News and Noise Shaping International Yield Curves*

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Abstract

We study the joint response of US and euro area yields to both US and euro area news using a new semi-latent factor methodology, where some news are observable and some are not. US news announcements have larger effects than EA announcements, perhaps because the latter are less timely and released in a more staggered way. We show that not only are there spillovers from the US to the euro area, but also the other way around, although to a lesser extent. Overall, our understanding of yield curve movements is much better than previously thought.

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Keywords: Event Study, Bond Markets, High-Frequency Data, Identification.

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1 Introduction

Yield curves are constructed from bond prices, which (should) depend on the current and expected state of the economy, as well as risk pricing. Changes in the yield curves should therefore depend on news – updates to the current and expected state vector, which also drives risk pricing – and market noise. One hopes that market noise is not very large and that changes in yields can be related to updates to market participants' information sets.

But what constitutes news? Where to look to measure updates to information sets? The literature has focused on scheduled macroeconomic news releases for which expectations surveys exist and hence the news component can be measured. But although such news indeed seem to move yield curves, the fraction of the variance explained by news even in tight (20 minute) intraday event windows ranges from one-fifth to two-fifths, a very unsatisfactory state of affairs. Labeling the residual as noise both involves a rather strong assumption that the reaction to news is correctly measured and any residual is noise, and an argument that a great majority of bond pricing even around important economic news releases is just noise.

In this paper, we will tackle several issues about bond pricing and yield curves simultaneously. We will show *what* moves yields at various maturities, make a decomposition between observed news (surprises in headline announcements), latent news factors, and noise. The noise can further be decomposed into a common factor that exists with or without an announcement and a vector of uncorrelated residuals. We will show the interplay between US and euro area (EA) yield curves and news, and we will have an answer to *why* these curves behave the way they do.

It turns out that news explains a great majority of event window changes in short-term yields in both the US and the EA. We also discuss what these news represent. The most pertinent news for both countries[1] are the US news but spillovers are not unidirectional, some EA news affect US yields as well. News explains a large share of variance in long-

[1] We use the term "country" for both the US and EA for convenience although the EA obviously is not one country.

term US yields in the event windows, but we find that they explain less of EA long-term yields. That brings us to *why*, which required the joint study of the two countries. The main difference between the US and EA in our sample period (2002-2019) is that the ECB was a credible inflation targeter for all of this period but the FOMC only articulated a numerical inflation target in 2012, past the middle of the sample.

Hence, EA long-term yields are less sensitive to incoming news as expected steady state inflation is anchored (not always at the desired level) whereas learning about the target – the definition of "stable prices" – was ongoing in the US. News' contribution to long-term yield variance is therefore quite different in the two countries. However, noise is noise and similarly affects pricing in the US and EA. Thus, noise explains a greater share of long-term yields in the EA but this is a share of much lower total variance.

Methodologically, we make use of a long line of research utilizing event studies going back to Fama, Fisher, Jensen and Roll (1969). All of this literature focuses on headline news but news releases are multidimensional – think of the FOMC statement or the details in the employment report – and hence contain more news than is observable to the econometrician. Focusing only on headline news understates the fraction of variance in asset prices that is attributable to news. We therefore use the new method proposed by Gürkaynak, Kısacıkoğlu and Wright (2020) – henceforth GKW – to pin down news perceived by market participants but unobservable to researchers as latent variables.

In what follows, we first introduce the data, then explain how our estimator works and why it is appropriate for these questions, and then present results. Discussion of the results and some robustness tests follow, with a lot more relegated to appendices.

2 Data

We study yield curve responses in the US and the euro area (EA). Our high-frequency data are based on interest rate and bond futures and cover six different maturities, ranging from three months to thirty years. The sample period is from March 2002 to December

2019. Appendix A has details.

We study responses to two types of news: macroeconomic data releases and monetary policy announcements of the US and the EA. For all news, we study yield curve responses over a 20 minute window from 5 minutes before the release to 15 minutes afterwards. The only exceptions are central bank announcements that were followed by a press conference. In those cases, our event window starts 5 minutes before the press release and ends 70 minutes after the start of the press conference.[2]

For macroeconomic data releases, we compute "surprises" as the difference between the actual release and its median forecasted value. Throughout, we scale surprise series by their sample standard deviation, to make the units comparable.

US news: For the US, we study the same 14 releases as in GKW. All of these releases take place at 8:30 a.m. US Eastern Time. As our US monetary policy news measure we use changes in short-dated federal funds futures around scheduled FOMC announcements, as in Kuttner (2001).[3]

Euro area news: For the EA, we study ten different news releases. EA aggregate data releases usually contain no surprises as country level data are released beforehand and weights are known. Hence, most releases we utilize are specific to Germany, but we also consider releases of euro area M3 and CPI as well as monetary policy news. Apart from monetary policy, all releases occur at 10:00 a.m., 11:00 a.m. or 12:00 (noon) Central European Time (CET). Our monetary policy news measure for the euro area is the change in the one-month OIS rate around scheduled ECB announcements.[4] The monetary policy surprise is obtained from the dataset of Altavilla, Brugnolini, Gürkaynak, Motto and

[2]If there was no trade within 30 minutes before the window start or within 30 minutes after the window end, we impute missing values. For monetary policy announcements this restriction is not imposed, i.e. we allow for overnight changes if e.g. an FOMC announcement occurs after trading hours in Europe (which happened occasionally prior to 2005).

[3]For FOMC days with a press release at 12:30 p.m. and a press conference at 2:15 p.m., we use an event window from 12:25-3:25 p.m. For FOMC days with a press release at 2:00 p.m. and a press conference at 2:30 p.m., we use an event window from 1:55-3:40 p.m. For FOMC days without a press conference, we use the usual 20 minute event window around the press release.

[4]On ECB Governing Council meeting days, we use a window from 1:40 to 3:40 p.m. This window spans the press release at 1:45 p.m. and the ensuing press conference that starts at 2:30 p.m. For meetings without a press conference, we use the usual 20 minute event window around the press release.

Ragusa (2019).

Control windows: For all of the above-mentioned news, we use appropriate control windows without news. To achieve maximum comparability, we construct control windows by shifting event windows by exactly one week in either direction. The only exception are US initial jobless claims, which are released weekly. In this case, we instead shift the event windows by one day forward and backward. This approach generates two candidate control windows of equal length and with identical intraday times for each event window. As a last step, we drop any control windows that overlap with an event window.[5]

3 Methodology

We consider a number of ways of estimating the effects of macroeconomic news announcements on asset returns. The first is the simple OLS method which is well known to produce estimates that explain a low fraction of the variance. We will use this to build intuition. The OLS set up is:

$$y_t = \beta' s_t + \varepsilon_t \tag{1}$$

where y_t is a vector of yield changes at times of day where there may or may not be an announcement. The vector s_t captures observable surprises in macroeconomic or monetary policy announcements, i.e. s_t is set to 0 if there is no announcement in that window. y_t includes 12 yield changes, covering six different maturities for both the US and the EA. Likewise, s_t captures 24 observable surprises, 14 from the US and 10 from the EA. Equation (1) can straightforwardly be estimated by OLS, and this is the most common event study methodology.

This approach relies on the surprises being well measured. An alternative approach posits instead that the surprise is observed with classical measurement error. In this case,

[5] One further complication arises from the fact that US initial jobless claim releases usually coincide with the start of ECB press conferences. Hence, some US event windows from 2:25 to 2:45 p.m. Central European Time (CET) fall within ECB event and control windows from 1:40 to 3:40 p.m. CET. In these cases, we compute market responses only over the 2 hour windows, dropping the 20 minute windows in both event and control windows.

the model can still be identified using the approach of Rigobon and Sack (2003, 2004, 2005, 2008) which relies on comparing the variance of y_t in announcement windows, the variance of y_t in comparable windows without announcements, and the covariance between y_t and the mismeasured surprise in announcement windows, known as heteroskedasticity-based identification.

Our approach instead posits that the surprises are measured with negligible error – which GKW document for the US news – but that these observed surprises are only part of the news that comes out in the announcement. Think of the revision to the previous release that is part of many data releases, or information about expenditure components' growth that is part of the GDP report. Expectations for these are not surveyed so we do not know what the surprises are, but we do know that such surprises are possible in these windows. We estimate these as latent factors and also estimate their effects in one efficient step.

The baseline model that we specify is:

$$y_t = \beta' s_t + \gamma' d_t f_t + \varepsilon_t \tag{2}$$

where d_t is a dummy that is 1 if there is an announcement in that window and 0 otherwise, f_t is an i.i.d. $N(0,1)$ latent variable and ε_t is i.i.d. normal with mean zero and diagonal variance-covariance matrix. GKW show that this is roughly equivalent to estimating the responses to observable surprises by OLS and the responses to unobserved surprises by heteroskedasticity-based identification using the residuals, but is efficiently done in one step.

Note that f_t is a latent factor common to all data releases. The variance of f_t is normalized to 1, because otherwise γ would be identified only up to scale. For identification, we also require that d_t is equal to 1 for some, but not all, observations – that is, there are both event and control dates in the sample. We can then estimate equation (2) by maximum likelihood using the Kalman filter, giving us estimates of the latent factor f_t

as a by-product.

The model that we start out with assumes that there is a single factor common to all releases, but it seems desirable to relax this assumption. We can do this within the same framework in a number of ways. One possibility is to specify that:

$$y_t = \beta' s_t + \Sigma_{c=1}^{2} d_{ct}\gamma_c f_{ct} + \varepsilon_t \tag{3}$$

where d_{ct} is a dummy that is 1 if an announcement comes out in country c (the US or EA) on day t and zero otherwise. In this case the latent factors are differentiated by country.[6] The latent factors f_{ct} are i.i.d. standard normal and mutually independent, as before.

Another possibility is to specify that:

$$y_t = \beta' s_t + \Sigma_{i=1}^{I} d_{it}\gamma_i f_{it} + \varepsilon_t \tag{4}$$

where d_{it} is a dummy that is 1 if an announcement of the ith type comes out on day t and zero otherwise and I is the number of announcement types. This allows for factors specific to each type of release. The latent factors f_{it} are i.i.d. standard normal and mutually independent. We know from previous work that monetary policy announcements in both the US and the EA are sometimes associated with multiple distinct latent factors (eg. capturing forward guidance and quantitative easing, see Gürkaynak, Sack and Swanson, 2005; Swanson, 2021; Altavilla et al., 2019). Hence, we allow for three latent factors around both FOMC and ECB announcements. Since we are not directly interested in an economic interpretation of those factors, however, we do not aim to identify them (e.g. by applying a suitable rotation).

In equations (2)-(4) the only term that affects yields other than the observed and latent news is the residual, ε_t, the elements of which are assumed to be contemporaneously uncorrelated. This is a strong assumption that in event windows yields are driven either by news – observable and latent – or contemporaneously uncorrelated residuals. This

[6]The factors are differentiated based on the *origin* of the news, the LHS vector is the same.

does not allow for common ever-present market noise. The next extension we consider does, by allowing for a factor that affects yields in all intraday windows, whether there is an announcement or not. This model specifies that:

$$y_t = \beta' s_t + \Sigma_{i=1}^{I} d_{it}\gamma_i f_{it} + \gamma_0 f_{0t} + \varepsilon_t \tag{5}$$

and applies in all windows, as before. The new factor f_{0t} captures the common "background" noise in asset prices that would be present even without any announcement and we call it the "ever-present" factor. We consider the noise component to consist of both the ever-present factor and the residual vector.

While we will characterize the ever-present noise and its effects on yields, fully understanding what this noise is requires a study of its own. Are these the effects of trickling of minor news themselves? Changes in global risk aversion due to animal spirits? Artefacts of market microstructure? Or other movers of yields? We will show the weight of noise in moving yields and leave these questions for future work.

All of the models (2)-(5) can be estimated by maximum likelihood.

4 Results

4.1 Domestic Euro Area News Effects

To start with, we consider the analysis of the euro area alone. Table 1 shows that observable surprises explain little of the immediate yield reactions (see panel a) and that a single latent factor as in equation (2) dramatically raises the share of explained yield movements (see panel b).[7] The loadings of the latent factor are also hump-shaped along the yield curve, just as in the US case.

