Internet Appendix for:

Non-Monetary News in Central Bank Communication

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Table IA-1. Summary of high-frequency data

Futures type	Futures name	Exchange	Time zone	TickData symbol	BBG symbol
A. Federal Reserve; sample start: Sep 30, 1997					
Equity	S&P 500 E-Mini Futures	CME Group	America – Chicago	ES	ES1 Index
Interest rate	Eurodollar Futures CME	CME Group	America – Chicago	ED	ED1 Comdty
Interest rate	US 5-Year T-Note Futures	Chicago Board of Trade	America – Chicago	FV	FV1 Comdty
Interest rate	US 2-Year T-Note Futures	Chicago Board of Trade	America – Chicago	TU	TU1 Comdty
Interest rate	US 10-Year T-Note Futures	Chicago Board of Trade	America – Chicago	TY	TY1 Comdty
Interest rate	US 30-Year T-Bond Futures	Chicago Board of Trade	America – Chicago	US	US1 Comdty
B. ECB; sample start: Jun 9, 1997					
Equity	DAX Index Futures	Eurex	Europe – Berlin	DA	GX1 Index
Interest rate	Euribor 3-Month Futures	ICE Futures Europe Financials	Europe – London	UR	ER1 Comdty
Interest rate	Euro-Schatz 2-Year Futures	Eurex	Europe – Berlin	BZ	DU1 Comdty
Interest rate	Euro-Bobl 5-Year Futures	Eurex	Europe – Berlin	BL	OE1 Comdty
Interest rate	Euro-Bund 10-Year Futures	Eurex	Europe – Berlin	BN	RX1 Comdty
C. BOE; sample start: Jul 9, 1998					
Equity	FTSE 100 Index Futures	ICE Futures Europe Financials	Europe – London	FT	Z 1 Index
Interest rate	Sterling 3-Month Futures	ICE Futures Europe Financials	Europe – London	ST	L 1 Comdty
Interest rate	Long Gilt Futures	ICE Futures Europe Financials	Europe – London	GL	G 1 Comdty
D. BOJ; sample start: Jul 15, 2003					
Equity	TOPIX Futures JPX	Osaka Exchange	Asia – Tokyo	TP	TP1 Index
Interest rate	Japanese 10-Year Bond Futures JPX	Osaka Exchange	Asia – Tokyo	JB	JB1 Comdty

A. Asset price responses to central bank communication: Details

This appendix provides details about the estimates discussed in Section III in the body of the paper.

We estimate the following regressions:

$$|x_{\tau-m,\tau+k}| = \gamma_{j,\text{CB}} + \beta_{j,\text{CB}}\mathbf{1}_{\tau,j,\text{CB}} + \varepsilon_{\tau-m,\tau+k}, \quad \text{(IA.1)}$$

where $|x_{\tau-m,\tau+k}|$ denotes the absolute stock return or absolute yield change (both in basis points) computed over a window from m minutes before the event to k minutes after; $\mathbf{1}_{j,\text{CB}}$ is a dummy variable equal to one for a communication event of type j, $j = \{\text{MPD}, \text{PC}, \text{MIN}, \text{IR}\}$. The regressions are estimated separately by asset, event type j, and for each central bank.

The $\beta_{j,\text{CB}}$ coefficient measures the average change in $|x_{\tau-m,\tau+k}|$ due to news released at event j *relative* to the average absolute return on other days. The average return on other days is reflected in the constant $\gamma_{j,\text{CB}}$. For monetary policy decision announcements, returns are computed from -15 to +15 minutes around the event. For press conferences, minutes and inflation report releases, they are computed over a longer window, from -15 to +90 minutes around the event, given that these communications tend to contain information that is broader than the in the decision announcements, and hence may take longer for the markets to process. To control for the baseline variation on days without central bank news, returns and yield changes on those non-event days are constructed for the same window length as the event returns. To avoid dependence of the results on a particular time of day, control returns are sampled three times per day at 10am, 12pm and 2pm local time. These are the conventions that we also follow elsewhere in the paper, unless otherwise noted. The control group excludes all local cental bank announcements contained in our event database. Using the US as an example, we exclude days with announcements by the Fed but not by other central banks. We have verified that excluding days with announcements by all central banks does not significantly alter the results.

Figure 1 in the main text summarizes the estimates of the above regressions. Bars in each graph present $\beta_{j,\text{CB}}$ coefficients (along with 95% robust confidence interval), showing the *incremental* effect of communication events relative to the baseline variation in asset prices absent central bank news. The number displayed on each bar reports the slope coefficient divided by the intercept in regression (IA.1), $\beta_{j,\text{CB}}/\gamma_{j,\text{CB}}$. This ratio measures an increase in absolute returns (or yield changes) around a given communication event relative to the average absolute return on other days (e.g., a ratio of 2 means that average absolute returns are 200% higher at an event than the baseline). Detailed regression estimates are presented in Appendix Table IA-2.

Table IA-2. Reactions of stocks and yields to central bank communication events

This table accompanies Figure 1 in the body of the paper.

Panel A. Fed

	(1) eq	(2) 3m	(3) 2y	(4) 5y	(5) 10y	(6) 30y
Monetary policy decisions (MPD)						
β	24.0	2.61	3.13	3.11	2.07	1.65
	(5.81)	(5.88)	(8.19)	(9.57)	(7.64)	(5.75)
γ	17.5	0.35	0.72	0.81	0.70	0.75
	(106.80)	(64.83)	(88.71)	(102.46)	(107.98)	(116.45)
ratio β/γ	1.37	7.38	4.38	3.85	2.93	2.19
R^2	0.016	0.089	0.086	0.093	0.062	0.040
Press conferences (PC)						
β	21.0	0.20	1.45	1.83	1.47	1.03
	(4.98)	(3.91)	(12.78)	(10.06)	(8.74)	(5.02)
γ	21.7	0.19	0.56	0.96	0.92	1.15
	(68.24)	(48.99)	(65.23)	(70.25)	(72.53)	(74.45)
ratio β/γ	0.97	1.06	2.60	1.90	1.60	0.90
R^2	0.005	0.003	0.032	0.020	0.015	0.005
Minutes of FOMC meetings (MIN)						
β	3.99	0.22	0.70	0.85	0.59	0.28
	(1.42)	(2.29)	(4.46)	(5.04)	(4.42)	(2.30)
γ	31.2	0.56	1.20	1.40	1.23	1.34
	(106.60)	(69.98)	(97.23)	(110.73)	(114.73)	(120.44)
ratio β/γ	0.13	0.40	0.58	0.61	0.48	0.21
R^2	0.000	0.001	0.002	0.003	0.002	0.000

Panel B. ECB

	(1) eq	(2) 3m	(3) 2y	(4) 5y	(5) 10y
Monetary policy decisions (MPD)					
β	2.54	0.74	0.48	0.30	0.14
	(1.47)	(5.54)	(5.63)	(4.24)	(2.56)
γ	17.3	0.29	0.45	0.52	0.51
	(98.21)	(70.22)	(95.04)	(108.57)	(115.57)
ratio β/γ	0.15	2.52	1.06	0.56	0.28
R^2	0.000	0.031	0.012	0.005	0.001
Press conferences (PC)					
β	9.96	1.67	1.84	1.72	1.14
	(3.29)	(8.64)	(8.27)	(8.93)	(8.11)
γ	32.0	0.51	0.84	1.03	1.02
	(101.82)	(74.77)	(96.06)	(107.09)	(115.60)
ratio β/γ	0.31	3.28	2.19	1.67	1.12
R^2	0.001	0.056	0.042	0.032	0.018

Table IA-2. Reactions of stocks and yields to central bank communication events (continued)

This table accompanies Figure 1 in the body of the paper.

