# Appendix A Methods and Results

## A.1 Sign Restriction Implementation

Denote by $X$ the $T \times N$ $(189 \times 2)$ matrix containing the immediate change in 2-year yields and stock price around ECB announcements (see Section B.4.1):

$$\underset{T\times N}{X} = \underset{T\times N}{Z} \quad \underset{N\times N}{\Pi}$$

$$\iff (x^{2y\,yield}, x^{stocks}) = (Z^{\text{PP}}, Z^{\text{I}}) \begin{pmatrix} \Pi^{\text{PP}}_{2y\,yield} & \Pi^{\text{PP}}_{stocks} \\ \Pi^{\text{I}}_{2y\,yield} & \Pi^{\text{I}}_{stocks} \end{pmatrix}$$

The sign restrictions are then implemented by generating $2 \times 2$ matrices $\hat{\Pi}$, such that

- $\hat{\Pi}^{\text{PP}}_{2y\,yield} > 0$ and $\hat{\Pi}^{\text{I}}_{2y\,yield} > 0$, i.e. both surprises raise the 2-year bond yield
- $\hat{\Pi}^{\text{PP}}_{stocks} < 0$, i.e. a pure policy surprise lowers stock prices
- $\hat{\Pi}^{\text{I}}_{stocks} > 0$, i.e. a central bank information surprise raises stock prices
- and $Z^{\text{PP}}$ and $Z^{\text{I}}$ are orthogonal to each other.

In practice, I obtain candidate matrices $\hat{\Pi}$ by applying a QR decomposition to $2 \times 2$ matrices drawn from a standard normal distribution.

Having drawn 2000 matrices $\hat{\Pi}$, I apply the median target criterion of Fry and Pagan (2011) to select a unique matrix $\Pi$. In particular, I compute the median of each entry across all draws of $\hat{\Pi}$, and select the matrix $\Pi$ that minimizes the sum of squared deviations from these median values.[9]

## A.2 Bootstrap Algorithm

Since the surprise series $Z$ are generated rather than directly observed, I apply a bootstrap procedure to obtain standard errors that incorporate the associated additional uncertainty.[10] In particular, for each bootstrap repetition, I

- randomly select $T$=189 time periods $\tau$ with replacement from $\tau \in \{1, ..., T\}$
- collect the high-frequency futures movements $x_{i\tau}$ in matrix $\mathbf{X}$
  - define $\mathbf{Z}^{\text{PN}}$ as the resampled 2-year yield changes
  - obtain $\mathbf{Z}^{\text{PP}}$ and $\mathbf{Z}^{\text{I}}$ by applying the sign restrictions from Section A.1 to $\mathbf{X}$
- obtain $\hat{\beta}^j_i$ by regressing $\Delta Y_{i\tau}$ on $\mathbf{Z}^j$, for $j \in \{PN, PP, I\}$

[9] Note that Cieslak and Schrimpf (2019) and Andrade and Ferroni (2021) define $\Pi$ by averaging matrix entries across all admissible rotations $\hat{\Pi}$. I apply the median target criterion instead to ensure that $\Pi$ yields exactly orthogonal surprises $Z$.

[10] The bootstrap algorithm is identical to the one proposed by Gürkaynak et al. (2005), see their footnote 24. Swanson (2021), in contrast, generates artificial data by resampling residuals from a factor model instead of resampling the observed data.

The bootstrapped standard errors in Section 3 are based on the empirical distribution of $\hat{\beta}_i^j$ using 2000 bootstrap repetitions. To keep the algorithm manageable, I draw only 200 admissible rotations $\hat{\Pi}$ for each bootstrap sample (instead of 2000 for the point estimates, see Section A.1).

## A.3 Robustness and Further Results

To show that the yield responses in the top panel of Table 1 are not unique to Germany, Table A1 reproduces the results for French sovereign bonds.[11]

Table A1: Response of French Government Bond Yields

| | | **Policy News** | | **Pure Policy** | | **Information** | |
|---|---|---|---|---|---|---|---|
| | | $\hat{\beta}$ | *s.e.* | $\hat{\beta}$ | *s.e.* | $\hat{\beta}$ | *s.e.* |
| *Nominal Bond Yields* | 1 year | $0.70^{***}$ | 0.14 | $0.66^{***}$ | 0.19 | $0.80^{***}$ | 0.14 |
| | 2 year | $0.98^{***}$ | 0.13 | $0.99^{***}$ | 0.17 | $0.96^{***}$ | 0.13 |
| | 5 year | $0.91^{***}$ | 0.12 | $0.90^{***}$ | 0.19 | $0.91^{***}$ | 0.12 |
| | 10 year | $0.57^{***}$ | 0.12 | $0.57^{***}$ | 0.20 | $0.58^{***}$ | 0.13 |

This table reproduces the top panel of Table 1 for French instead of German nominal bond yields. The number of observations is 173 at the 1-year maturity (data starts December 2002) and 189 otherwise.

Table A2, furthermore, shows that the response of stock prices and analyst forecasts are broadly similar when looking at national stock market indices instead of the aggregate Euro STOXX 50 index.

Similarly, Table A3 reports survey revisions on macroeconomic aggregates for individual euro area member states, confirming the aggregate results shown in Table 2.

Table A4 reports analyst revisions of earnings and dividends in the Euro STOXX 50 for different revision horizons. Recall that the benchmark results in Table 2 show revisions over the two weeks following ECB announcements, because stock analysts update their forecasts infrequently, see Section B.5.1. In line with this, Table A4 shows that revisions accumulate gradually.

Table A5, lastly, reproduces Tables 1 and 2 from the main body of the text, but instead of using the bootstrap algorithm from Section A.2, I follow Andrade and Ferroni (2021) and treat the surprises as observable regressors and use robust standard errors.

[11] Yields of euro area periphery countries, in contrast, exhibit a substantially different response to ECB announcements. Leombroni et al. (2021) show that this wedge is due to the sovereign debt crisis, during which periphery yields contained a substantial "euro-area break-up premium".

Table A2: Stock Prices and Analyst Revisions Across Countries

| | | Policy News | | Pure Policy | | Information | |
|---|---|---|---|---|---|---|---|
| | | $\hat{\beta}$ | *s.e.* | $\hat{\beta}$ | *s.e.* | $\hat{\beta}$ | *s.e.* |
| **Stock Prices** | | | | | | | |
| | Germany | -2.2 | 3.8 | -17.5*** | 5.1 | 17.2*** | 4.5 |
| | France | -0.5 | 3.8 | -16.3*** | 4.8 | 19.4*** | 4.4 |
| | Italy | -0.2 | 3.6 | -17.4*** | 5.1 | 21.5*** | 5.0 |
| | Spain | 0.1 | 3.6 | -17.1*** | 4.9 | 21.8*** | 4.8 |
| **Earnings Revisions** | | | | | | | |
| | Germany | -2.1 | 3.9 | -6.8 | 5.5 | 4.5 | 3.5 |
| | France | -0.7 | 2.0 | -4.9** | 3.0 | 5.1* | 3.0 |
| | Italy | -0.2 | 2.1 | -3.3 | 2.6 | 4.1 | 4.4 |
| | Spain | -1.6 | 3.6 | -6.2** | 3.6 | 4.9 | 5.0 |
| **Dividend Revisions** | | | | | | | |
| | Germany | -1.1 | 3.1 | -4.8 | 4.5 | 4.2 | 3.0 |
| | France | 0.3 | 1.3 | -1.9 | 2.1 | 3.3 | 2.0 |
| | Italy | -0.5 | 3.8 | 3.4 | 4.1 | -5.9 | 8.1 |
| | Spain | -2.7 | 3.2 | -6.8** | 3.2 | 3.7 | 4.4 |

Results for Germany refer to the DAX index, for France to the CAC index, for Italy to the FTSE MIB index, and for Spain to the IBEX index. The top panel shows daily responses of national stock prices (analogous to Table 1). The two lower panels show 2-week revisions in I/B/E/S analyst forecasts (analogous to Table 2; for Italy, forecasts are available only since June 2009).