Table 2 provides an additional piece of evidence consistent with our interpretation of the latent factor as surprises perceived by the market participants that are unobserv-

[7]Throughout this paper, we report White standard errors in brackets and indicate statistical significance at the 10/5/1% level with */**/***.

able to the econometrician due to a lack of surveys for those components of the data or policy release. The table compares OLS and heteroskedasticity-based estimates for ECB announcement surprises, distinguishing between ECB press releases and press conferences. The idea here is that unobservable "non-headline" news should be more important for press conferences than for boilerplate press releases. Hence, the difference between heteroskedasticity-based estimates and OLS-based estimates should be larger for press conferences than for press releases.

The results in Table 2 are in line with this prediction. The difference between OLS-based and heteroskedasticity-based estimates is much larger for press conferences than for press releases. Even for boilerplate press releases, however, the two estimation methods often yield different estimates, suggesting that press releases already signal information beyond the one-month horizon.

Table 1: Euro area News Effects on Domestic Yields

(a) OLS Estimates

	3-Month	1-Year	2-Year	5-Year	10-Year	30-Year
ECB GCM	1.70**	1.91***	1.80***	1.37***	0.59***	0.19
	(0.67)	(0.50)	(0.44)	(0.31)	(0.22)	(0.18)
Euro area M3	0.10***	0.27***	0.15***	0.13**	0.09**	0.08
	(0.04)	(0.06)	(0.06)	(0.06)	(0.05)	(0.06)
Euro area Consumer Prices	0.08	0.25**	0.20**	0.22**	0.16**	0.13**
	(0.05)	(0.12)	(0.08)	(0.10)	(0.08)	(0.06)
Germany Factory Orders	0.09*	0.25***	0.15**	0.20**	0.17***	0.11
	(0.05)	(0.07)	(0.06)	(0.08)	(0.06)	(0.07)
Germany Industrial Production	0.05	0.13*	0.14**	0.10	0.05	-0.00
	(0.05)	(0.07)	(0.06)	(0.07)	(0.07)	(0.10)
Germany ifo Business Climate	0.02	0.21	0.26	0.21	-0.03	-1.08
	(0.19)	(0.34)	(0.30)	(0.26)	(0.22)	(0.73)
Germany ifo Current assessment	0.33**	0.73***	0.56***	0.65***	0.59***	1.08***
	(0.14)	(0.24)	(0.21)	(0.19)	(0.15)	(0.42)
Germany ifo Expectations	0.04	0.16	0.00	0.10	0.20	0.76
	(0.13)	(0.27)	(0.23)	(0.21)	(0.17)	(0.48)
Germany ZEW Expectations	0.16**	0.42***	0.37***	0.42***	0.37***	0.25***
	(0.07)	(0.09)	(0.07)	(0.08)	(0.07)	(0.06)
Germany ZEW Current Situation	0.10	0.04	-0.02	0.04	0.05	-0.03
	(0.12)	(0.10)	(0.06)	(0.07)	(0.06)	(0.07)
R^2	0.16	0.14	0.16	0.12	0.07	0.03

(b) Latent Factor Model

	3-Month	1-Year	2-Year	5-Year	10-Year	30-Year
ECB GCM	1.70**	1.95***	1.80***	1.37***	0.59***	0.13
	(0.67)	(0.50)	(0.44)	(0.31)	(0.22)	(0.19)
Euro area M3	0.10***	0.27***	0.15***	0.12**	0.09**	0.08
	(0.04)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)
Euro area Consumer Prices	0.08*	0.25**	0.20**	0.22**	0.16**	0.14**
	(0.05)	(0.12)	(0.08)	(0.10)	(0.08)	(0.06)
Germany Factory Orders	0.09*	0.25***	0.15**	0.20**	0.17***	0.12*
	(0.05)	(0.07)	(0.06)	(0.08)	(0.06)	(0.07)
Germany Industrial Production	0.05	0.13**	0.14**	0.10	0.05	-0.00
	(0.05)	(0.07)	(0.06)	(0.07)	(0.07)	(0.10)
Germany ifo Business Climate	0.04	0.25	0.26	0.21	-0.03	-0.86
	(0.19)	(0.33)	(0.30)	(0.26)	(0.22)	(0.58)
Germany ifo Current assessment	0.33**	0.71***	0.56***	0.65***	0.59***	0.96***
	(0.14)	(0.23)	(0.21)	(0.19)	(0.15)	(0.33)
Germany ifo Expectations	0.02	0.13	0.00	0.10	0.20	0.63
	(0.13)	(0.27)	(0.23)	(0.21)	(0.17)	(0.39)
Germany ZEW Expectations	0.16**	0.42***	0.37***	0.42***	0.37***	0.26***
	(0.07)	(0.09)	(0.07)	(0.08)	(0.07)	(0.06)
Germany ZEW Current Situation	0.11	0.03	-0.02	0.04	0.05	-0.03
	(0.12)	(0.10)	(0.06)	(0.07)	(0.06)	(0.07)
Factor	1.25***	1.97***	1.67***	1.62***	1.03***	0.57***
	(0.17)	(0.19)	(0.17)	(0.11)	(0.07)	(0.09)
R^2 no factor	0.16	0.14	0.16	0.12	0.07	0.03
R^2 with factor	0.75	0.94	0.95	0.90	0.64	0.27

Estimated effect of euro area news on euro area yields. Panel (a) refers to OLS estimates, panel (b) shows results for the basic latent factor model as in equation (2).

Table 2: ECB Announcement Effects on Domestic Yields

	3-Month	1-Year	2-Year	5-Year	10-Year	30-Year
Press Release (1:35-2:00 p.m.)						
OLS	0.61***	0.36***	0.35***	0.22***	0.03	-0.02
	(0.08)	(0.08)	(0.08)	(0.07)	(0.05)	(0.05)
IDHET	0.79***	0.83***	0.77***	0.98**	2.98	-5.13
	(0.08)	(0.24)	(0.17)	(0.40)	(4.15)	(15.15)
Press Conference (2:25-3:40 p.m.)						
OLS	1.69***	1.88***	1.39***	1.03***	0.43***	0.09
	(0.27)	(0.40)	(0.25)	(0.22)	(0.16)	(0.13)
IDHET	7.32***	10.11***	8.98***	8.43***	5.25**	9.72
	(2.43)	(3.65)	(3.24)	(3.08)	(2.48)	(15.80)
Equivalence Test Statistics (OLS vs IDHET Estimates)						
Press Release	-1.61	-1.81*	-2.25**	-1.86*	-0.71	0.34
Press Conference	-2.31**	-2.24**	-2.33**	-2.39**	-1.94*	-0.61

Results are based on the pre-2015 sample because ECB press releases contain additional information beyond policy rate decisions since 2015. As before, our policy news measure is the one-month OIS change from Altavilla et al. (2019) during the relevant window. In contrast to elsewhere in the paper, however, policy surprises are not standardized, i.e. they are kept as basis point changes. The equivalence test statistics refer to the null hypothesis that the OLS and heteroskedasticity-based estimates are identical.

4.2 Factor Model

In equations (2)-(4), the shocks ε_t are assumed to be mutually uncorrelated. Thus any common movements in yields that are not explained by the observable surprise will be soaked up by the latent factor. This makes for a potential model mis-specification. Including the ever-present factor resolves this problem, as the common movement can be ascribed either to the latent news or the background noise factors, depending on the variance-covariance matrices in announcement and control windows. Thus equation (5) is our preferred specification. We estimate this model twice, once for US yields around US event/control windows, and once for EA yields around EA event/control windows.

Instead of the common 2020m3-2019m12 sample, US results are now based on the data Burcin sent, i.e. the 1992m1-2018m12 sample. Results are virtually unchanged, however.

Table 3 and Figure 1 show that this model produces virtually perfect fits for the

entire US and EA yield curves beyond the 1-year maturity. What is striking, moreover, is how much explanatory power the ever-present factor has for EA yields. At the 10-year maturity, for instance, when we exclude the ever-present factor the R^2 drops from almost 100% to 20% for EA yields, but only to 60% for US yields. At shorter maturities, this difference is smaller. That is, news explain yield curve movements less well in the EA than the US, particularly at the long end of the curve.

Figure 1 panel (b) shows that the ever-present factor has almost identical effects on US and EA yields, with a double hump-shape at 1 and 5 years. This is in contrast to the latent news factors shown in panel (c) and (d), which virtually all have their peak impact at the 1-year maturity and then monotonically decline.

Lastly, the effects of latent news releases on long-term yields in the EA are much smaller than is true in the US. A natural interpretation for this is that longer-term inflation expectations are more stable in the EA, perhaps because the euro zone had an explicit inflation target long before the US. Beechey, Johannsen and Levin (2011) compare the effects of US and EA news announcements on changes in daily inflation swaps and breakeven rates and find that long-term inflation expectations are more stable in the EA, very much consistent with our findings here. Gürkaynak, Levin and Swanson (2010a) reached a similar conclusion comparing US, UK and Swedish data. We dig deeper into why the ever-present factor explains a bigger share of long-term EA yields around announcements in the next subsection.

Table 3: Release-Specific & Ever-Present Factor

(a) US yields

	3-Month	1-Year	2-Year	5-Year	10-Year	30-Year
Core CPI	0.68***	1.62***	1.20***	1.52***	1.24***	0.79***
Durable Goods Orders	0.39***	0.87***	0.66***	0.82***	0.57***	0.37***
Employment Cost	0.70***	1.51***	1.15***	1.50***	1.16***	0.75***
GDP	0.72***	1.78***	1.31***	1.73***	1.31***	0.76***
Initial Jobless Claims	-0.32***	-0.75***	-0.58***	-0.68***	-0.55***	-0.33***
Nonfarm Payrolls	2.86***	5.66***	4.45***	5.26***	3.97***	2.41***
Core PPI	0.67***	1.15***	0.84***	1.09***	0.93***	0.70***
Retail Sales	0.28*	0.70***	0.54***	0.47**	0.32*	0.10
Unemployment	-1.23***	-2.04***	-1.64***	-1.70***	-1.18***	-0.68***
Hourly Earnings	0.88***	1.84***	1.44***	2.02***	1.61***	0.97***
PPI	0.11	0.27	0.19	0.20	0.24*	0.17*
Retail Sales Ex Auto	0.40***	0.96***	0.86***	1.17***	0.93***	0.72***
CPI	0.01	-0.07	-0.02	0.10	0.14	0.19
F CPI	1.07***	2.35***	1.88***	2.01***	1.36***	0.84***
F Durable Goods	0.75***	1.73***	1.28***	1.22***	0.86***	0.49***
F Employment Cost	0.94***	2.92***	2.40***	2.95***	2.20***	1.42***
F GDP	1.53**	2.69***	1.85***	1.94***	1.40**	0.69*
F Initial Jobless Claims	0.55***	1.14***	0.75***	0.62***	0.26**	0.06
F Nonfarm Payrolls	2.87***	4.98***	3.93***	3.62***	2.19***	1.04***
F PPI	1.34***	2.34***	1.85***	2.03***	1.56***	1.06***
F Retail Sales	1.49***	2.77***	1.90***	1.79***	1.20***	0.61***
Ever-present Factor	0.45***	1.27***	1.01***	1.60***	1.44***	1.01***
R^2 no factor	0.32	0.38	0.39	0.39	0.36	0.31
R^2 release-specific factors	0.77	0.82	0.83	0.70	0.59	0.48
R^2 all factors	0.80	0.96	0.97	0.99	1.00	0.95