Panel C. BOE

	(1) eq	(2) 3m	(3) 10y
Monetary policy decisions (MPD)			
β	3.82	2.20	0.92
	(2.50)	(6.95)	(5.37)
γ	13.3	0.45	0.66
	(102.69)	(76.33)	(116.73)
ratio β/γ	0.29	4.94	1.40
R^2	0.001	0.089	0.026
Inflation reports (IR)			
β	6.95	2.75	1.56
	(1.81)	(6.56)	(5.03)
γ	26.2	0.70	1.26
	(103.54)	(81.64)	(120.95)
ratio β/γ	0.27	3.95	1.24
R^2	0.000	0.041	0.010
Minutes of MPC meetings (MIN)			
β	4.82	1.09	0.82
	(2.31)	(7.18)	(5.71)
γ	26.2	0.70	1.26
	(103.54)	(81.64)	(120.95)
ratio β/γ	0.18	1.56	0.65
R^2	0.000	0.017	0.007

Panel D. BOJ

	(1) eq	(2) 10y
Monetary policy decision (MPD)		
β	11.9	0.19
	(3.50)	(3.20)
γ	17.7	0.34
	(71.39)	(66.59)
ratio β/γ	0.67	0.54
R^2	0.009	0.006
Minutes of monetary policy meetings (MIN)		
β	35.5	0.21
	(5.73)	(3.47)
γ	32.1	0.59
	(70.78)	(65.87)
ratio β/γ	1.11	0.35
R^2	0.022	0.002

B. Robustness of the results to the event window size

For robustness, we compare realized stock-yield covariances constructed over different window sizes. We also discuss selected events which require special attention.

In Figure IA-1, we first present scatter plots of realized covariances around the Fed's monetary policy decisions (MPD). For the moment, we focus only on MPDs for transparency of the plots, and present analysis covering other event types below. In contrast to MPD announcements by the ECB, MPD announcements made by the Fed are accompanied by a statement providing background information on the decision. Such information may take some time for markets to process. Therefore, the sample of the Fed's MPDs serves as a good laboratory for assessing the sensitivity of our results to the choice of the window size. We compare covariances over the (-15,+15) minute window—our baseline window for MPD announcements—with alternative window sizes: (-10,+20) minutes (as used by Gürkaynak et al. (2005a, GSS)), and for longer windows of (-15, +30/+60/+90) minutes. We report the results for the covariances of stock returns with the two- and ten-year yield changes.

Several observations from Figure IA-1 are worth highlighting. First, the covariances are effectively identical if we use the (-15,+15) or GSS's (-10,+20) minutes' window. Second, while the correlation between the narrow- and longer-window covariances decreases as we extend the window (which is to be expected), it still remains very high, with most observations located along a 45-degree line. One visible exception to this is the datapoint on Sep 16, 2008, which we explore in more detail below. Notice that even in the case of deviations from the 45-degree line, the sign of the covariances stays unchanged. Therefore, changing the window would not lead us to classify more events as being dominated by the non-monetary component.

In addition to scatter plots in Figure IA-1, in Table IA-3 we report regression-based comparisons for all Fed events in our data set. We regress realized covariances computed over different windows on covariances computed over the baseline (-15,15) minute window:

$$\text{RCov}_{\tau}^{(n)}(\tau^{-}, \tau^{+}) = \alpha + \beta \times \text{RCov}_{\tau}^{(n)}(-15, +15) + \varepsilon_{\tau}. \tag{IA.2}$$

We estimate this equation with OLS and quantile regression (for the median) which is more robust to outliers, and present result for both. The R^2 from the OLS regression is essentially equal to one for the (-10,+20)-minute window and it drops to the minimum of 0.73 for the two-year yield covariance and the longest window (-15,+90) minutes. The slope coefficients across specifications are close to unity, suggesting that covariances of different window size move one for one: one bps-squared increase in the (-15,+15) minute window covariance corresponds to roughly one bps-squared increase in the longer-window covariance. There is a level difference (visible in the constant) as the longer-window covariances are generally higher than the narrow-window ones. However, comparing the OLS and quantile regression estimates, we see that these level differences are driven by a few influential observations. The constant in the quintile regression shows that the longer-window covariances are slightly higher, which suggests that by extending the window we allow other types of news to affect the covariances.

Note that covariances around Fed's MPDs are generally negative, which we show in the paper (Table II). So the positive constant in the regression in Table IA-3 means that longer-window covariances dampen the initial effect of monetary policy news. This can happen due to non-monetary news revealed by the statement as both growth and risk premium shocks should move stocks and yields in the positive direction. But it could also stem from news not directly related to the Fed: We know that absent monetary policy news (on non-monetary days) stock-yield covariances are generally positive (see discussion in Section IV.B of the paper). To keep our identification consistent with the literature following GSS, we use the narrow window identification for the MPDs, and a longer window for the press conferences and minutes. When we focus on the unconventional monetary policy, we also follow the convention of using longer windows (+90 minutes post announcements). However, going beyond 90 minutes risks inducing too much contamination from other news that may not be due to central bank communication. Importantly, the narrow-window approach seems to be appropriate given our paper's purpose to quantify the amount of non-monetary news in central bank communication as it provides a conservative assessment of the importance of such news.[34]