Table A3: Macroeconomic Survey Revisions Across Countries

| | Policy News | | | Pure Policy | | | Information | | |
|---|---|---|---|---|---|---|---|---|---|
| | GDP | IP | CPI | GDP | IP | CPI | GDP | IP | CPI |
| Germany | -0.50 | 0.08 | -0.00 | -1.32*** | -1.82* | -0.26 | 0.22 | 1.78 | 0.22 |
| France | -0.12 | -0.30 | 0.04 | -0.73** | -1.91** | -0.34 | 0.43 | 1.12 | 0.39 |
| Italy | -0.22 | -0.86 | -0.22 | -0.89*** | -2.49*** | -0.38 | 0.37 | 0.56 | -0.08 |
| Spain | 0.03 | -0.80 | -0.35 | -0.61 | -1.61 | -0.77* | 0.61 | -0.10 | 0.01 |
| Netherlands | -0.38 | | -0.10 | -1.39*** | | -0.11 | 0.51 | | -0.10 |
| Austria | -0.47* | -1.64* | -0.36* | -0.85*** | -2.22** | -0.72** | -0.14 | -1.09 | -0.05 |
| Belgium | -0.33 | -0.98 | -0.15 | -0.96*** | -2.07** | -0.33 | 0.23 | -0.04 | 0.00 |
| Finland | -0.69* | -2.19* | -0.06 | -1.21*** | -3.11*** | 0.00 | -0.24 | -1.44 | -0.11 |
| Greece | -0.19 | -0.12 | -0.20 | -0.49 | 1.10 | 0.26 | 0.07 | -1.19 | -0.62 |
| Ireland | 0.14 | 0.09 | -0.05 | -1.26* | -0.84 | -0.31 | 1.40 | 0.89 | 0.19 |
| Portugal | 0.11 | 0.88 | 0.03 | -0.63 | -1.42 | -0.23 | 0.78 | 2.85 | 0.27 |

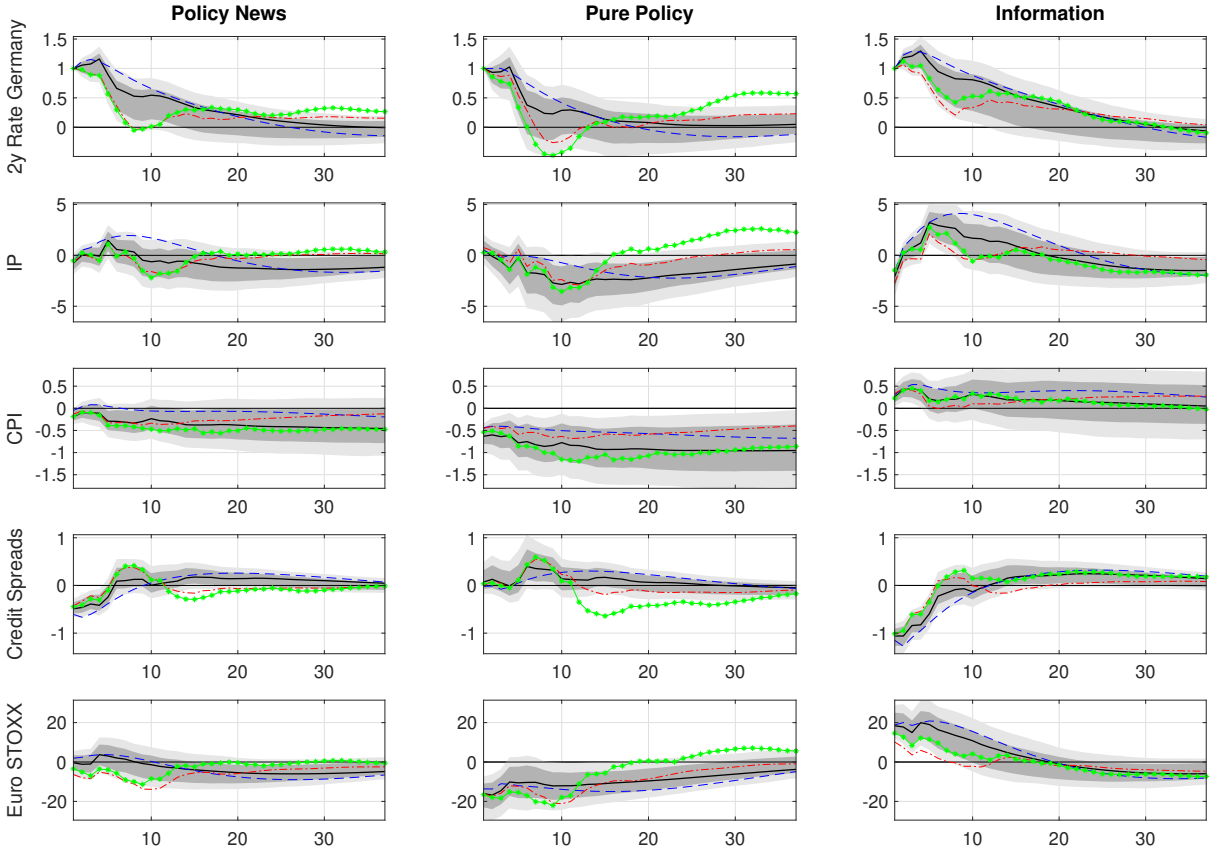
Results refer to monthly revisions in GDP growth, industrial production growth, and CPI inflation, see Table 2 for details.

Table A4: Analyst Revisions for the Euro STOXX 50 Over Time

| | Policy News | | Pure Policy | | Information | |
|---|---|---|---|---|---|---|
| | $\hat{\beta}$ | *s.e.* | $\hat{\beta}$ | *s.e.* | $\hat{\beta}$ | *s.e.* |
| **Earnings Revisions after ...** | | | | | | |
| 1 week | -2.3 | 2.5 | -4.4 | 3.7 | 0.7 | 1.9 |
| 2 weeks | -1.5 | 2.6 | -6.2** | 3.8 | 4.9 | 2.8 |
| 3 weeks | -2.1 | 3.6 | -7.7* | 5.3 | 5.6 | 3.8 |
| 4 weeks | -0.8 | 4.6 | -8.8* | 6.5 | 10.4** | 4.9 |
| **Dividend Revisions after ...** | | | | | | |
| 1 week | -1.1 | 2.5 | -2.4 | 3.5 | 0.6 | 2.9 |
| 2 weeks | 0.9 | 2.2 | -4.0* | 3.1 | 7.7*** | 2.9 |
| 3 weeks | 0.6 | 3.2 | -5.4 | 4.5 | 9.0** | 3.5 |
| 4 weeks | 3.2 | 4.0 | -6.1 | 5.3 | 16.1*** | 5.0 |

This table reproduces the top two rows from Table 2 for different revision periods.