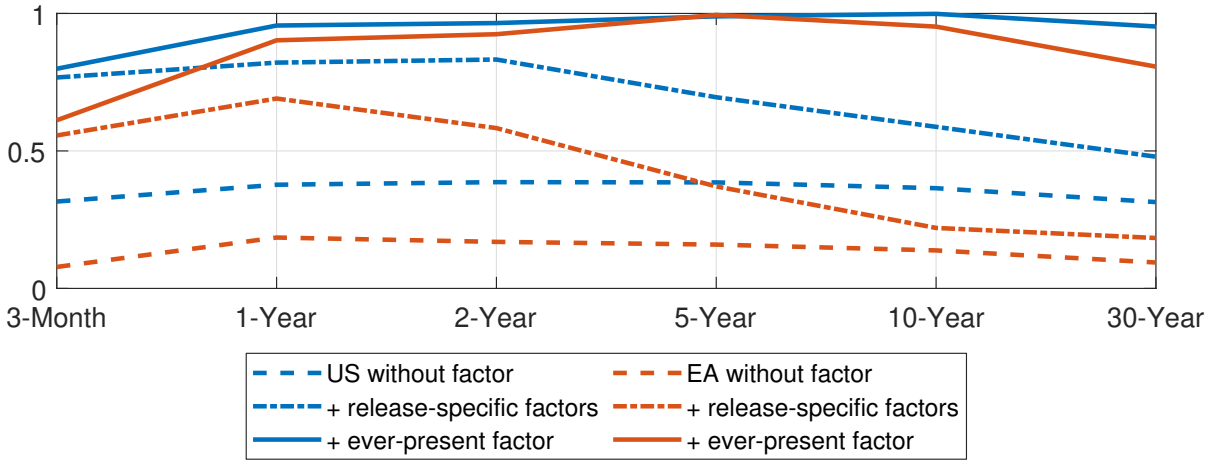
(b) EA yields

	3-Month	1-Year	2-Year	5-Year	10-Year	30-Year
Euro area M3	0.09***	0.25***	0.14***	0.11**	0.08*	0.06
Euro area Consumer Prices	0.08*	0.25**	0.20**	0.22**	0.16**	0.12**
Germany Factory Orders	0.09*	0.25***	0.15**	0.20**	0.17***	0.13*
Germany Industrial Production	0.05	0.13**	0.14**	0.10	0.05	0.02
Germany ifo Business Climate	0.05	0.27	0.28	0.22	-0.03	-0.43
Germany ifo Current assessment	0.33**	0.71***	0.55***	0.64***	0.59***	0.70**
Germany ifo Expectations	0.02	0.11	-0.01	0.09	0.20	0.34
Germany ZEW Expectations	0.16**	0.42***	0.37***	0.42***	0.37***	0.26***
Germany ZEW Current Situation	0.11	0.03	-0.02	0.04	0.05	-0.03
F Euro area M3	0.19***	0.37***	0.32***	0.14	-0.03	-0.19*
F Euro area Consumer Prices	0.35***	0.62***	0.37*	0.30	0.10	-0.06
F Germany Factory Orders	0.29***	0.46***	0.38***	0.34***	0.13	-0.15
F Germany Industrial Production	0.18***	0.35**	0.35**	0.20	0.00	-0.18
F Germany ifo Business Climate	0.56***	1.26***	1.02***	0.89***	0.51***	0.28***
F Germany ZEW Expectations	0.50**	0.54***	0.20	0.09	-0.05	-0.18
Ever-present Factor	0.20***	0.53***	0.51***	0.72***	0.63***	0.51***
R^2 no factor	0.08	0.19	0.17	0.16	0.14	0.09
R^2 release-specific factors	0.56	0.69	0.58	0.37	0.22	0.18
R^2 all factors	0.61	0.90	0.92	0.99	0.95	0.81

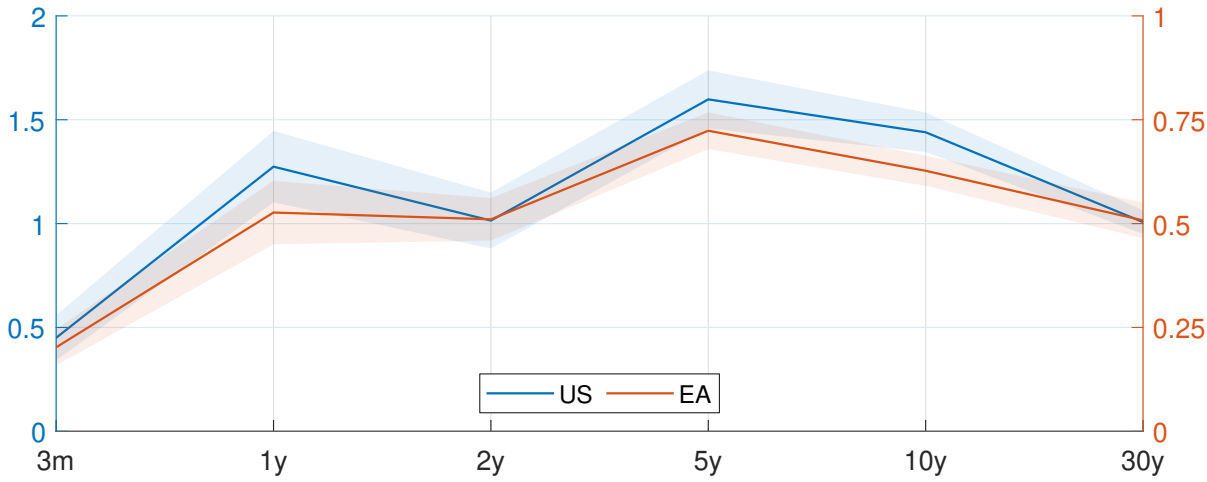
Maximum likelihood estimation results of equation (5), i.e. adding release-specific factors and an ever-present factor to the observable surprises. Standard errors are omitted for brevity.