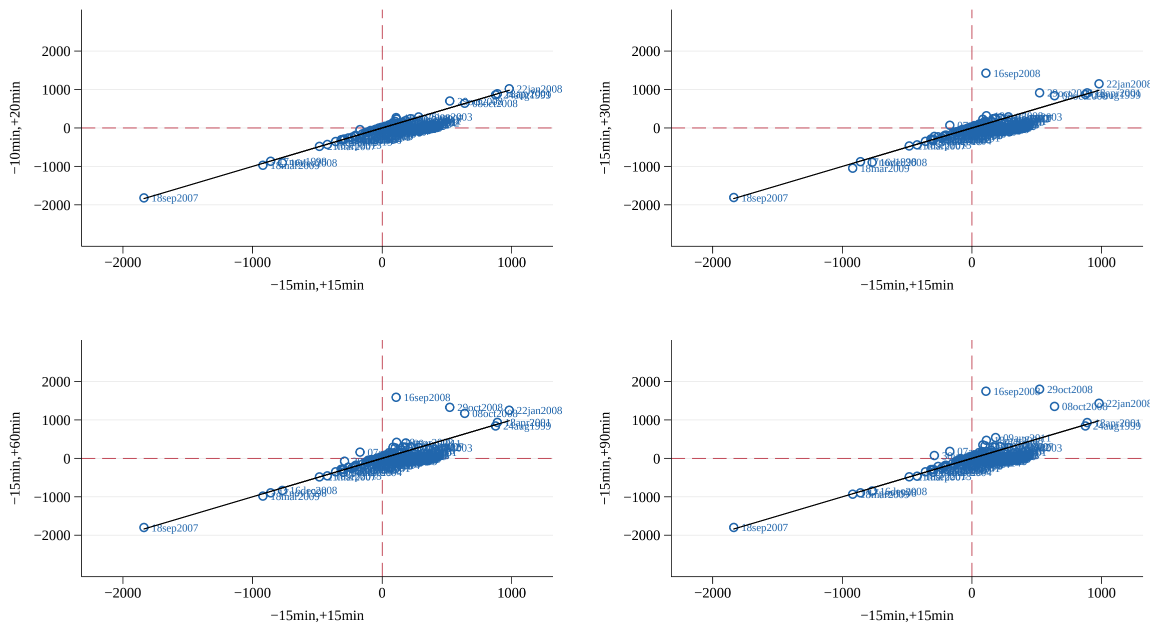
The data point for which the narrow- and longer-window covariances differ the most is the MPD on September 16, 2008, and the differences are particularly visible in the 2-year covariances. Figure IA-2 shows the dynamics of stocks and yields on that day. The Fed decided to keep rates unchanged which led to the initial drop in the stock market on impact, and a small drop in yields. This initial reaction to the announcement is captured by the -15,+15 minute window quite well. After a while, however, the stock market rebounded and yields started to increase. This case illustrates the ambiguity associated with the choice of the window. Fortunately, for our purposes, it is also the most extreme case we see in our sample (Figure IA-1). The media commentary on that day indeed suggested that the market took time to arrive at an interpretation of the statement and of the Fed's move. For the sake of being conservative in our news classification (and for consistent treatment of all MPD events), we rely on the narrow window identification when estimating various regression specifications.

To illustrate how quickly markets usually absorb information in central bank communication, it is useful to look at the behavior of stocks and bonds on July 26, 2012, surrounding Mario Draghi's famous "whatever it takes" speech. This speech was not a formal program announcement, and it covered several topics.[35] One could argue that both of these facts made the message complex. Figure IA-3 shows that the (-15, +90) minute windows is sufficient to capture the market's reaction to the speech.

[34]Note that GSS consider both the narrow window of (-10,+20) minutes and a longer window of (-15,+45) minutes. They very well discuss the tradeoff involved in the selection of the window size. The goal of the GSS is to distinguish between the shocks due to Fed's actions versus shocks due to Fed's "words" revealed in the statement. While complex statements may take more time to process by the market, they emphasize the use of the narrow window, writing: "(...) we continue to emphasize our tight window responses in the analysis below because most of the policy information is incorporated within that window and having a narrower window reduces the amount of noise in our left-hand-side variables, increasing the precision of our estimates."

[35]The 'whatever it takes' speech is commonly regarded as foreshadowing the introduction of the ECB's program of Outright Monetary Transactions (OMT)— a point of inflection of the European sovereign debt crisis.

Panel A. Realized covariance of equity returns and two-year yield changes



Panel B. Realized covariance of equity returns and ten-year yield changes

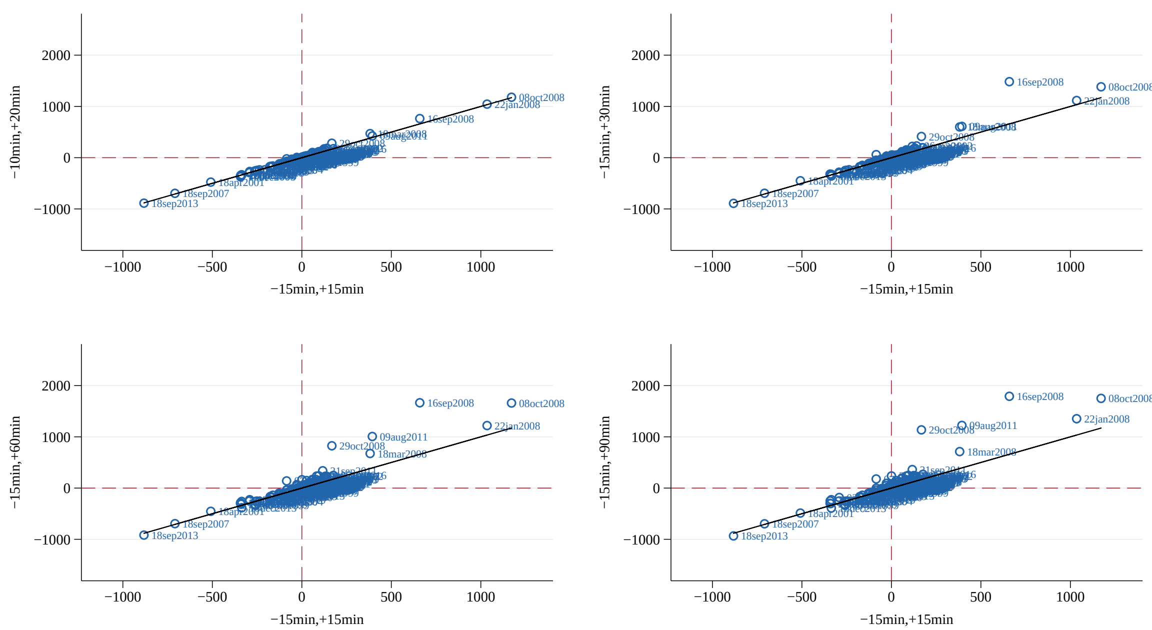


Figure IA-1. Comparison of realized stock-yield covariances for different event windows around Fed's MPD announcements

The figure compares the realized covariances between the equity returns and two- and ten-year yield changes for different window sizes. The realized covariances are defined in equation (5) of the paper, and are reported in bps-squared. The plot is based on the Fed's monetary policy decision announcements only for better readability. Panel B of the figure omits one data point, an outlier on Mar 18, 2009, which distorted the figure's readability. (On that day, however, the covariances across different window specification were similar ranging from -5111 to -4840.) Regressions in Table IA-3 use all Fed events in our database.

Table IA-3. Comparison of realized covariances with different window sizes

This table compares realized covariances constructed around Fed events over different window sizes. We regress realized covariances computed over different windows on covariances computed over the (-15,15) minute window: $\text{RCov}_{\tau}^{(n)}(\tau^{-},\tau^{+}) = \alpha + \beta \times \text{RCov}_{\tau}^{(n)}(-15,+15) + \varepsilon$. The different window specifications for the dependent variables are reported in columns of the table, e.g. (-10,+20) denotes a window from -10 minutes before to +20 minutes after the event. The regressions are estimated for all events included in our sample (Figure IA-1 compares these covariances only for monetary policy decision announcements). Columns (1) through (4) are estimated using OLS (with robust standard errors); columns (5) though (8) are estimated with quantile (median) regressions (with bootstrapped standard errors).