Figure A1: Robustness of VAR Results to Different Lag Length




Black lines and grey areas reproduce Figure 2, based on a VAR with 6 lags. Blue dashed lines refer to a VAR with 3 lags, red dash-dotted lines to a VAR with 9 lags, and green lines (marked with an asterisk) to a VAR with 12 lags.

Table A5: Results with Robust Standard Errors

| | | **Policy News** | | **Pure Policy** | | **Information** | |
|---|---|---|---|---|---|---|---|
| | | $\hat{\beta}$ | *s.e.* | $\hat{\beta}$ | *s.e.* | $\hat{\beta}$ | *s.e.* |
| *Nominal Bond Yields* | 1 year | 0.71*** | 0.13 | 0.74*** | 0.19 | 0.68*** | 0.18 |
| | 2 year | 1.00*** | 0.12 | 1.00*** | 0.19 | 1.00*** | 0.20 |
| | 5 year | 0.91*** | 0.12 | 0.85*** | 0.18 | 0.98*** | 0.16 |
| | 10 year | 0.61*** | 0.10 | 0.54*** | 0.16 | 0.69*** | 0.14 |
| *Inflation-Linked Swaps* | 1 year | -0.00 | 0.11 | -0.12 | 0.14 | 0.16 | 0.10 |
| | 2 year | 0.04 | 0.11 | -0.12 | 0.14 | 0.27** | 0.10 |
| | 5 year | -0.02 | 0.08 | -0.15 | 0.10 | 0.17** | 0.06 |
| | 10 year | 0.03 | 0.05 | -0.09* | 0.05 | 0.18*** | 0.06 |
| *Stocks* | Euro STOXX 50 | -1.0 | 3.6 | -17.5*** | 4.1 | 19.8*** | 4.0 |
| | Euro STOXX Banks | 0.8 | 4.5 | -19.8*** | 4.9 | 26.9*** | 5.8 |
| | VSTOXX | 6.6 | 12.3 | 49.8*** | 16.6 | -48.0*** | 16.6 |
| *Exchange Rates* | US Dollar | 7.6*** | 1.7 | 9.8*** | 2.5 | 4.8** | 2.3 |
| | British Pound | 6.3*** | 1.0 | 8.0*** | 1.4 | 4.1** | 1.6 |
| | Swiss Franc | 3.9*** | 1.1 | 3.6*** | 1.1 | 4.3*** | 1.6 |
| | Japanese Yen | 7.3*** | 2.1 | 8.0*** | 2.8 | 6.3* | 3.5 |
| | Chinese Yuan | 3.1** | 1.3 | 2.6 | 1.9 | 3.8** | 1.7 |
| Euro STOXX 50 Earnings | | -1.5 | 2.4 | -6.2* | 3.4 | 4.9* | 2.6 |
| Euro STOXX 50 Dividends | | 0.9 | 2.1 | -4.0 | 2.8 | 7.7*** | 2.8 |
| *GDP Growth* | Euro area | -0.20 | 0.31 | -0.95** | 0.37 | 0.47 | 0.51 |
| | Country panel | -0.26 | 0.30 | -0.97** | 0.39 | 0.36 | 0.50 |
| *Ind. Prod. Growth* | Euro area | -0.52 | 1.05 | -1.91* | 1.04 | 0.72 | 1.88 |
| | Country panel | -0.72 | 0.70 | -1.67** | 0.74 | 0.11 | 1.24 |
| *Unemp. Rate* | Euro area | 0.35* | 0.21 | 0.93*** | 0.32 | -0.16 | 0.26 |
| | Country panel | 0.27* | 0.15 | 0.77*** | 0.23 | -0.18 | 0.23 |
| *CPI Inflation* | Euro area | -0.08 | 0.19 | -0.40 | 0.28 | 0.21 | 0.29 |
| | Country panel | -0.03 | 0.23 | -0.50** | 0.25 | 0.38 | 0.43 |
| *PPI Inflation* | Euro area | -0.64 | 0.52 | -1.62** | 0.63 | 0.23 | 0.93 |
| | Country panel | -0.30 | 0.36 | -0.74 | 0.46 | 0.08 | 0.63 |

See Tables 1 and 2 for details. Robust standard errors are obtained by treating the surprises as observable regressors.

# Appendix B Data Details

## B.1 Event Days

As mentioned in Section 2, I study high-frequency futures prices on ECB Governing Council meeting (GCM) days. From late 2001 onwards, GCMs took place on the first Thursday of each month, with a few exceptions at the beginning of the year and during the summer recess. Since 2015, meetings dedicated to monetary policy changed to a new six-week cycle, whereas non-monetary policy meetings continue to be held at least once a month.[12] As is standard in the literature, I only study GCMs dedicated to monetary policy. As is also standard, I exclude the unscheduled meeting on 8 October 2008, in which the ECB announced a coordinated rate cut with other major central banks. In total, my sample consists of 189 meetings, the exact dates of which are shown in Table A6. Seven

Table A6: Overview of Governing Council Meeting Days

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2002 | | | 7 | 4 | 2 | 6 | 4 | 1* | 12 | 10 | 7 | 5 |
| 2003 | 9 | 6 | 6 | 3 | 8 | 5 | 10,31* | | 4 | 2 | 6 | 4 |
| 2004 | 8 | 5 | 4 | 1 | 6 | 3 | 1 | 5* | 2 | 7 | 4 | 2 |
| 2005 | 13 | 3 | 3 | 7 | 4# | 2 | 7 | 4* | 1 | 6 | 3 | 1 |
| 2006 | 12 | 2 | 2 | 6 | 4 | 8 | 6 | 3,31 | | 5 | 2 | 7 |
| 2007 | 11 | 8 | 8 | 12 | 10 | 6# | 5 | 2* | 6 | 4 | 8 | 6 |
| 2008 | 10 | 7 | 6 | 10 | 8 | 5 | 3 | 7 | 4 | 2 | 6 | 4 |
| 2009 | 15 | 5 | 5 | 2 | 7 | 4 | 2 | 6 | 3 | 8 | 5 | 3 |
| 2010 | 14 | 4 | 4 | 8 | 6 | 10 | 8 | 5 | 2 | 7 | 4 | 2 |
| 2011 | 13 | 3 | 3 | 7 | 5 | 9 | 7 | 4 | 8 | 6 | 3 | 8 |
| 2012 | 12 | 9 | 8 | 4# | 3 | 6# | 5 | 2 | 6 | 4 | 8 | 6 |
| 2013 | 10 | 7 | 7 | 4 | 2 | 6 | 4 | 1 | 5 | 2# | 7 | 5 |
| 2014 | 9 | 6 | 6 | 3 | 8 | 5 | 3 | 7 | 4 | 2 | 6 | 4 |
| 2015 | 22 | | 5 | 15# | | 3# | 16 | | 3 | 22 | | 3 |
| 2016 | 21 | | 10 | 21 | | 2 | 21 | | 8 | 20 | | 8 |
| 2017 | 19 | | 9 | 27 | | 8 | 20 | | 7 | 26 | | 14 |
| 2018 | 25 | | 8 | 26 | | 14 | 26 | | 13 | 25 | | 13 |
| 2019 | 24 | | 7 | 10# | | | | | | | | |

times, the GCM was preponed to a Wednesday (marked with a hash character). On five of the selected GCM dates, no press conference was held (marked with an asterisk). In the latter cases, I extract future price movements only around the press release at 13:45 (CET), i.e. I use an event window from 13:35 till 14:05.[13] For all other GCMs, I use an event window from 13:35 until 20 minutes after the end of the press conference.