Figure 1: Model with Release-Specific & Ever-Present Factor

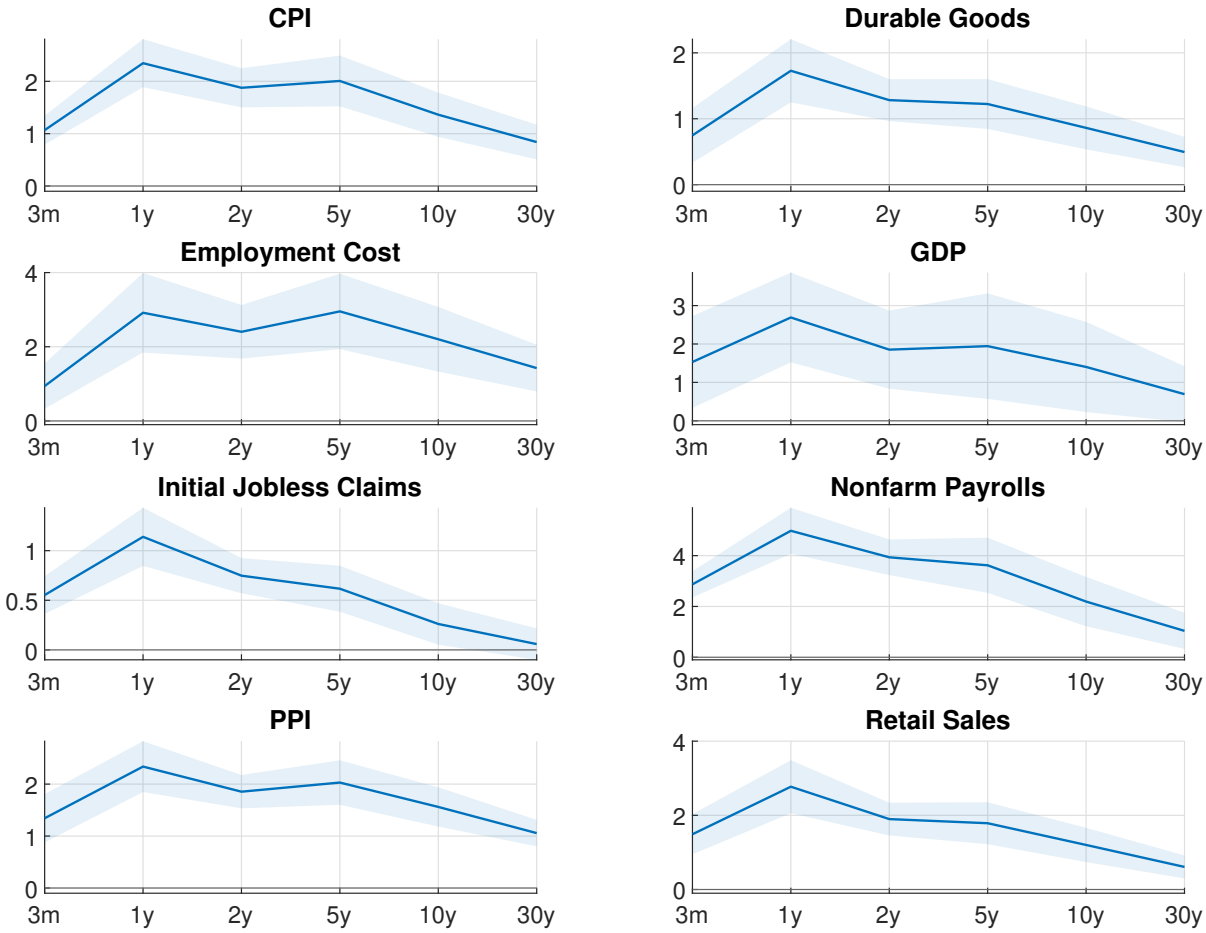
(a) Adj. R^2



(b) Effect of Ever-Present Factor

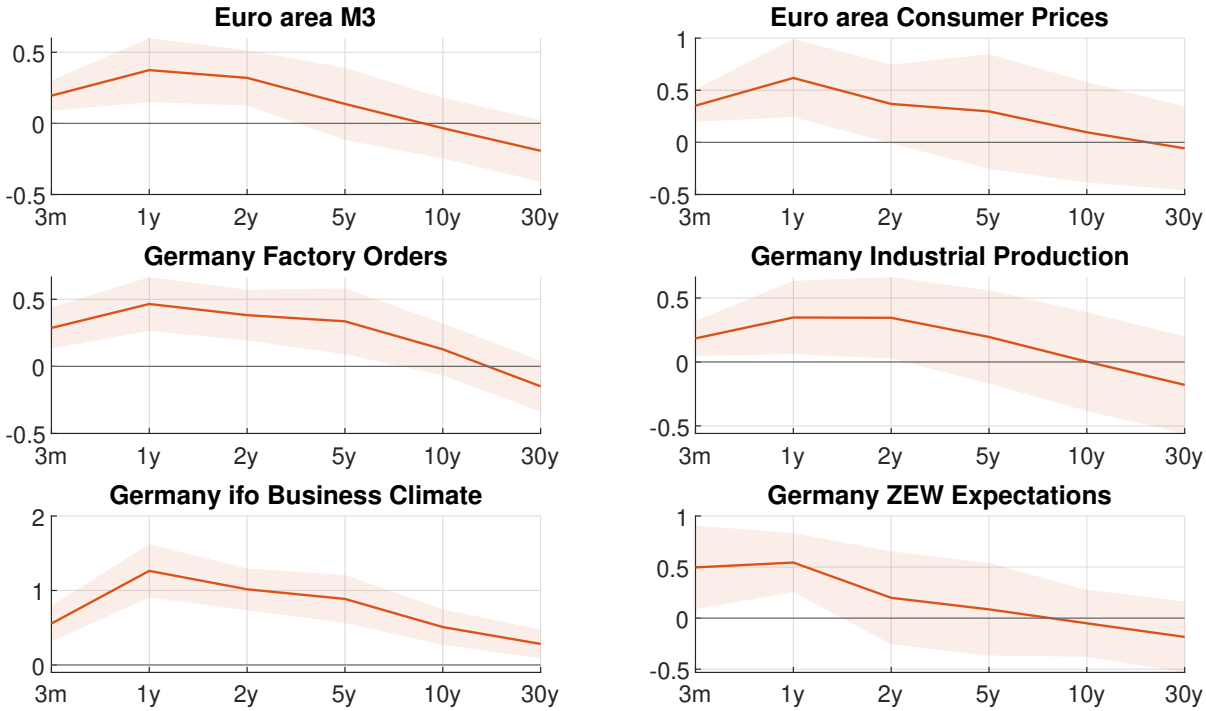


(c) Effect of US Release-Specific Latent Factors



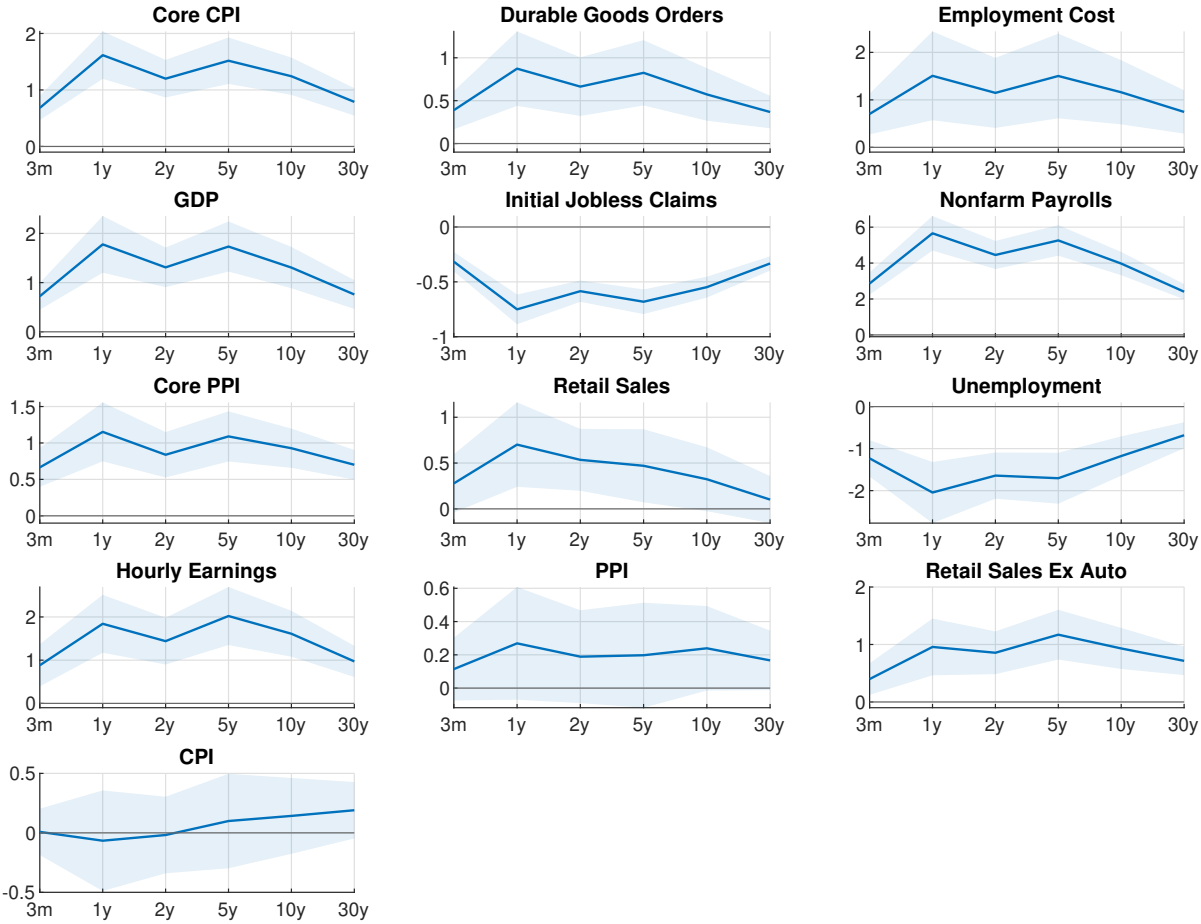
Results from Table 3. Solid lines refer to point estimates, shaded areas to 95% confidence bands.

(d) Effect of EA Release-Specific Latent Factors



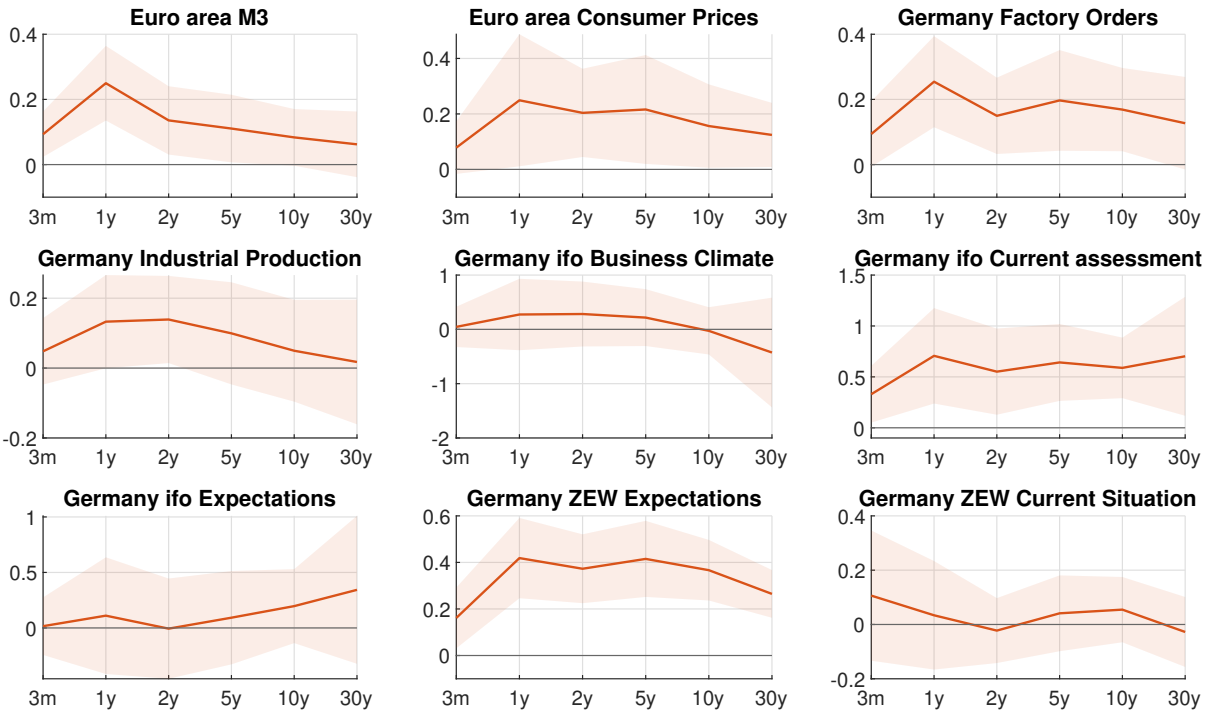
Results from Table 3. Solid lines refer to point estimates, shaded areas to 95% confidence bands.

(e) Effect of US Observable News Surprises



Results from Table 3. Solid lines refer to point estimates, shaded areas to 95% confidence bands.

(f) Effect of EA Observable News Surprises



Results from Table 3. Solid lines refer to point estimates, shaded areas to 95% confidence bands.

4.3 Pre/Post Fed inflation target announcement in 2012

The Fed announced its explicit two percent inflation target on January 25, 2012. Hence, estimate the previous model separately for the sample period prior and post announcement.

- In the US, loadings of observable and unobservable news falls post 2012, in line with anchoring story
- ever-present factor changes shape in both US and EA, pre 2012 its similarly hump-shaped as the news factors, post 2012 its a monotonically increasing slope factor

Table 4: Release-Specific & Ever-Present Factor

(a) US yields, 1992-2011

	3-Month	1-Year	2-Year	5-Year	10-Year	30-Year
Core CPI	0.80^{***}	1.79^{***}	1.29^{***}	1.57^{***}	1.29^{***}	0.82^{***}
Durable Goods Orders	0.53^{***}	1.19^{***}	0.91^{***}	1.06^{***}	0.71^{***}	0.44^{***}
Employment Cost	0.64^{***}	1.35^{***}	1.03^{**}	1.28^{***}	1.01^{***}	0.71^{***}
GDP	0.82^{***}	1.91^{***}	1.37^{***}	1.74^{***}	1.28^{***}	0.73^{***}
Initial Jobless Claims	-0.37^{***}	-0.86^{***}	-0.67^{***}	-0.75^{***}	-0.59^{***}	-0.35^{***}
Nonfarm Payrolls	3.08^{***}	5.92^{***}	4.59^{***}	5.17^{***}	3.81^{***}	2.25^{***}
Core PPI	0.79^{***}	1.31^{***}	0.91^{***}	1.13^{***}	0.98^{***}	0.74^{***}
Retail Sales	0.26	0.71^{***}	0.53^{***}	0.46^{**}	0.29^{*}	0.08
Unemployment	-1.40^{***}	-2.30^{***}	-1.84^{***}	-1.92^{***}	-1.31^{***}	-0.74^{***}
Hourly Earnings	0.98^{***}	1.83^{***}	1.38^{***}	1.86^{***}	1.52^{***}	0.99^{***}
PPI	0.14	0.32^{*}	0.22	0.28	0.32^{**}	0.22^{**}
Retail Sales Ex Auto	0.50^{***}	1.02^{***}	0.90^{***}	1.11^{***}	0.90^{***}	0.70^{***}
CPI	-0.03	-0.16	-0.07	0.00	0.07	0.14
F CPI	1.23^{***}	2.65^{***}	2.13^{***}	2.30^{***}	1.59^{***}	1.02^{***}
F Durable Goods	0.86^{***}	1.97^{***}	1.44^{***}	1.42^{***}	1.04^{***}	0.62^{***}
F Employment Cost	1.08^{***}	3.40^{***}	2.79^{***}	3.51^{***}	2.68^{***}	1.83^{***}
F GDP	1.74^{**}	3.12^{***}	2.20^{***}	2.38^{***}	1.75^{***}	0.90^{**}
F Initial Jobless Claims	0.62^{***}	1.33^{***}	0.86^{***}	0.75^{***}	0.35^{***}	0.13
F Nonfarm Payrolls	3.34^{***}	5.87^{***}	4.73^{***}	4.89^{***}	3.34^{***}	1.91^{***}
F PPI	1.55^{***}	2.73^{***}	2.15^{***}	2.39^{***}	1.85^{***}	1.28^{***}
F Retail Sales	1.73^{***}	3.25^{***}	2.22^{***}	2.19^{***}	1.52^{***}	0.80^{***}
Ever-present Factor	0.48^{***}	1.39^{***}	1.07^{***}	1.61^{***}	1.44^{***}	0.98^{***}
R^2 no factor	0.35	0.39	0.40	0.38	0.36	0.31
R^2 release-specific factors	0.80	0.86	0.88	0.78	0.69	0.60
R^2 all factors	0.81	0.96	0.96	0.99	1.00	0.96

(b) US yields, 2012-2018

	3-Month	1-Year	2-Year	5-Year	10-Year	30-Year
Core CPI	0.19**	0.94***	0.81***	1.23***	1.01***	0.62***
Durable Goods Orders	0.08	0.22**	0.15*	0.33	0.29	0.24*
Employment Cost	0.72**	1.76***	1.46***	2.36***	1.68***	0.71***
GDP	0.06	0.58**	0.52**	1.06***	0.96***	0.67***
Initial Jobless Claims	-0.01	-0.15***	-0.17***	-0.35***	-0.33***	-0.24***
Nonfarm Payrolls	0.67***	2.88***	2.81***	5.57***	5.05***	3.61***
Core PPI	0.15*	0.57***	0.56***	0.99***	0.83***	0.65***
Retail Sales	0.24	0.04	0.23	0.52	0.76*	0.48
Unemployment	-0.07	-0.49	-0.57*	-1.01**	-0.88**	-0.67**
Hourly Earnings	0.39***	1.64***	1.46***	2.40***	1.82***	0.87***
PPI	-0.07	-0.15	-0.08	-0.41	-0.36	-0.27
Retail Sales Ex Auto	0.02	1.09***	0.84***	1.48***	0.92**	0.62*
CPI	0.16	0.35	0.27	0.59*	0.53*	0.43**
F CPI	0.42***	1.35***	1.10***	1.47***	1.06***	0.64***
F Durable Goods	0.26***	0.62***	0.51***	0.85***	0.61***	0.31**
F Employment Cost	0.63***	1.26***	0.87***	1.03***	0.69***	0.19
F GDP	-0.01	0.44*	0.51***	0.38	0.06	-0.17
F Initial Jobless Claims	0.14***	0.25***	0.19***	0.13	-0.05	-0.17
F Nonfarm Payrolls	0.86***	2.42***	1.95***	1.94***	0.80*	-0.02
F PPI	0.12**	0.56***	0.59***	0.82**	0.56**	0.28
F Retail Sales	0.15*	0.93***	0.81***	0.98**	0.62	0.28
Ever-present Factor	0.09***	0.44***	0.43***	1.07***	1.07***	0.87***
R^2 no factor	0.14	0.36	0.40	0.45	0.43	0.34
R^2 release-specific factors	0.55	0.83	0.83	0.64	0.52	0.39
R^2 all factors	0.58	0.94	0.97	0.99	1.00	0.92