	OLS regressions				Quantile regression			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	(-10,+20)	(-15,+30)	(-15,+60)	(-15,+90)	(-10,+20)	(-15,+30)	(-15,+60)	(-15,+90)
A. Realized covariance of equity returns with two-year yield								
$\text{RCov}_{\tau}^{(2Y)}$ (-15,+15)	1.02	1.09	1.15	1.21	1.00	1.02	1.05	1.04
	(63.34)	(27.52)	(16.48)	(12.09)	(138.38)	(34.58)	(31.38)	(21.94)
Constant	1.58	11.7	22.6	30.8	0.0039	1.85	3.45	3.84
	(1.30)	(2.77)	(3.98)	(4.32)	(0.12)	(4.00)	(3.19)	(4.62)
R^2	0.98	0.86	0.79	0.73	–	–	–	–
B. Realized covariance of equity returns with ten-year yield								
$\text{RCov}_{\tau}^{(10Y)}$(-15,+15)	0.99	1.01	1.03	1.05	1.00	1.02	1.09	1.09
	(133.17)	(25.93)	(15.36)	(12.72)	(84.16)	(21.01)	(11.07)	(8.06)
Constant	1.85	12.4	27.1	36.4	0.59	3.62	9.75	13.2
	(2.01)	(4.06)	(5.61)	(6.08)	(2.70)	(4.70)	(11.27)	(6.20)
R^2	1.00	0.97	0.93	0.89	–	–	–	–

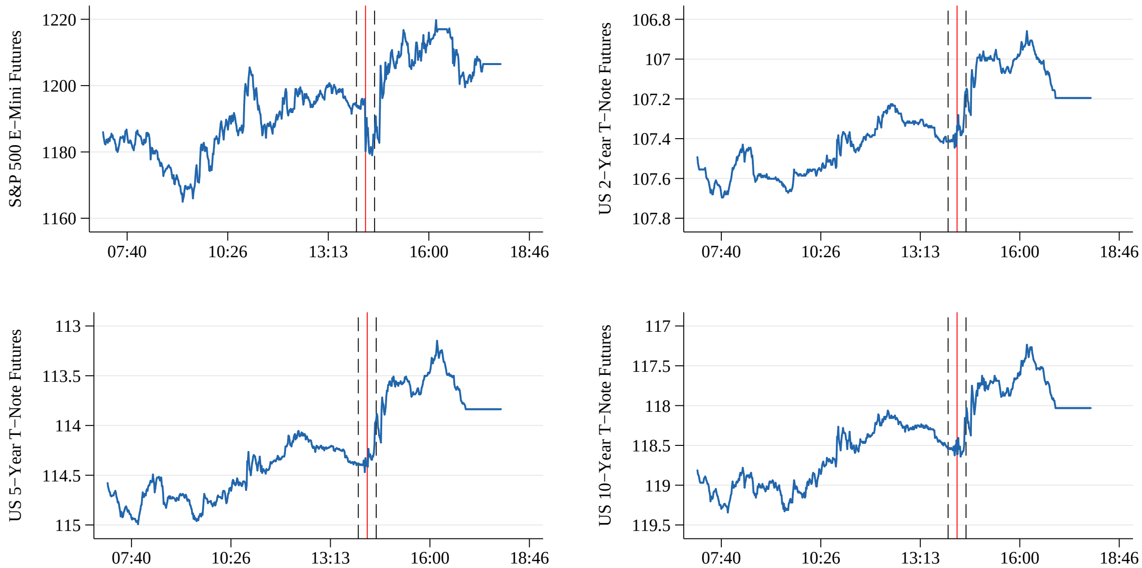


Figure IA-2. US equity and bond futures prices on Sep 16, 2008

The figure presents the evolution of prices for S&P500 stock futures and US bond futures in the US on Sep 16, 2008. In all plots, the first solid (red) line marks the time of the monetary policy decision (08:20am and 14:15pm, respectively). The dashed (black) lines indicate the time interval from -15 to +15 minutes of the policy decision. For bond prices, the y-axis is reversed to be consistent with the direction of the movement in yields. All times are reported in New York time.

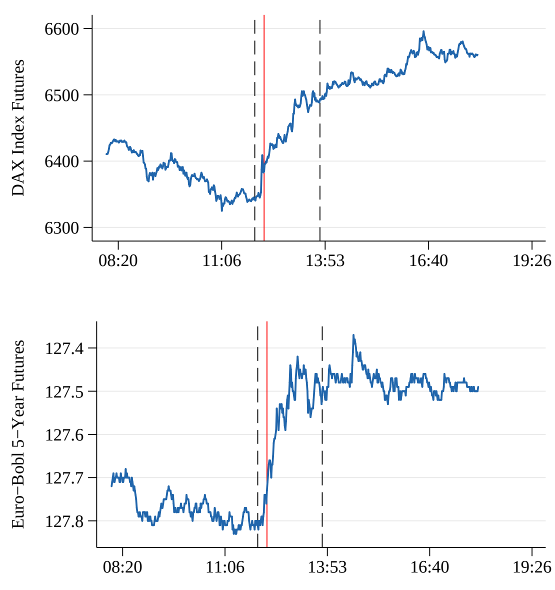


Figure IA-3. German equity and bond futures prices on Jul 26, 2012

The figure presents evolution of prices for DAX stock futures and German five-year bond futures on Jul 26, 2012. The solid (red) line marks the time of the beginning of the speech as reported by Bloomberg (12:15pm), while the dashed (black) lines mark the time 15 minutes before to 90 minutes after the beginning of the talk. For bond futures prices, the y-axis is reversed to be consistent with the direction of the movement in yields. All times are reported in Berlin time.

C. Comovement of stocks and yields around macroeconomic announcements

This appendix provides additional results about the effects of macro releases on variances of stocks and yields and on stock-yield comovement. Regression of variances and covariances on the dummy for macro announcements are summarized in Table IA-4. These regressions present the incremental effect of macro news on the second moments of asset prices, relative to the baseline variation on days without macro or monetary policy news. Figure IA-4 presents the average realized variances of yields around macroeconomic announcements.

Table IA-4. Variances and covariances around US macroeconomic releases

The table accompanies Figure 3 in the body of the paper. The table presents the regressions of realized covariances and variances on a macroeconomic announcement dummy. The time stamps of macroeconomic announcements are from Bloomberg and we use the following tickers: USURTOT Index for unemployment rate (released together with non-farm payrolls); CPI CHNG Index for CPI inflation rate (other CPI indices are announced at the same time); GDP CQOQ Index for GDP growth (advance announcement). The event window spans from -15 minutes before to +60 minutes after macro release. The sample of control covariances is constructed over the same window for days without local monetary policy news and macro news, in analogy to the approach to constructing control returns described in Section III. Realized (co)variances are reported in units of basis points squared. Robust standard errors are reported in parentheses.