[12] See www.ecb.europa.eu/press/pr/date/2014/html/pr140703_1.en.html

[13] Up until 2014, press releases only announced policy rate decisions. In January and December 2015, the releases contained an additional note that "*further monetary policy measures will be communicated [..] at [the] press conference [..] today*" (in the ensuing press conferences, the introduction and extension of the public sector purchase programme were announced, respectively). Since March and July 2016, press releases contain even more detailed information about non-standard policy measures, namely about purchase programmes (e.g. regarding volumes and horizons) and future policy rates, respectively.

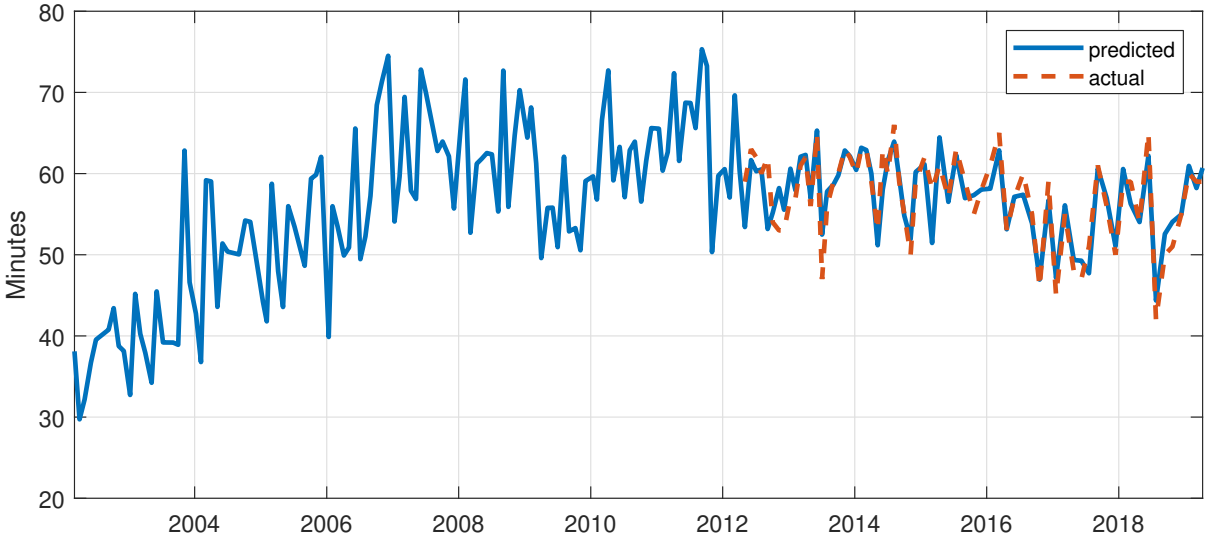
## B.2 Press Conference Duration

While the start of ECB press conferences is fixed at 14:30, their duration is not. Hence, I use video recordings to manually determine the duration $D_t$. Since there are no recordings of press conferences prior to May 2012, I obtain an estimate $\hat{D}_t$ of their length as follows:[14]

$$\begin{aligned} &\text{I regress} && D_t = \mu + \delta_t \#Words_t + \zeta_t && \text{for } t = \{62 \text{ GCMs with video recording}\} \\ &\text{and predict} && \hat{D}_t = \hat{\mu} + \hat{\delta}_t \#Words_t && \text{for } t = \{117 \text{ GCMs without video recording}\} \end{aligned}$$

where $\#Words$ is the number of words in each press conference transcript. The regression yields an $R^2$ of 78% and, as Figure A2 shows, the transcripts document a substantial variation in the length of press conferences over time (as also shown by Ehrmann and Fratzscher, 2009). Most notably, ECB press conferences in the early 2000s were often only half as long as those since the financial crisis.

Figure A2: Length of ECB Press Conferences



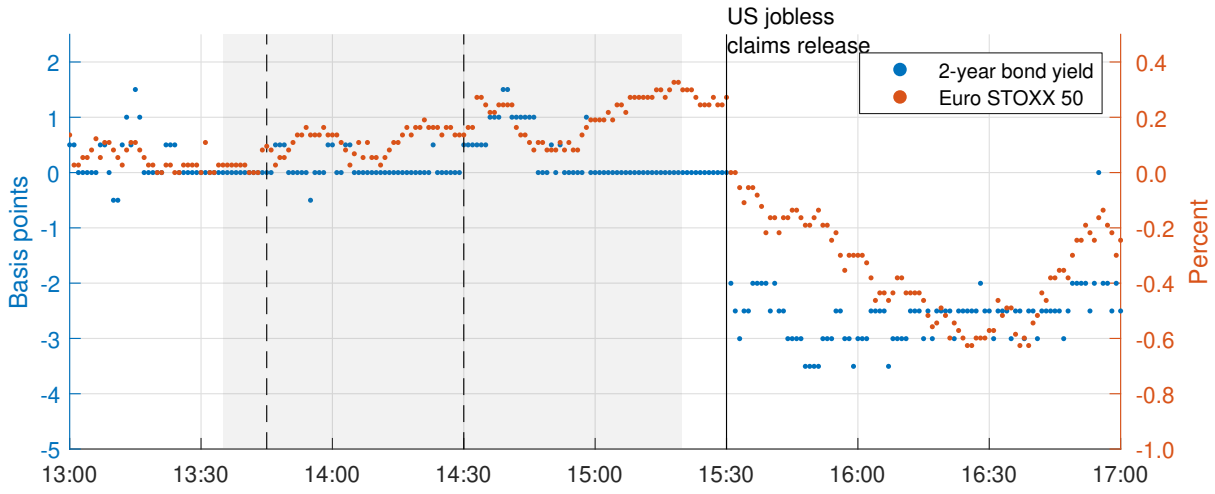

The dashed red line shows the actual length of all press conferences for which a video recording is available. The solid blue line shows the predicted press conference length based on the number of words in the respective conference transcript.

Figure A3, moreover, shows how important the precise timing of press conferences can be. In particular, the figure shows future prices on the GCM day of 4 April 2002. This day is noteworthy for three reasons: First, the press conference on that day was particularly brief (according to the transcript word count it lasted only about half an hour). Second, US initial jobless claim numbers were released at 15:30 (CET) that day, not at 14:30 as usual (due to different daylight saving time periods between Europe and the US).[15] Third, the released jobless claim numbers were much higher than expected (constituting the second-largest surprise throughout the sample). As the figure shows,

[14] Video recordings are available for all press conferences since May 2012 at www.ecb.europa.eu/press/tvservices/webcast, transcripts of all conferences at www.ecb.europa.eu/press/pressconf.

[15] In Europe, daylight saving time applied between the last Sunday in March and the last Sunday in October throughout my sample. In the US, the corresponding dates were the first Sunday in April and the last Sunday in October (till 2006), and the second Sunday in March and the first Sunday in November (from 2007 onwards).

Figure A3: Intraday Futures Data on 4 April 2002




The grey area indicates the event window from 13:35 to 15:20 (CET), i.e. 10 minutes prior to the press release and 20 minutes after the end of the press conference. At 15:30, unexpectedly high US initial jobless claim numbers were released.