(c) EA yields, 2002-2011

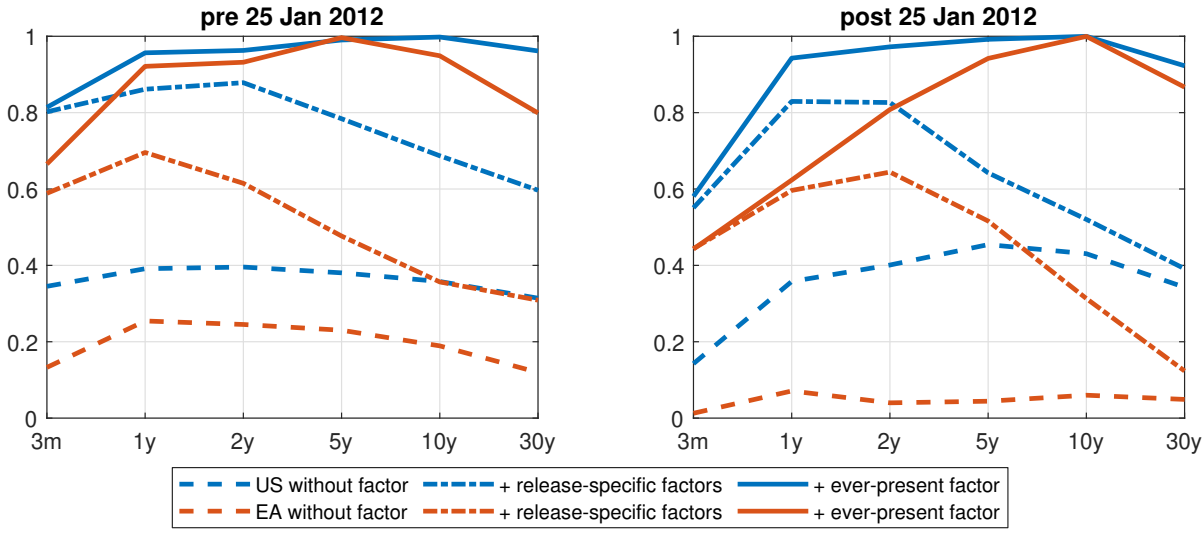
	3-Month	1-Year	2-Year	5-Year	10-Year	30-Year
Euro area M3	0.18***	0.35***	0.19**	0.14**	0.11**	0.09
Euro area Consumer Prices	0.08	0.29	0.26**	0.23*	0.17**	0.20***
Germany Factory Orders	0.10*	0.26***	0.15**	0.19**	0.15**	0.11
Germany Industrial Production	0.04	0.13*	0.16**	0.10	0.03	0.02
Germany ifo Business Climate	0.04	0.22	0.28	0.24	0.02	-0.37
Germany ifo Current assessment	0.51***	1.12***	0.91***	0.92***	0.72***	0.77*
Germany ifo Expectations	-0.03	0.20	0.03	0.11	0.15	0.24
Germany ZEW Expectations	0.30***	0.69***	0.57***	0.64***	0.50***	0.32***
Germany ZEW Current Situation	0.17	0.07	-0.02	0.02	0.03	-0.05
F Euro area M3	0.19**	0.46***	0.44***	0.28	0.08	-0.16
F Euro area Consumer Prices	0.38***	0.80***	0.50***	0.43*	0.27	0.15
F Germany Factory Orders	0.26***	0.41***	0.34***	0.28	0.08	-0.21**
F Germany Industrial Production	-0.14*	-0.22	-0.17	-0.04	0.13	0.34*
F Germany ifo Business Climate	0.71***	1.54***	1.23***	1.12***	0.73***	0.45***
F Germany ZEW Expectations	-0.60**	-0.41*	0.07	0.17	0.21	0.39***
Ever-present Factor	0.27***	0.68***	0.63***	0.79***	0.63***	0.49***
R^2 no factor	0.13	0.25	0.25	0.23	0.19	0.12
R^2 release-specific factors	0.59	0.70	0.61	0.48	0.36	0.31
R^2 all factors	0.67	0.92	0.93	1.00	0.95	0.80

(d) EA yields, 2012-2019

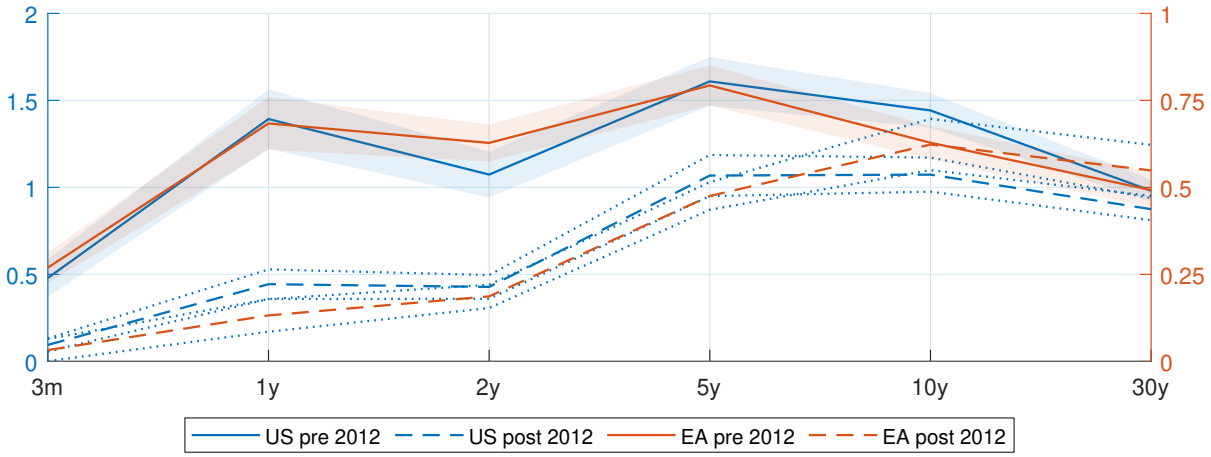
	3-Month	1-Year	2-Year	5-Year	10-Year	30-Year
Euro area M3	-0.07	0.06	0.02	0.03	0.01	0.02
Euro area Consumer Prices	0.07	0.19*	0.12	0.19	0.14	0.05
Germany Factory Orders	-0.00	0.20*	0.15**	0.26**	0.34***	0.28**
Germany Industrial Production	0.11	0.13	0.05	0.12	0.17	0.02
Germany ifo Business Climate	-0.54	0.08	-1.14**	-1.61	-1.63	-1.50*
Germany ifo Current assessment	0.36	0.11	0.70**	1.13*	1.21**	1.14**
Germany ifo Expectations	0.42	0.12	0.81**	1.18*	1.22*	1.08**
Germany ZEW Expectations	-0.05	0.01	0.07*	0.08	0.17**	0.17***
Germany ZEW Current Situation	-0.01	-0.02	-0.02	0.10	0.11	0.01
F Euro area M3	0.22***	0.26***	0.15***	0.23**	0.11	0.00
F Euro area Consumer Prices	0.35***	0.54***	0.48***	0.76***	0.57***	0.30***
F Germany Factory Orders	0.09	0.09	0.12	0.02	0.03	0.19
F Germany Industrial Production	0.31**	0.22*	-0.04	0.00	0.00	0.14
F Germany ifo Business Climate	-0.02	0.21*	0.25***	0.51***	0.45***	0.17
F Germany ZEW Expectations	0.17***	0.20***	0.14**	0.13	0.04	0.04
Ever-present Factor	0.03**	0.13***	0.19***	0.48***	0.62***	0.55***
R^2 no factor	0.01	0.07	0.04	0.04	0.06	0.05
R^2 release-specific factors	0.44	0.60	0.64	0.52	0.31	0.12
R^2 all factors	0.44	0.62	0.81	0.94	1.00	0.87