Panel A. Dependent variable: realized variance (bps-squared)

	(1) eq	(2) 3m	(3) 2y	(4) 5y	(5) 10y	(6) 30y
CPI Inflation						
Inflation release dummy	31.5	1.96	5.25	5.45	3.36	2.91
	(0.29)	(4.48)	(6.16)	(6.94)	(8.20)	(8.09)
Constant	853.7	1.76	3.08	2.94	2.12	2.16
	(46.64)	(28.04)	(21.15)	(22.04)	(24.78)	(22.42)
GDP (advance)						
GDP release dummy	841.3	2.91	9.30	11.9	6.58	5.96
	(2.01)	(4.64)	(4.17)	(3.32)	(4.48)	(3.95)
Constant	849.4	1.78	3.12	2.96	2.14	2.18
	(47.15)	(28.49)	(21.63)	(22.68)	(25.36)	(22.91)
Unemployment report						
Unemployment release dummy	2411.0	19.0	52.1	54.5	34.0	29.1
	(7.65)	(6.35)	(7.20)	(8.65)	(8.14)	(5.78)
Constant	812.4	1.46	2.27	2.08	1.58	1.71
	(46.88)	(54.23)	(55.28)	(49.39)	(74.86)	(89.22)

Panel B. Dependent variable: realized covariance (bps-squared)

	(1) 3m	(2) 2y	(3) 5y	(4) 10y	(5) 30y
CPI Inflation					
Inflation release dummy	-13.4	-25.3	-25.5	-22.1	-19.7
	(-4.79)	(-4.93)	(-6.43)	(-5.76)	(-6.40)
Constant	2.28	7.10	10.9	10.4	10.1
	(9.11)	(15.94)	(22.60)	(26.74)	(29.17)
GDP (advance)					
GDP release dummy	-3.03	-5.03	2.72	-12.4	-2.99
	(-0.47)	(-0.31)	(0.21)	(-0.70)	(-0.36)
Constant	2.07	6.69	10.4	10.1	9.74
	(8.27)	(15.20)	(21.90)	(26.78)	(28.44)
Unemployment report					
Unemployment release dummy	17.6	79.7	77.0	66.2	55.6
	(1.47)	(4.09)	(3.38)	(3.80)	(3.44)
Constant	1.75	5.28	9.12	8.86	8.76
	(12.19)	(18.57)	(34.70)	(37.49)	(45.53)

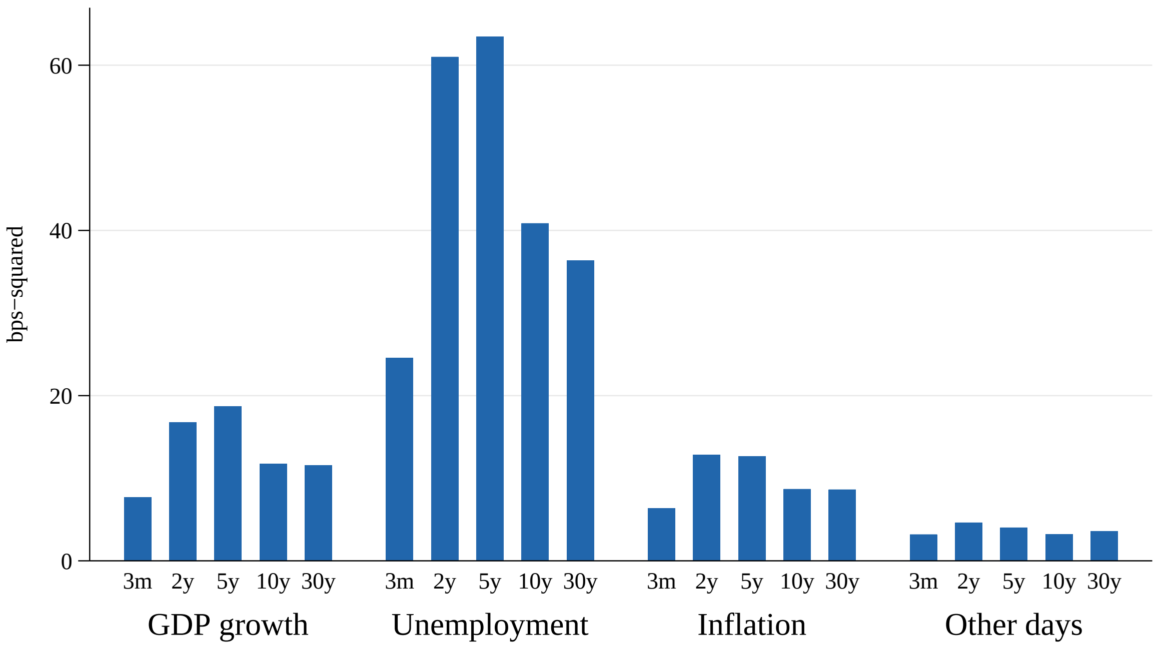


Figure IA-4. Average realized variances of yields around macro announcements

The figure plots the average realized variances of yields around macroeconomic announcements (same announcement as in Figure 3. For comparison, the last panel in the figure ("Other days") presents the average realized variances on days without those three macro announcements and without monetary policy news. The event window is (-15,+60) minutes around announcements.

D. Classification of unconventional monetary policy events

This appendix presents an overview of the types of UMP measures introduced by the Fed, ECB, BOE and BOJ during our sample, and accompanies Section V of the paper.

In the case of the Fed, in Table V, we distinguish the well-known rounds of Quantitative Easing (QE, referred to as QE1, QE2, QE3) as well as the maturity extension program (MEP, also called "Operation Twist"). We also account for early announcements related to the possible removal of monetary stimulus, denoted as "early exit" in Table V, even though the eventual exit from monetary accommodation was repeatedly postponed against the backdrop of a sluggish recovery. The analysis further accounts for exit announcements in the post 2013 period ("late exit"). Among those, we separately treat the taper tantrum in mid-2013, as well as announcements related to the wind-down of the Fed balance sheet in late 2017.

Table VI is based on the classification of the ECB's UMP announcements. A key component of the ECB's UMP toolkit during the crisis were longer-term refinancing operations (LTRO) geared towards proving liquidity to the banking sector. In our analysis, we distinguish four main LTRO phases. The first two phases, rolled out during the course of the sub-prime crisis period, were still fairly limited in terms of the maturity of the operations. The third round of LTROs was launched at the height of the euro area sovereign debt crisis in December 2011 and February 2012, and provided banks with funding at attractive rates for three years. After the sovereign debt crisis abated, another round of so-called targeted long-term refinancing operations (TLTRO) was initiated in June 2014, which we classify as phase four. The TLTROs provided term funding to euro area banks at attractive rates conditional upon fulfilment of certain criteria (regarding bank lending to the real economy).

Besides those liquidity provision measures, we also account for announcements related to asset purchases, including the launch of the ECB's covered bond purchase programme (CBPP), the securities markets programme (SMP) as well as outright monetary transactions (OMT). In terms of sequencing, the CBPP was already introduced prior to the sovereign debt crisis, mainly to alleviate banks' elevated funding costs. The SMP was launched later, in May 2010, at a time when tensions during the European sovereign debt crisis escalated. It involved purchases of government and corporate fixed income securities from euro area peripheral countries, and purchases were conducted with an aim to repair the broken transmission process of monetary policy. The OMT programme, allowing for (in principle) unlimited asset purchases of sovereign debt (subject to conditionality), had a similar focus. Even though never activated, the OMT is generally thought to have significantly alleviated the euro area sovereign debt crisis. The main goal of these crisis-related policies, which involved purchases of sovereign debt of countries affected by the crisis, was to repair the broken transmission mechanism of monetary policy and to combat intra-euro area spread widening. With its decision in January 2015 to purchase public sector debt securities (PSPP) on a large scale, the ECB Governing Council formally embarked on QE policies, aimed at fulfilling its price stability mandate. The asset purchase programme, which is still ongoing at the time of writing, was complemented in early 2016 with purchases of corporate bonds via the corporate sector purchase program (CSPP).