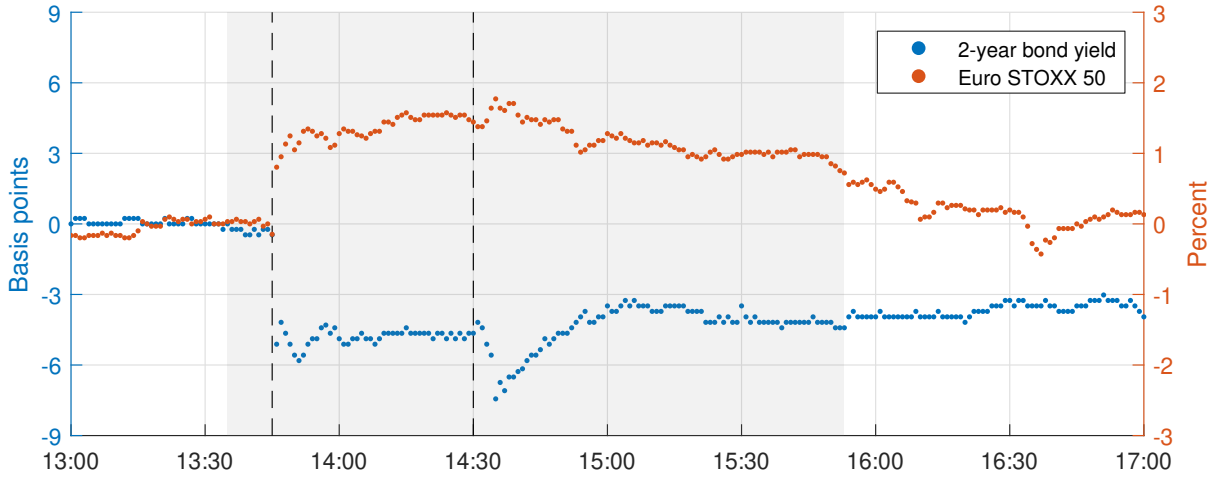
the unexpected bad news about the US economy led to an immediate and sizeable drop in German bond yields and stock prices beginning at 15:30. If one were to use a fixed event window end at 15:50 or even later – as is commonly done in the literature – one might falsely attribute these market reactions to the ECB press conference, which had already ended at about 15:00. Note that I use data releases like the one on 4 April 2002 – i.e. releases that occurred outside of event windows – to purge the effect of releases that occurred within event windows, see Section B.4.1.

## B.3 Narrative Evidence

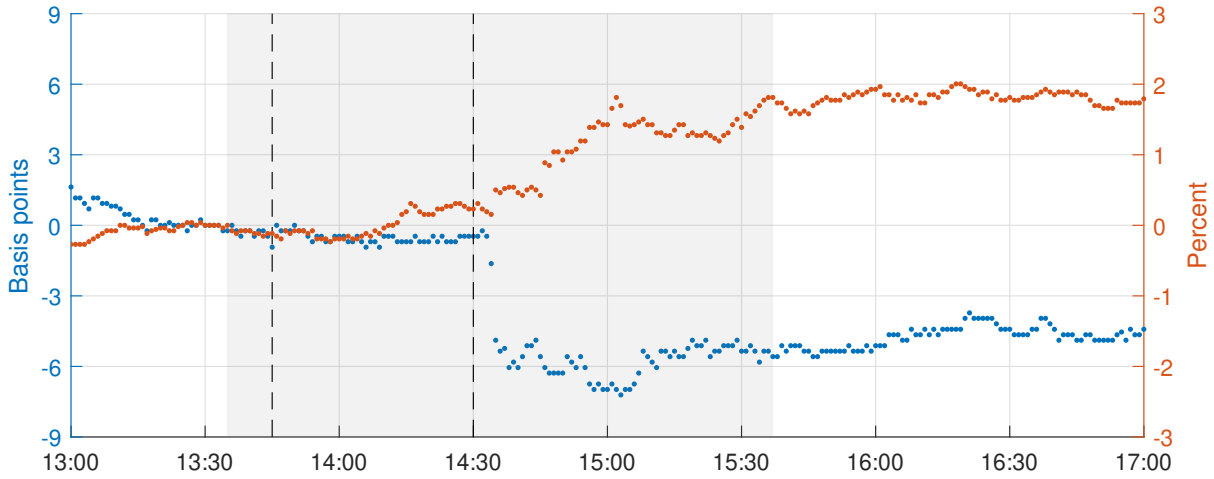
Figure A4 plots yield and stock price movements around three selected Governing Council meetings, marked by black asterisks in Figure 1. Panel (a) refers to 7 November 2013, when the ECB surprised markets with a 25bp rate cut. Panel (b) shows market reactions to the previous July meeting. On that day, policy rates were kept unchanged, in line with market expectations, but in the press conference the ECB surprised markets by introducing forward guidance to its policy toolkit. In particular, the introductory statement announced that "the Governing Council expects the key ECB interest rates to remain at present or lower levels for an extended period of time". Panel (c), lastly, refers to the meeting on 22 October 2015, when ECB president Mario Draghi – in his introductory statement and during the subsequent Q&A session – fueled expectations about an extension of the public sector purchase programme (which was indeed announced in December). All three announcements led to an immediate drop in 2-year bond yields, suggesting they were expansionary policy surprises. And indeed, as yields declined, stock prices climbed each time.

Figure A5, on the other hand, depicts three Governing Council meetings where market reactions are hard to reconcile with monetary policy news alone, those meetings are marked by crosses in Figure 1. Judged by the response of bond yields – which fell in all three cases – the announcements were expansionary. Stock prices, however, *declined* along with yields, which is exactly the opposite of what we would expect from expansionary

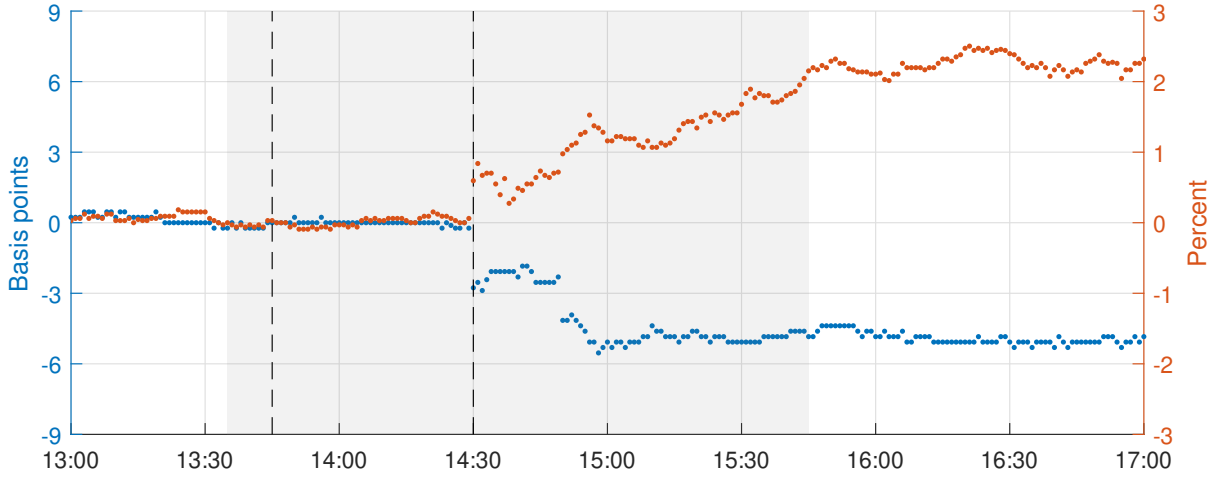
Figure A4: Examples of Expansionary Monetary Policy Surprises




