We're not assessing **distributional impact** (but remember that even German stocks went up…).