Figure 2: Model with Release-Specific & Ever-Present Factor, pre/post 2012

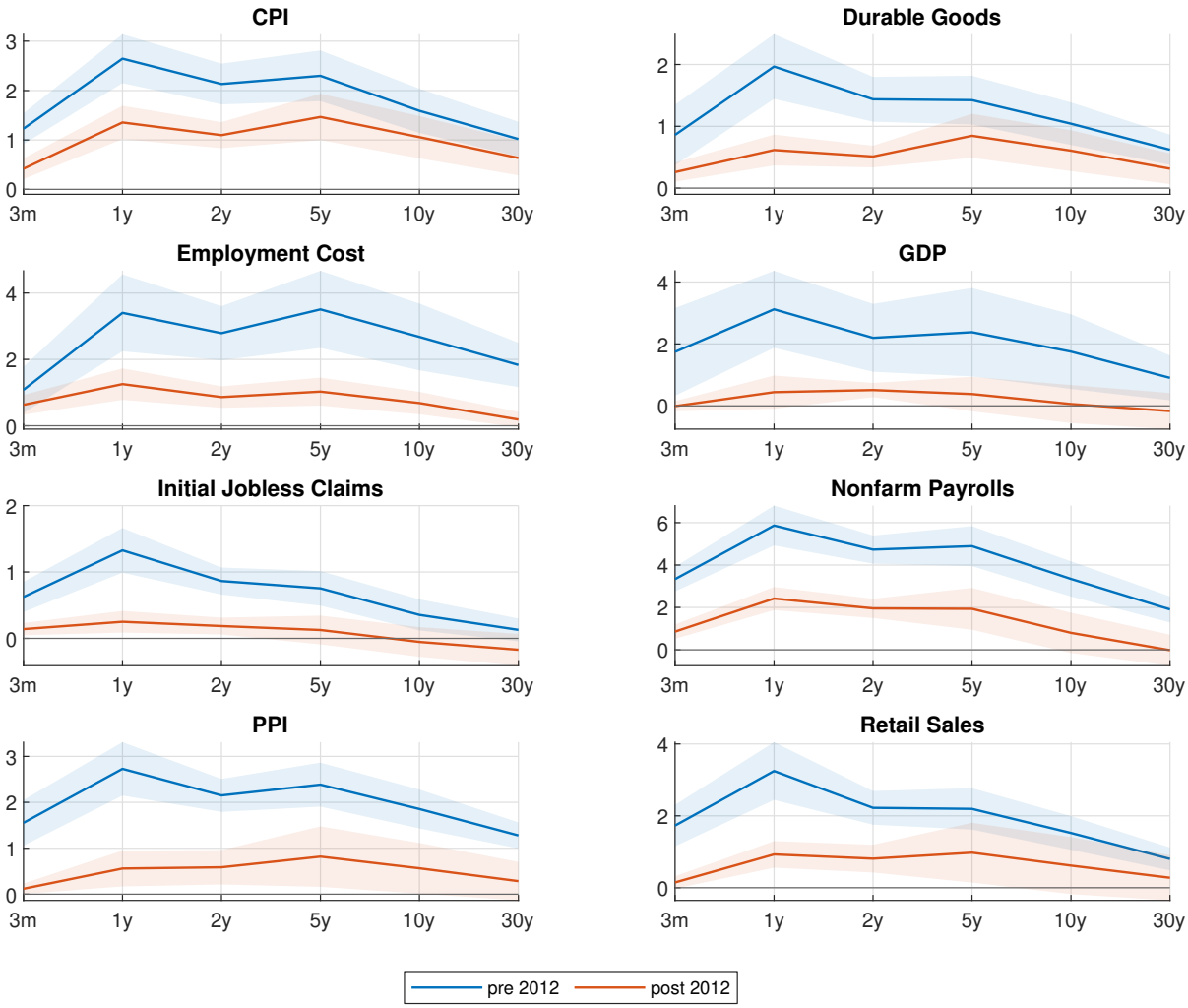
(a) Adj. R^2



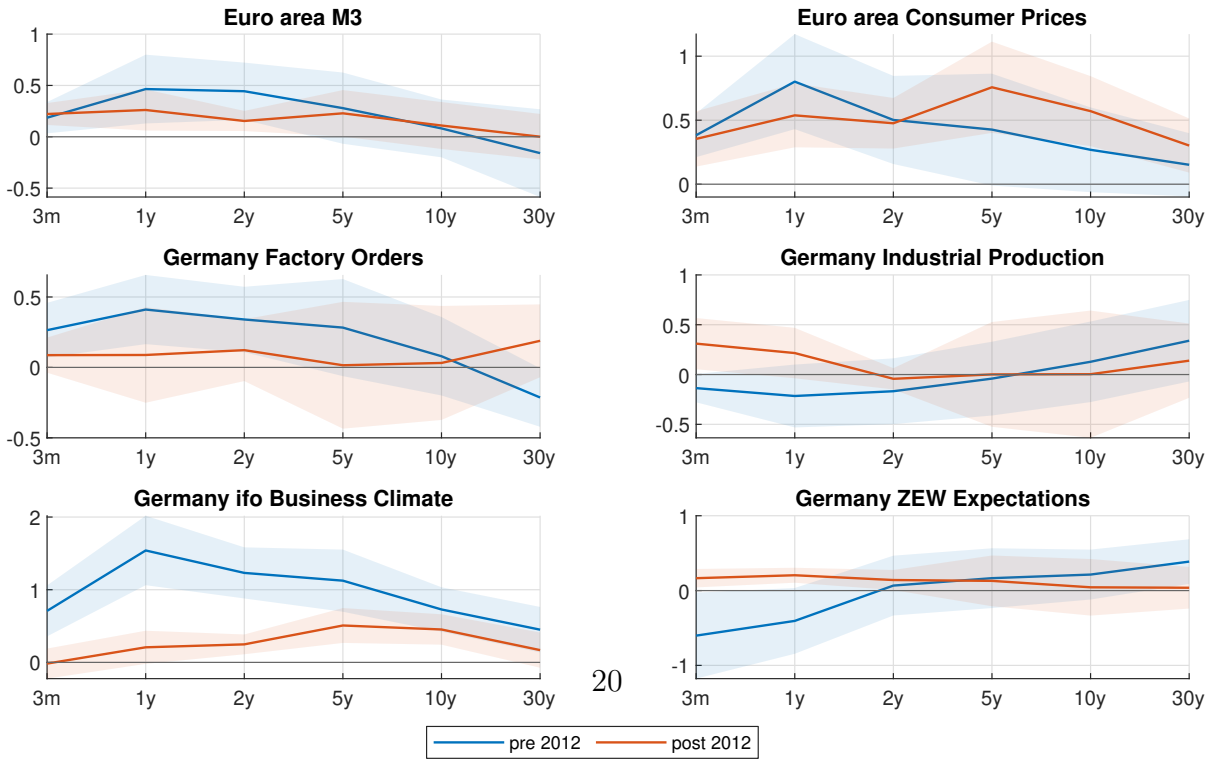
(b) Effect of Ever-Present Factor



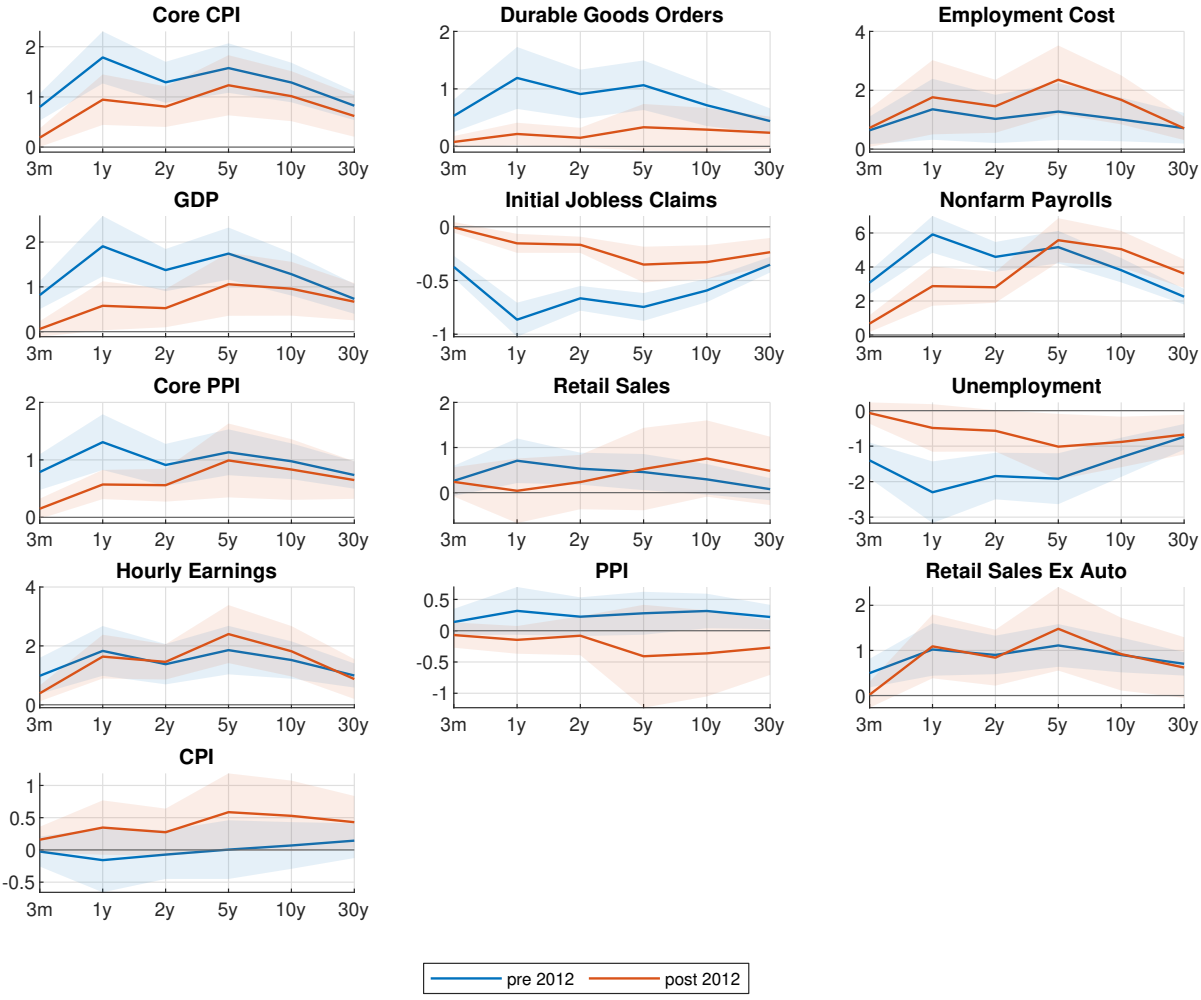
(c) Effect of US Release-Specific Latent Factors



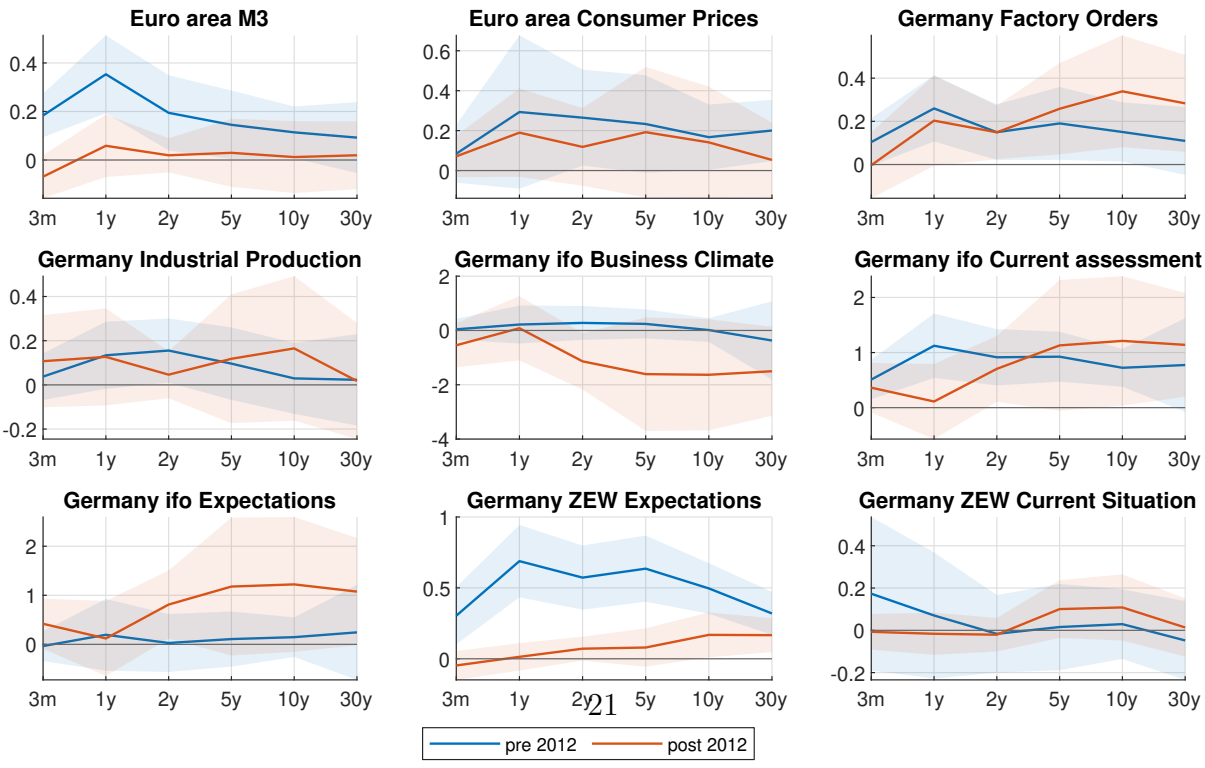
(d) Effect of EA Release-Specific Latent Factors



(e) Effect of US Observable News Surprises



(f) Effect of EA Observable News Surprises



4.4 Sensitivity of US yields to news over time

Our anchoring story implies that US yields have become less sensitive to news post 2012. Instead of a simple split sample analysis, we can also test this claim with the methodology of Swanson & Williams (2014) (https://www.aeaweb.org/articles?id=10.1257/aer.104.10.3154). The key assumption is that the relative magnitude of the impact of different types of news on yields is constant over time, whereas the overall sensitivity of yields to news can vary over time.

As a sanity check, Figure 3 shows the sensitivity of 1y yields. Panel (a) confirms the main finding of SW2014, namely that short-term yields have become insensitive to observable news around 2010, due to the zero lower bond. Panel (b) shows that this phenomenon is even stronger for unobservable news (the release-specific factors from Table 3): 1y yield have become entirely unresponsive to unobservable news since around 2010.

Figure 4 repeats the same exercise for 10y yields. Panel (a) shows that long-term yields have not become less responsive to observable news. This is somewhat in contrast to the original figure of SW2014, which indicates a decreasing sensitivity at the end of their 2012 sample. It seems also at odds with our anchoring story.