(a) Governing Council meeting on 7 November 2013



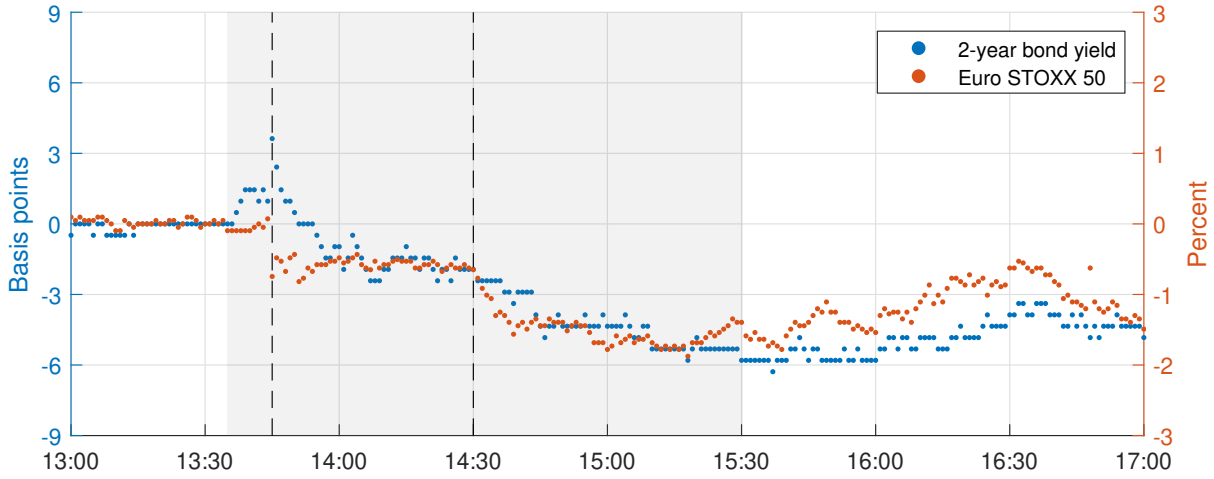

(b) Governing Council meeting on 4 July 2013



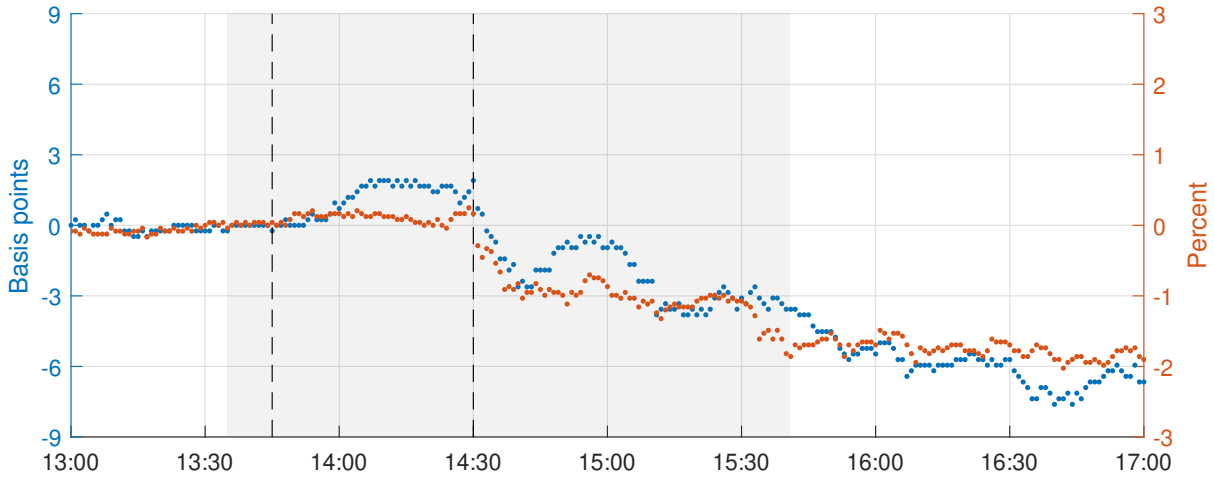

(c) Governing Council meeting on 22 October 2015

Change in yields (in basis points, left axis) and stock prices (in percent, right axis) normalized to 0 at 13:35. Vertical dashed lines mark the press release at 13:45 and the press conference start at 14:30. The grey area indicates the event window.

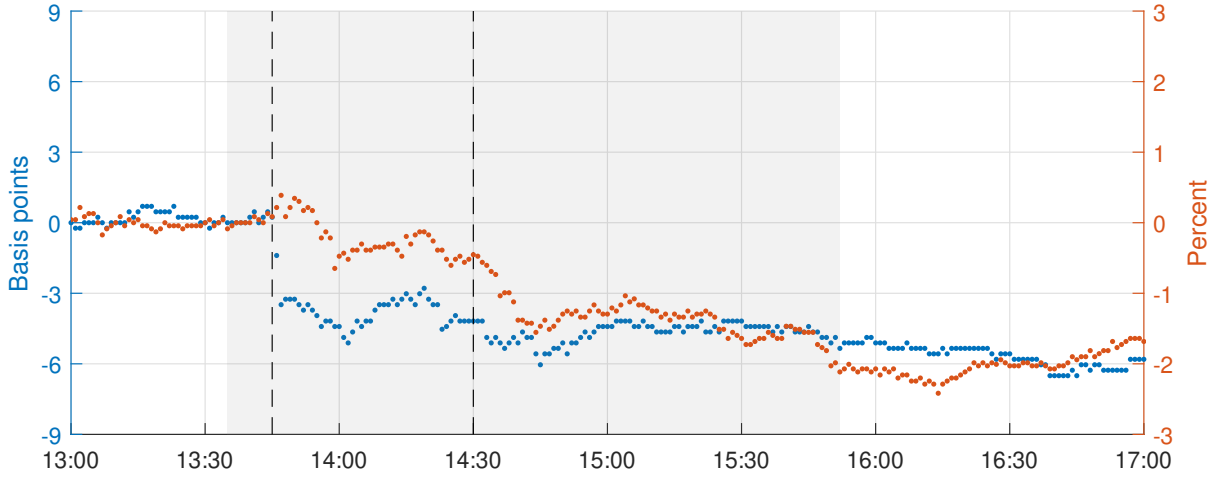
Figure A5: Examples of Adverse Central Bank Information Surprises




(a) Governing Council meeting on 6 March 2003




(b) Governing Council meeting on 2 July 2009




(c) Governing Council meeting on 5 July 2012

Change in yields (in basis points, left axis) and stock prices (in percent, right axis) normalized to 0 at 13:35. Vertical dashed lines mark the press release at 13:45 and the press conference start at 14:30. The grey area indicates the event window.

policy surprises. Strikingly, stocks mainly declined during press conferences, and in each of these conferences the ECB discussed a deterioration in the economic outlook.