Table VII gives an overview of UMP programs by the BOE and the BOJ. In case of the former, we capture the dates when the BOE (in coordination with the UK Treasury) first created its asset purchase facility (APF) and then expanded the amounts held in the facility. Overall, we distinguish four QE phases by the BOE (APF1-APF4), corresponding to distinct phases when holdings of gilts in the APF were significantly expanded.

In light of persistently deflationary environment in Japan and issues related to the zero lower bound, the BOJ actually started to embrace unconventional policies already in the early-2000s. We classify the early phase of the BOJ's QE from 2002 to 2006 as QEP. At the height of the sub-prime crisis, the BOJ introduced further round of bond purchases which we refer to as QEAPP. A major shift, however, occurred in April 2013 when the BOJ launched quantitative and qualitative easing (QQE), a program aimed at expanding the monetary base via purchases of Japanese government bonds. To prop up asset prices, the BOJ also began purchasing local equities (via ETFs) and real estate investment trusts (REITS), and we classify these announcements separately. QQE was then modified with the introduction of negative interest rates (QQE Neg Rates) and the introduction of yield curve control (YCC).

E. Implementation of sign and monotonicity restrictions

This appendix accompanies Section VI of the paper and describes the details of the sign and monotonicity restrictions algorithm.

Our main goal is to decompose reduced-form shocks u_t into structural shocks ϵ_t. Start from the variance-covariance matrix of reduced-form shocks,

$$\Sigma_u = Var(u_t) = PP', \tag{IA.3}$$

where P is the lower triangular matrix from a Cholesky decomposition of Σ_u and

$$u_t = P\epsilon_t^{Chol}. \tag{IA.4}$$

We use the notation ϵ_t^{Chol} to denote candidate ϵ_t shocks obtained using Cholesky decomposition. While P orthogonalizes u_t ensuring that ϵ_t shocks are uncorrelated, $Var(\epsilon_t^{Chol}) = I$, it does not have a particular economic interpretation. Specifically, one can obtain an observationally identical set of reduced-form shocks by finding an orthogonal (rotation) Q matrix such that $QQ' = Q'Q = I$,

$$u_t = PQ'Q\epsilon_t = P^Q\epsilon_t^Q, \tag{IA.5}$$

where ϵ_t^Q is another candidate set of shocks corresponding to matrix Q.

We want to select a rotation matrix Q that satisfies the restrictions on contemporaneous responses discussed in Section VI:

$$PQ' = A^{-1}. \tag{IA.6}$$

The restrictions are imposed using the Householder algorithm (see Kilian and Lütkepohl (2017), Chapter 13) in the following way:

1. Generate 3×3 matrix M with elements drawn from the standard normal distribution $N(0,1)$.
2. Perform a QR decomposition of M, obtain upper triangular matrix R and orthogonal matrix Q. If the (i,i) element on the diagonal of R is negative ($diag(R)_{ii} < 0$), switch the sign of the i-th column of the Q matrix as $Q(:,i) = -Q(:,i)$. The last step ensures that the Q matrix is drawn from a uniform distribution over the space of orthogonal matrices.
3. Check whether PQ' satisfies the restrictions.
4. Repeat until N Q matrices satisfy the restrictions, where we set $N = 2000$.

F. Additional figures

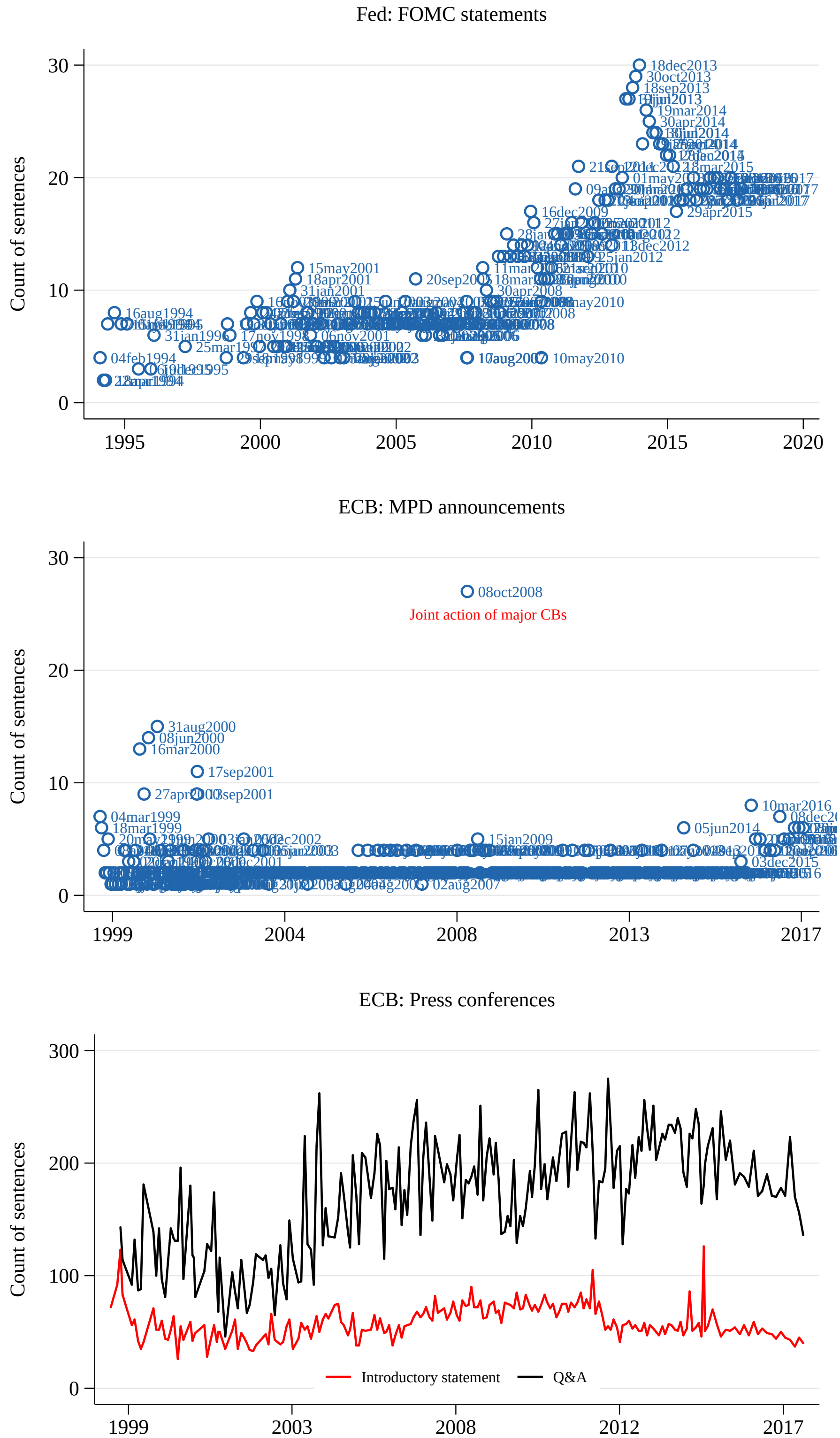


Figure IA-5. Variation in the length of monetary policy decision announcements and press conferences over time

The figure presents the count of sentences included in FOMC statements of policy decisions, ECB's monetary policy decisions and ECB's press conferences.