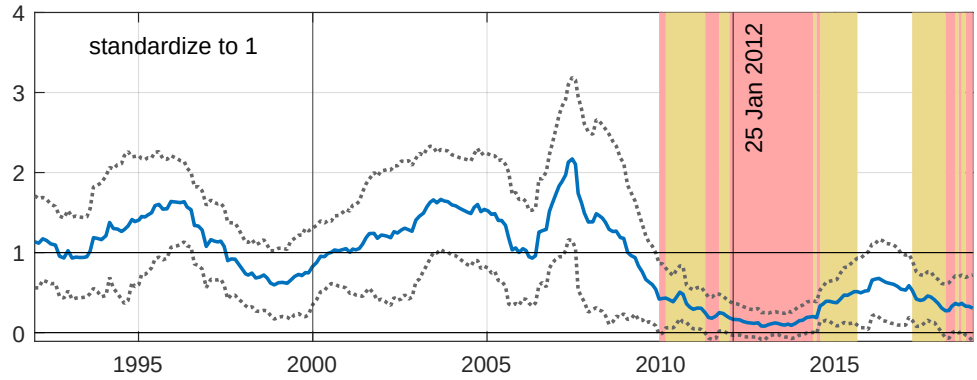
But interestingly, panel (b) shows that the sensitivity of 10y yields to unobservable news did not just decrease, the loadings actually *switched signs* around 2010. (I also confirmed this by running year-by-year regressions of 10y yields on release-specific factors.)

Figure 5 repeats the same exercise for 5y5y forward yields, with identical results to 10y yields.

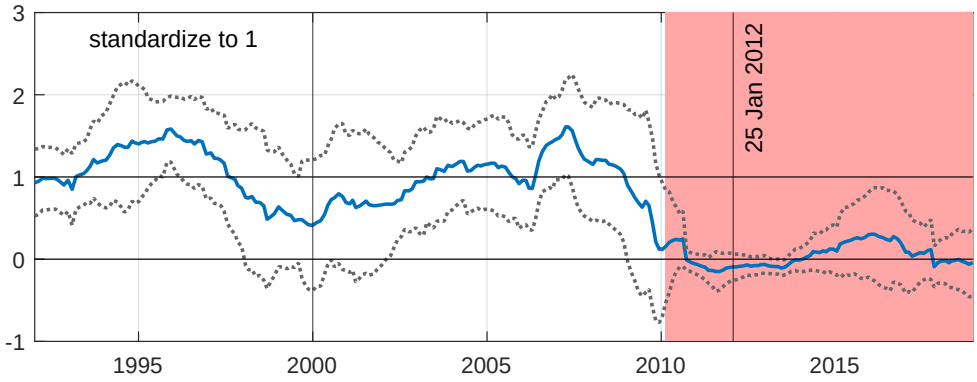
Bottom line: the relatively low r2 of news for 10y yields is due to a "regime change" around 2010. In the 1992-2009 sample, the r2 is 74% compared to 52% in the 2010-2018 sample and 58% in the full sample. Can we reconcile this break with the anchoring story or is it due to the zero lower bound? Why should the ZLB have changed the relationship between observable/unobservable news?

Figure 3: Sensitivity of 1y US yields

(a) to observable news



(b) to latent release-specific factors



(c) to the ever-present factor

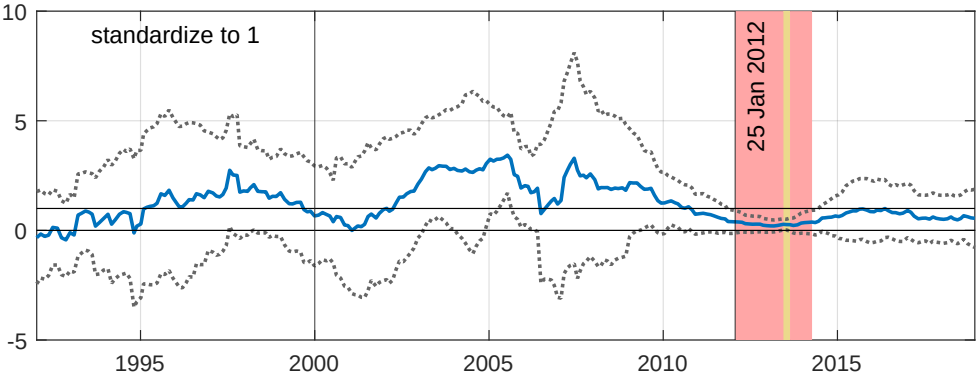
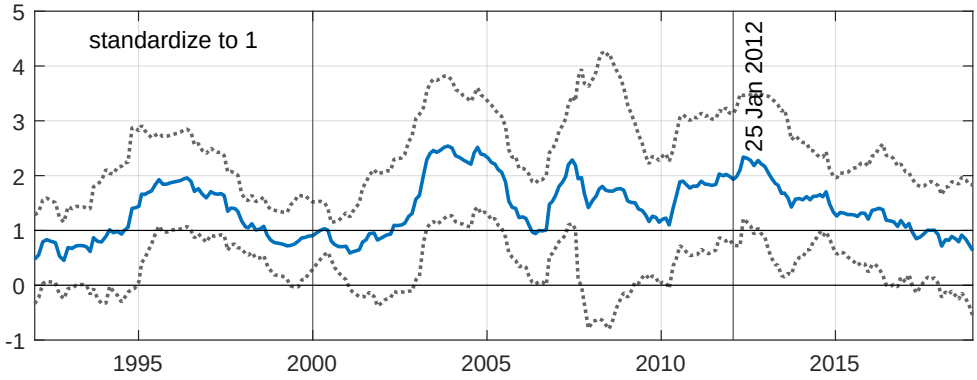
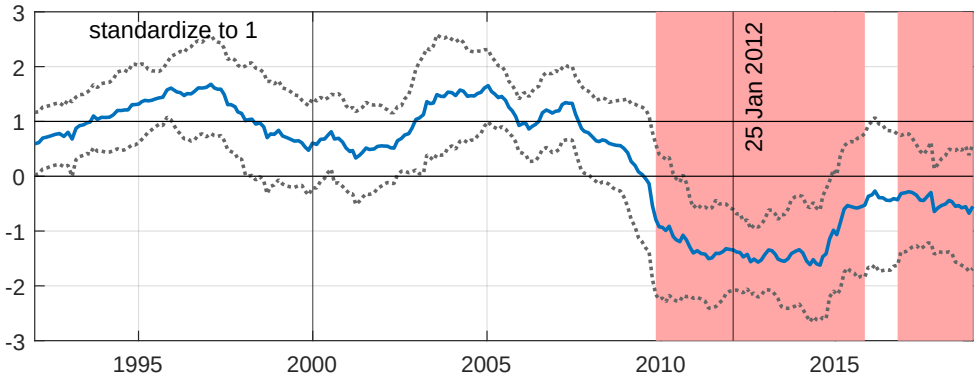


Figure 4: Sensitivity of 10y US yields

(a) to observable news



(b) to latent release-specific factors



(c) to the ever-present factor

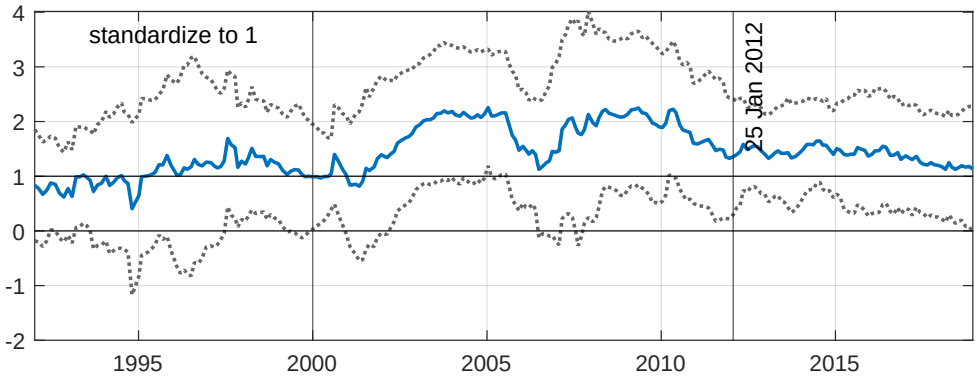
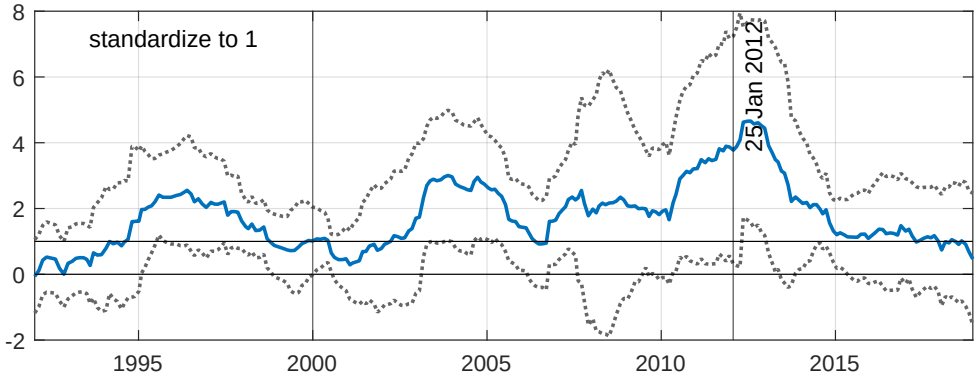
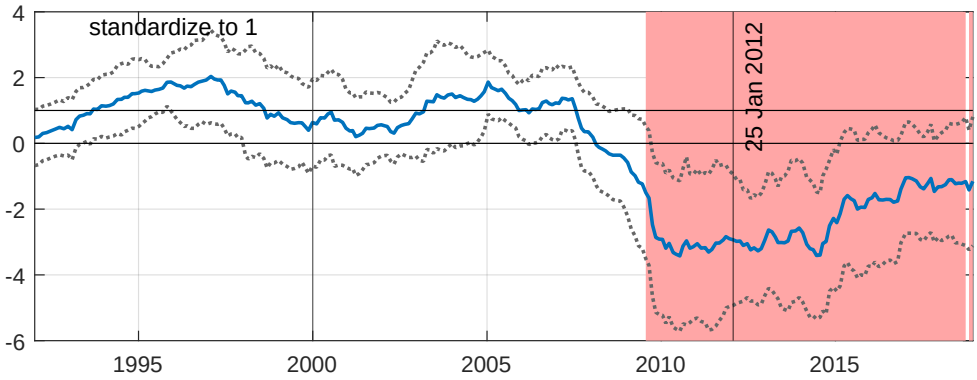


Figure 5: Sensitivity of 5y5y US forward yields

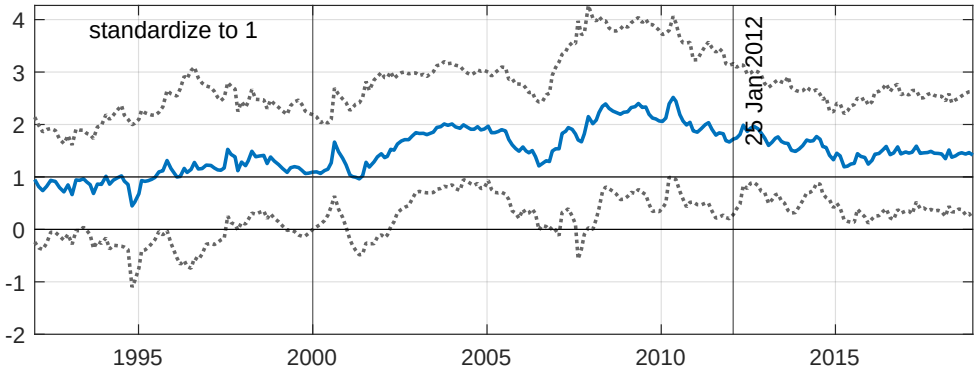
(a) to observable news



(b) to latent release-specific factors



(c) to the ever-present factor



4.5 Anchoring of inflation expectations

Do long rates in the euro area respond less to news because the policy framework better anchors inflation expectations? To test this hypothesis, we regress changes in market-based measures of long-term inflation expectations in the US and EA onto observable news and the factors that we have estimated.[8]

Table 5 shows the results from regressing changes in market-based inflation expectations on the same set of regressors as in Table 3, i.e. observable surprises, release-specific factors, and an ever-present factor. The table largely verifies the above mentioned conjecture: US long-term inflation expectations respond much more strongly to news than their EA counterparts. This effect is entirely driven by observable news.