Panel (a) refers to 6 March 2003, when then-president Willem Duisenberg explained in his introductory remarks that the ECB has cut its policy rates by 25bp because "the outlook for economic growth in the euro area in 2003 has weakened compared with previous expectations". In response to a journalist's question, he later added that "growth figures and the inflation figures had, sorry to say it, to be revised downward and not insignificantly". On 2 July 2009, shown in panel (b), Duisenberg's successor Jean-Claude Trichet declared in his introductory remarks that "economic activity over the remainder of this year is likely to remain weak". Panel (c), lastly, depicts the Governing Council meeting on 5 July 2012. After lowering policy rates by 25bp, ECB president Mario Draghi commenced the ensuing press conference by saying that "downside risks to the euro area growth outlook have materialised" and that "economic growth in the euro area continues to remain weak".

According to the central bank information literature, it is these pessimistic statements that might have caused the simultaneous drop in yields and stock prices around all three meetings, namely by inducing downward revisions in the growth forecasts of market participants.

## B.4 High-Frequency Data

The core of my analysis is based on tick-by-tick data on two futures traded on the derivatives exchange Eurex, see Table A7.[16]

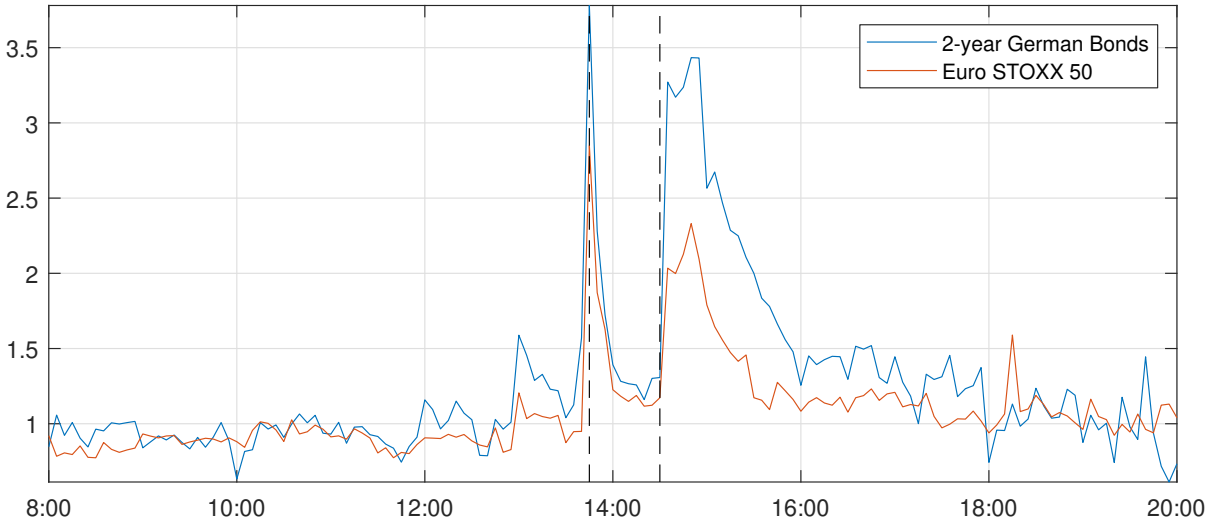
Table A7: Overview High-Frequency Futures

| | Underlying | avg. trading volume on GCM days | avg. abs. change around event window |
|---|---|---|---|
| 2-year yield | German bonds maturing in 1.75-2.25y | 416,581 | 2.9 bp |
| Stock prices | Euro STOXX 50 index | 751,463 | 50.2 bp |

Both futures are highly liquid, ensuring that any new information released by the ECB is quickly incorporated into market prices. In line with this, Figure A6 compares the intraday trading volume pattern on Thursdays with Governing Council meetings to those without. The figure documents two obvious spikes in trading activity. The first one coincides with the ECB's press release at 13:45, when the number of traded contracts is roughly three times as high as usual. Consistent with the brief and highly standardized text of those releases, market participants seem to digest the new information quickly, as trading decreases almost back to normal within a few minutes. The second spike in trading activity occurs right after the press conference start at 14:30 and is more persistent, roughly matching the average conference length of one hour.

[16] For each future, three contracts with different expiring horizons can be traded on Eurex (one for each of the three nearest quarterly months of the March, June, September and December cycle). Throughout, I use only data on the shortest-dated futures, which account for over 90% of all traded contracts. German bond futures have a contract value of EUR 100,000. The Euro STOXX 50 future has a contract value of EUR 10 per index point, with a base value of the index of 1000 on 31 December 1991.

Figure A6: Intraday Trading Activity on Governing Council meeting Days




Ratio of average trading volume on event days versus control days, in five-minute intervals. Trading volume refers to the number of traded contracts of the shortest-dated future. Event days refer to the 189 Governing Council meetings listed in Table A6. Control days are all 657 Thursdays between March 2002 and April 2019 without an ECB announcement. Vertical dashed lines refer to 13:45 and 14:30.

To isolate the immediate market reaction to each ECB announcement, I select $P_1$, the last trading price prior to the event window (i.e. before 13:35), and $P_2$, the first trading price after the event window (i.e. 20 minutes after the press conference ended). For the stock market future, the "raw" intraday change $\tilde{x}_t$ refers to simple percentage changes

$$\tilde{x}_t^{stocks} = \frac{P_t^2 - P_t^1}{P_t^1} * 100. \tag{A1}$$

For the bond future, which is quoted in percent of the par value, I follow Rogers, Scotti, and Wright (2014) and transform price changes into approximate yield changes as

$$\tilde{x}_t^{2y\,yield} = \left( \frac{P_t^2 - P_t^1}{P_t^1} * 100 \right) / - D_t \tag{A2}$$

where $D_t$ is the modified duration of the cheapest-to-deliver bond at time $t$, taken from Bloomberg. This procedure is necessary because at expiration of the contract, the seller of a bond future can fulfill his delivery obligation with any German government bond that matures within 1.75 to 2.25 years. In practice, however, only one of the eligible bonds is used: the so-called cheapest-to-deliver.[17] Thus, to translate price changes in a future into the implied yield changes in the underlying, one has to adjust for the duration of the cheapest-to-deliver bond.

[17]Since bond futures refer to notional bonds with a coupon of 6%, Eurex provides conversion factors for all deliverable bonds in each future contract, see www.eurexchange.com/exchange-en/market-data/clearing-data/deliverable-bonds-and-conversion-factors.

### B.4.1 Purging the Effect of Contemporaneous US Data Releases

As Figure A3 shows by way of example, data releases about the US economy can have a large impact on the futures I study. This is problematic because many data releases occur on Thursdays at 8:30 (ET), i.e. simultaneously to the start of the ECB's press conference at 14:30 (CET). US data releases might thus invalidate the key assumption from Section 2 that ECB announcements are the main driver of the intraday future movements I study.