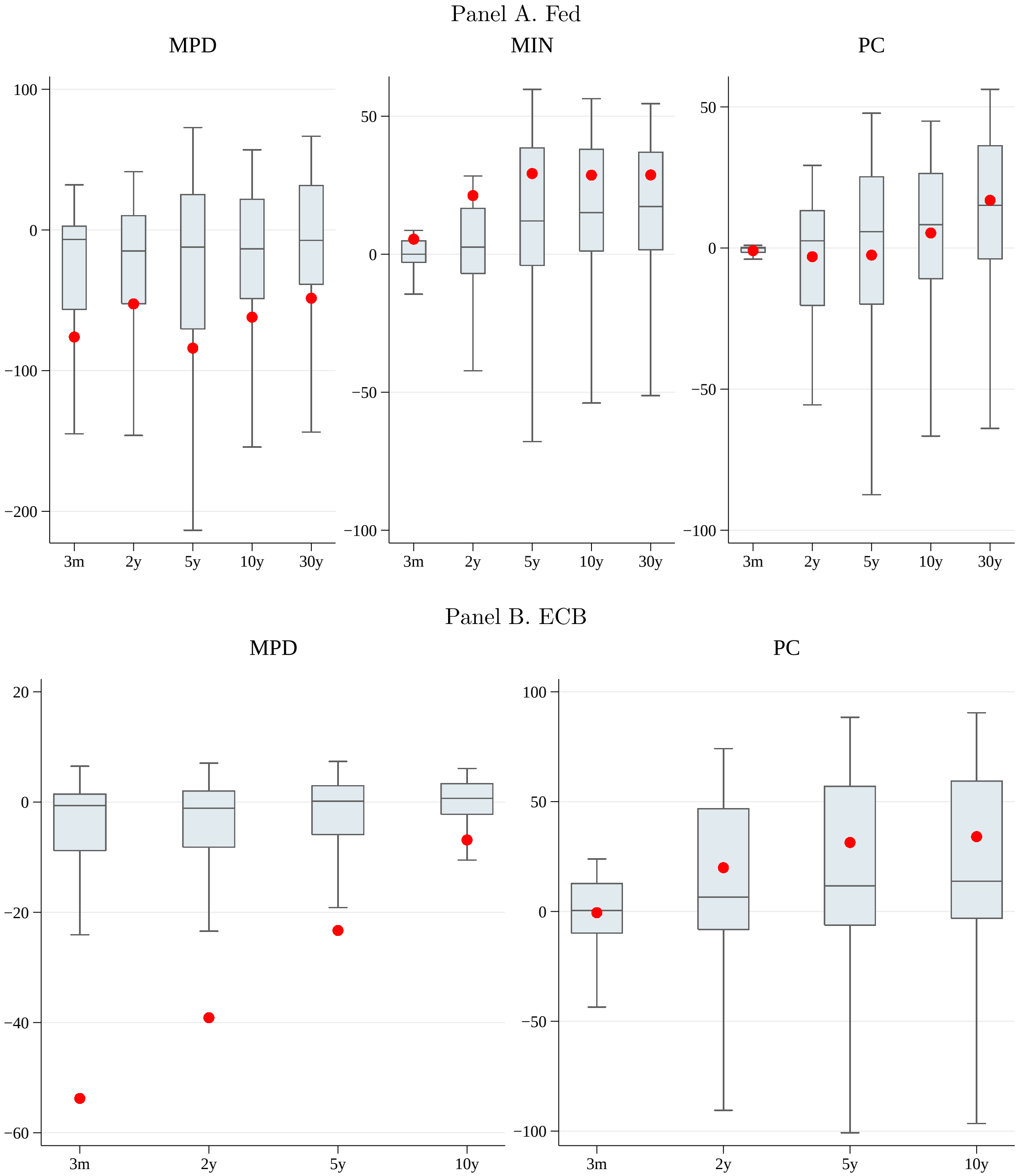
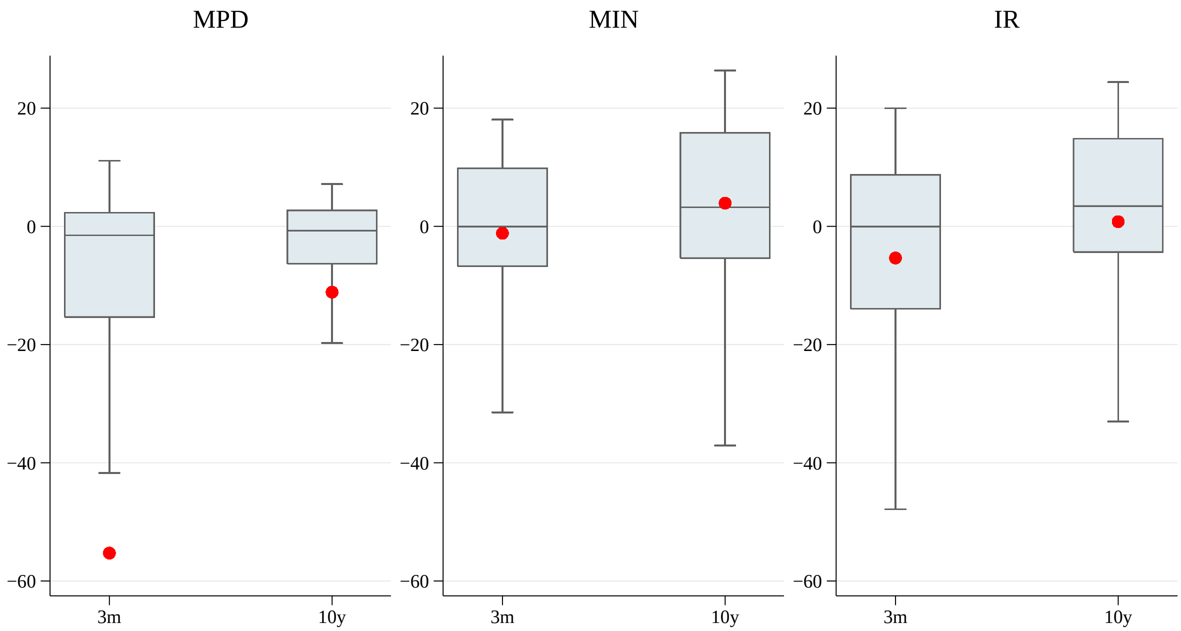


Figure IA-6. Term structures of stock-yield covariances (full sample)

The figure presents the distributions of realized covariances. Covariances are reported in bps-squared. We consider monetary policy decision (MPD) announcements and press conferences (PC) for the ECB, minutes releases (MIN) for the Fed, the BOE and the BOJ, and inflation report (IR) releases for the BOE. Covariances are constructed over a (-15,+15) minute window for MPDs, and over (-15,+90) minute window around other communication events. Mean covariances are indicated with dots. The box borders indicate the upper and lower quartiles and the line within the box marks the median. The whiskers identify the largest and smallest adjacent values calculated as upper quartile +1.5×IQR (interquartile range) and lower quartile −1.5×IQR. Extreme values are not shown.