To address this issue, I run the following regression for each future $i$:

$$x^i_{t_{US}} = \gamma^i + \Theta^i s_{t_{US}} + e^i_{t_{US}} \qquad \text{for } t_{US} = \{1465 \text{ releases outside event windows}\}. \quad \text{(A3)}$$

The vector $s_t$ contains "surprise components" of US economic indicators that may be released during ECB event windows. Surprise components are defined as the difference between the actual release and its median forecasted value, divided by the standard deviation of forecasts. The dependent variable $x^i_{t_{US}}$ is the 30-minute future movement corresponding to each release date (10 minutes prior and 20 minutes after the release). When there is no data release for a series on a particular US release date $t_{US}$ – or the released value is identical to the expected value – the corresponding entry in $s$ is zero. Since I want to estimate the independent effect of US macro releases, I exclude any releases that occurred within ECB event windows. As Table A8 shows, most US data releases have a highly significant impact on European futures. Furthermore, during all but six of the 189

Table A8: Reaction of Futures to US Data Releases

| | 2-year yield | | Stock prices | | |
|---|---|---|---|---|---|
| | $\hat{\Theta}$ | *s.e.* | $\hat{\Theta}$ | *s.e.* | # releases in event windows |
| Constant | 0.00 | 0.03 | 2.07** | 0.92 | |
| Initial Jobless Claims | -0.30*** | 0.04 | -8.34*** | 1.20 | 167 |
| Continuing Claims | -0.11** | 0.05 | -2.07 | 1.33 | 155 |
| Nonfarm Productivity | 0.04 | 0.13 | 8.36*** | 2.90 | 48 |
| Trade Balance | 0.17** | 0.08 | 5.37** | 2.42 | 16 |
| Employment Change (ADP Report) | 0.35*** | 0.08 | 11.32*** | 2.56 | 11 |
| Philadelphia Fed Business Outlook | 0.42*** | 0.10 | 10.86*** | 3.06 | 6 |
| Retail Sales Advance MoM | 0.34*** | 0.10 | 15.50*** | 3.01 | 5 |
| Change in Nonfarm Payrolls | 1.64*** | 0.24 | 36.38*** | 3.99 | 3 |
| PPI MoM | 0.24** | 0.11 | -4.53 | 3.19 | 3 |
| adj. $R^2$ | 0.20 | | 0.16 | | |

Each column refers to a separate regression, see Equation (A3). The dependent variable is the 30-min movement in the future listed in the column header. Rows refer to explanatory macro releases. Coefficients refer to basis point changes to one standard deviation surprises. The number of observations is 1527, the total number of non-zero surprises is 2493.

event windows from Section B.1, at least one US indicator has been released. As the last column of Table A8 shows, US jobless claim figures most frequently coincide with ECB announcements.

To control for these contemporaneous releases, I purge the "raw" futures movements from Section B.4 as follows:

$$x_{it} = \tilde{x}_{it} - \hat{\Theta}_i s_t, \qquad \text{for } t = \{180 \text{ releases within event windows}\}. \quad \text{(A4)}$$

### B.4.2 Effect of Domestic Macroeconomic Data Releases

In principle, the effect of an improved economic outlook on stock prices is a priori ambiguous: higher output raises not just dividend expectations, but also the interest rates at which these dividends are discounted. The positive cash flow effect, in other words, could be outweighed by the negative discount rate effect.

To test the relevance of this concern, I run the same regression as in Equation (A3) for eight European data releases. Table A9 shows that higher-than-expected output increases both yields and stock prices. The same is true for surveys: positive surprises to the current and expected economic situation lift both yields and stock prices. Most of these effects are also highly significant. In sum, the results are in line with the assumption from Section 2 that a positive central bank information surprise raises stock prices.

Table A9: Reaction of Futures to Domestic Macroeconomic Releases

| | 2-year yield | | Stock prices | |
|---|---|---|---|---|
| | $\hat{\Theta}$ | *s.e.* | $\hat{\Theta}$ | *s.e.* |
| Constant | 0.05** | 0.02 | 0.99 | 0.69 |
| **Output** | | | | |
| Euro area Industrial Production | 0.16** | 0.07 | 2.90* | 1.74 |
| Germany Industrial Production | 0.18** | 0.07 | 4.31** | 1.85 |
| Germany Factory Orders | 0.36*** | 0.09 | 10.85*** | 2.69 |
| **Surveys** | | | | |
| Euro area Economic Sentiment Index | 0.23*** | 0.05 | 0.69 | 2.03 |
| ifo Current Situation | 0.65*** | 0.14 | 9.66*** | 2.28 |
| ZEW Current Situation | 0.07 | 0.06 | 3.52** | 1.61 |
| ifo Expectations | 0.26** | 0.11 | -2.35 | 2.28 |
| ZEW Expectations | 0.43*** | 0.07 | 4.38*** | 1.45 |
| adj. $R^2$ | 0.14 | | 0.04 | |

Each column refers to a separate regression, as in Table A8. The dependent variable is the 30-minute movement in the future listed in the column header. Rows refer to explanatory macro releases. Coefficients refer to basis point changes to one standard deviation surprises. The number of observations is 1200, the total number of non-zero surprises is 1558.

## B.5 Lower Frequency Data

In Section 3.1, I study the response of various financial variables to policy announcements. Daily sovereign bond yields, exchange rates, and stock market indices are sourced from Bloomberg. As a market-based measure of inflation expectations I use data on inflation-linked swaps from Datastream, since the inflation-indexed bond market is still comparatively small in the euro area. Sections B.5.1 and B.5.2 describe the two surveys I use in Section 3.2 to investigate whether market participants revise their economic expectations in response to ECB announcements. In both cases, I use constant-horizon 1-year forecasts, computed as a weighted average of forecasts for the current and next year.

### B.5.1 I/B/E/S Analyst Forecasts

Forecasts of earnings and dividend growth for the Euro STOXX 50 index are from the Institutional Brokers Estimate System (I/B/E/S). The weekly forecasts are available since

2006 and refer to the cap-weighted averages of individual stock forecasts. These individual stock forecasts in turn are based on the average forecast across analysts (each of the 50 constituent stocks is covered by roughly 30 analysts). Since forecasts are "sticky", I study analysts' revisions over the two-week period following ECB Governing Council meetings (the frequency of revisions fluctuates in sync with the quarterly earnings season; on average, about 22% of all analysts revise their earnings forecasts from one week to the next, while 11% revise their dividend forecasts). Table A4 confirms that results are similar when using shorter or longer (one- to four-week) revision horizons.

### B.5.2 Consensus Economics Forecasts

Forecasts of macroeconomic aggregates are based on monthly surveys from Consensus Economics, covering GDP growth, industrial production growth, the unemployment rate, and CPI and PPI inflation. Besides aggregate euro area figures, forecasts are available for up to eleven individual member states (Germany, France, Italy, Spain, the Netherlands, Austria, Belgium, Finland, Greece, Ireland and Portugal).[18] I define forecast revisions as the difference between the first forecasted value after a Governing Council meeting and the previous forecast. In the few cases where two announcements took place between the forecasts, I cumulate the surprise series.

One important caveat regarding the Consensus data is that the survey schedule overlaps with the day of ECB Governing Council meetings (at least till 2015, see Table A6). In particular, Consensus Economics dispatches its survey on the first Wednesday of every month (i.e. often the day before the ECB meeting) and accepts responses until the following Monday. This is problematic, because survey responses could be sent before or after the policy announcement, invalidating any Granger causality tests. In private correspondence, however, Consensus Economics confirmed that very few participants answer the survey immediately. Most participants reply on Monday, i.e. any news released by the ECB on the previous Thursday ought to be incorporated into their forecasts.

[18] GDP and CPI forecasts are available for eleven countries (see Table A3), industrial production forecasts for ten countries (not for the Netherlands), unemployment rate forecasts for three countries (Germany, France, Italy), and producer price inflation forecasts for two countries (Germany and France).