Panel C. BOE



Panel D. BOJ

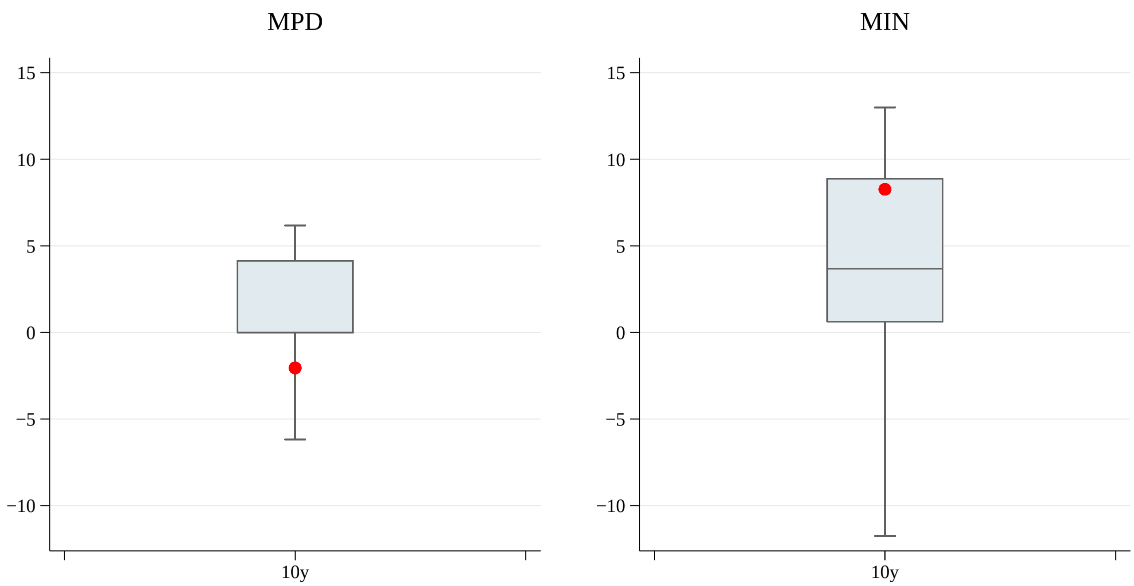


Figure IA-6. Term structure of stock-yield covariances around CB communication events (continued)

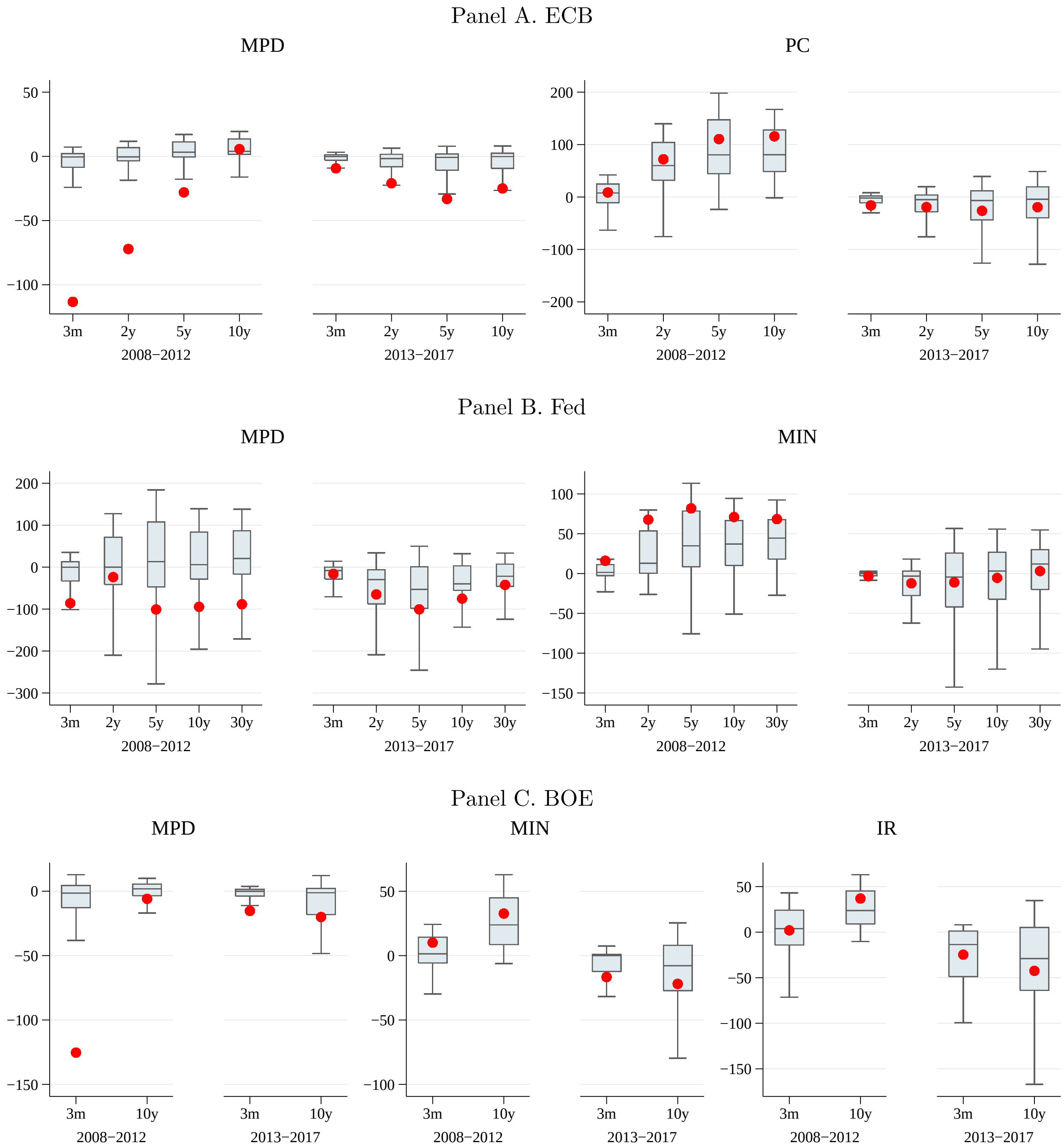


Figure IA-7. Term structures of realized covariances pre- and post-2013

The figure presents distributions of realized stock-yield covariances across available maturities around central bank communication events, for two subperiods: 2008–2012 and 2013–2017. Covariances are reported in bps-squared. We consider monetary policy decision (MPD) announcements and press conferences (PC) for the ECB, minutes releases (MIN) for the Fed and the BOE, and inflation report (IR) releases for the BOE. Covariances are constructed over a (-15,+15) minute window for MPDs, and over (-15,+90) minute window around other communication events. Mean covariances are indicated with dots. The box borders indicate the upper and lower quartiles and the line within the box marks the median. The whiskers identify the largest and smallest adjacent values calculated as upper quartile $+1.5\times$IQR (interquartile range) and lower quartile $-1.5\times$IQR. Extreme values are not shown.