OLD Text: That US inflation expectations respond more to observable surprises than their EA counterparts has already been documented by Gürkaynak et al. (2010a) and Beechey et al. (2011).

But remember that the observable surprises are a minority of the news in any release, as shown in Section 4.2. Most of the event related variance is explained by unobservable latent surprises. Hence, responding more to the latent news is what makes US inflation expectations more volatile.

One further testable claim of our hypothesis can be derived from the fact that the Fed announced its explicit two percent inflation target only on January 25, 2012. Our above-mentioned hypothesis implies that the sensitivity of US inflation expectations to news should have decreased after this announcement.

The bottom two panels in Table 5 confirm this prediction. Prior to the target announcement, US long-term inflation expectations responded significantly to both types of news. Since the announcement, inflation expectations do not respond to news anymore, neither to observable nor unobservable ones.

Actually, the observable news and the ever-present factor are driving the results. Both moved long-term infl. expectations significantly prior to 2012 but not after. How does this square with the Swanson/Williams results from the previous section? The ever-present factor affected 5y5y forward yields throughout, but 5y5y infl.exp. only prior to 2012. So it moved real yields after 2012?

[8] For the US, we use breakeven inflation rates from Gürkaynak, Sack and Wright (2010b). For the euro area, we use inflation-linked swaps, since the inflation-indexed bond market is small. In both cases, we study 5y5y and 9y1y rates, i.e. the 5-year inflation rate beginning in 5 years and the 1-year rate beginning in 9 years. Of course, these market-based inflation expectations are not necessarily physical expectations; they also incorporate inflation risk premia.

Table 5: Response of Market-Based Inflation Expectations to (Un)Observable News

	US 5y5y	US 9y1y	EA 5y5y	EA 9y1y
Full Sample				
Observable News	7.89^{***}	6.23^{**}	2.02	3.92^{**}
Unobservable News	0.01	0.08	1.94	0.53
Background Noise	58.83^{***}	37.99^{***}	0.07	0.00
Pre-2012 Sample				
Observable News	6.18^{**}	5.56^{**}	4.81^{**}	3.24^{*}
Unobservable News	0.29	0.68	2.76^{*}	0.25
Background Noise	57.28^{***}	40.73^{***}	0.07	0.05
Post-2012 Sample				
Observable News	0.77	0.05	1.23	0.44
Unobservable News	2.53	0.35	1.49	0.24
Background Noise	2.00	0.05	0.06	0.08

Each column refers to a regression of changes in market-based inflation expectations onto the same set of regressors as in Table 3. For US yields, this means 13 observable news, 8 unobservable news (the release-specific factors) and background noise (the ever-present factor). For US yields, this means 9 observable news, 6 unobservable news and background noise. All regressors are cumulated to daily frequency. Each cell refers to an F-test statistic of the null hypothesis that all regressors mentioned at the beginning of the row are jointly zero. Tables B4-B5 in the Appendix contains detailed results for the full sample regression.

5 Conclusions

We understand exactly what moves yields in event windows, i.e. around macroeconomic data releases and monetary policy announcements. That understanding is common for the US and the EA. Short yields are affected almost exclusively by news, while long yields owe more of their variance to noise, depending on how firmly inflation expectations are anchored. While the ECB was a credible inflation targeter since its inception, the Fed only articulated a numerical inflation target in 2012. Hence, prior to 2012, news played a larger role in driving US long term yields.

Being able to do the analysis we have and coming to the conclusion just spelled out requires pinning down news and noise in a reliable way. We were able to do so by employing what is in essence a joint application of OLS and heteroskedasticity-based identification. The efficient estimator we utilized backed out responses to headline news, as well as backing out latent news and ever-present noise, and yield curve responses to these.

We have taken what will hopefully be an important step in understanding what moves yields in the US and EA. Now waiting to be studied are questions about the nature of these news – what is so special about US news that they move EA yields, or the few EA news that move US yields – and perhaps even more interestingly about the nature of noise. We show that noise is an important driver of yields but we are yet to understand what it is and why it affects bond prices the way it does. We hope others will find these questions that we are now able to ask properly as interesting as we do.

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Appendix A Data Details

- Table A1 lists the sources of our high-frequency data.
- Table A2 lists the Bloomberg codes of our macroeconomic surprises, along with the number of event and control windows for each surprise series.
- Table A3 shows the number of simultaneous releases within the US and within the euro area.
- Table A4 provides a breakdown of our sample by country and by type of window.
- Figure A1 shows the intraday times of US and EA windows.
- Figure A2 shows the realizations of all surprise series.
- Figure A3, lastly, compares our measure of surprises (actual release minus median forecast) with an alternative measure (actual release minus median forecast, divided by the standard deviation of forecasts across analysts).

Table A1: Overview High-Frequency Futures Data

Maturity	US	Euro Area
3-month	ED1 - First Eurodollar contract	ER1 - First Euribor contract
1-year	ED4 - Fourth Eurodollar contract	ER4 - Fourth Euribor contract
2-year	TU - Treasury bonds expiring in 1.75-2y	FGBS - German bonds expiring in 1.75-2.25y
5-year	FV - Treasury bonds expiring in 4.17-5.25y	FGBM - German bonds expiring in 4.5-5.5y
10-year	TY - Treasury bonds expiring in 6.5-10y	FGBL - German bonds expiring in 8.5-10.5y
30-year	US - Treasury bonds expiring in 15-25y	FGBX - German bonds expiring in 24-35y

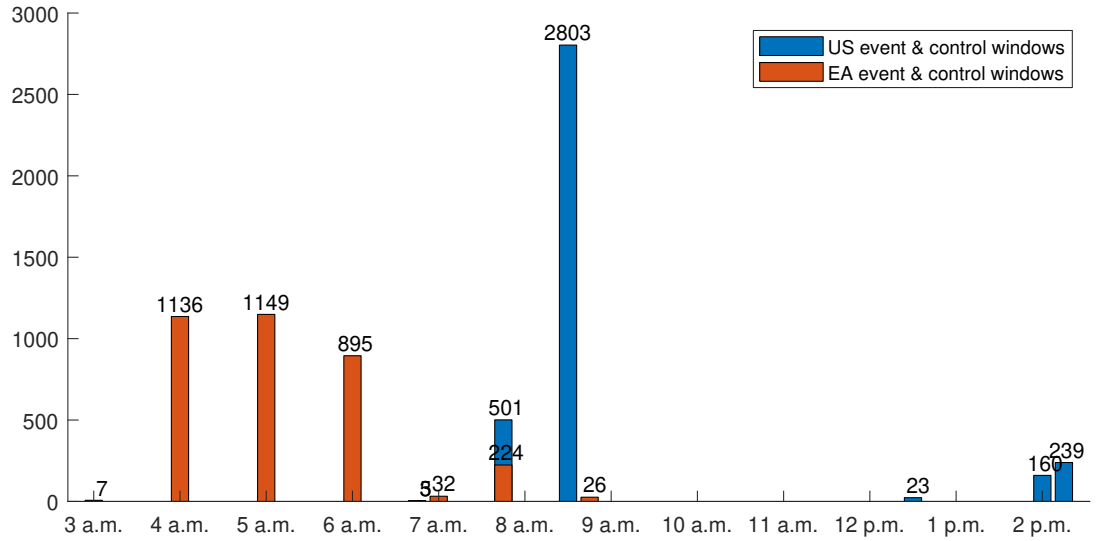
Data on Euribor futures is from the Intercontinental Exchange, data on German sovereign bond futures is from the derivatives exchange Eurex. The sample starts in March 2002, except for the FGBX future which was launched in September 2005. Yield changes are approximated as future price changes divided by minus the modified duration of the cheapest-to-deliver underlying bond, obtained via Bloomberg.

Table A2: Overview Macroeconomic Surprises

News	Code	# Event	# Control
FOMC		136	286
Nonfarm Payrolls	NFP TCH	215	218
Initial Jobless Claims	INJCJC	930	1204
Durable Goods Orders	DGNOCHNG	213	216
Employment Cost	ECI SA%	71	62
Retail Sales	RSTAMOM	214	-
Retail Sales Ex Auto	RSTAXMOM	214	242
GDP	GDP CQOQP	71	60
CPI	CPI CHNG	214	-
Core CPI	CPUPXCHG	213	254
PPI	PPI CHNG	214	-
Core PPI	FDIDSGMO	214	242
Hourly Earnings	USHETOT%	214	-
Unemployment	USURTOT	214	-
ECB GCM		194	387
Euro area M3	ECMAM3YY	213	421
Euro area Consumer Prices	ECCPEST	212	412
Germany Factory Orders	GRIORTMM	139	272
Germany Industrial Production	GRIPIMOM	143	280
Germany ifo Business Climate	GRIFPBUS	214	422
Germany ifo Current assessment	GRIFPCA	191	-
Germany ifo Expectations	GRIFPEX	191	-
Germany ZEW Expectations	GRZEWI	204	404
Germany ZEW Current Situation	GRZECURR	191	-

The underlying Bloomberg code for PPI surprises since 2014 is "FDIDFDMO", and for hourly earnings surprises since 2010 "AHE MOM% Index". For FOMC and ECB announcements, we do not use Bloomberg surprises, see Section 2. Some macro releases have no distinct control windows since they frequently coincide with other releases, see Table A3. These releases are also omitted in the heteroskedasticity-based identification, see e.g. Table B2.

Figure A1: Timing of Intraday Windows



Intraday times of event and control windows in US Eastern Time. Most US macro news are released at 8:30 a.m., but due to overlaps with ECB windows, some of the US windows are merged into longer windows starting at 7:45 a.m. (1:45 p.m. CET), see Section 2. The US windows at 12:30 p.m., 2:00 p.m. and 2:15 p.m. refer to FOMC windows. Most European macro news are released at 4:00 a.m., 5:00 a.m., or 6:00 a.m. (i.e. 10:00, 11:00 or 12:00 CET). Minor deviations are due to the different daylight savings time periods between the US and Europe.

Table A3: Overview of Simultaneous Data Releases

(a) US

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
(1) FOMC	136													
(2) Nonfarm Payrolls	0	215												
(3) Initial Jobless Claims	0	7	930											
(4) Durable Goods Orders	0	0	77	213										
(5) Employment Cost	0	0	17	1	71									
(6) Retail Sales	0	0	48	0	0	214								
(7) Retail Sales Ex Auto	0	0	48	0	0	214	214							
(8) GDP	0	0	18	2	34	0	0	71						
(9) CPI	0	0	47	1	0	21	21	0	214					
(10) Core CPI	0	0	46	1	0	21	21	0	213	213				
(11) PPI	0	0	52	1	0	56	56	0	0	0	214			
(12) Core PPI	0	0	52	1	0	56	56	0	0	0	214	214		
(13) Hourly Earnings	0	214	6	0	0	0	0	0	0	0	0	0	214	
(14) Unemployment	0	214	6	0	0	0	0	0	0	0	0	0	214	214

(b) EA

	1	2	3	4	5	6	7	8	9	10
(1) ECB GCM	194									
(2) Euro area M3	0	213								
(3) Euro area Consumer Prices	0	0	212							
(4) Germany Factory Orders	0	0	0	139						
(5) Germany Industrial Production	0	0	0	0	143					
(6) Germany ifo Business Climate	0	23	0	0	0	214				
(7) Germany ifo Current assessment	0	16	0	0	0	191	191			
(8) Germany ifo Expectations	0	16	0	0	0	191	191	191		
(9) Germany ZEW Expectations	0	0	0	0	0	0	0	0	204	
(10) Germany ZEW Current Situation	0	0	0	0	0	0	0	0	191	191

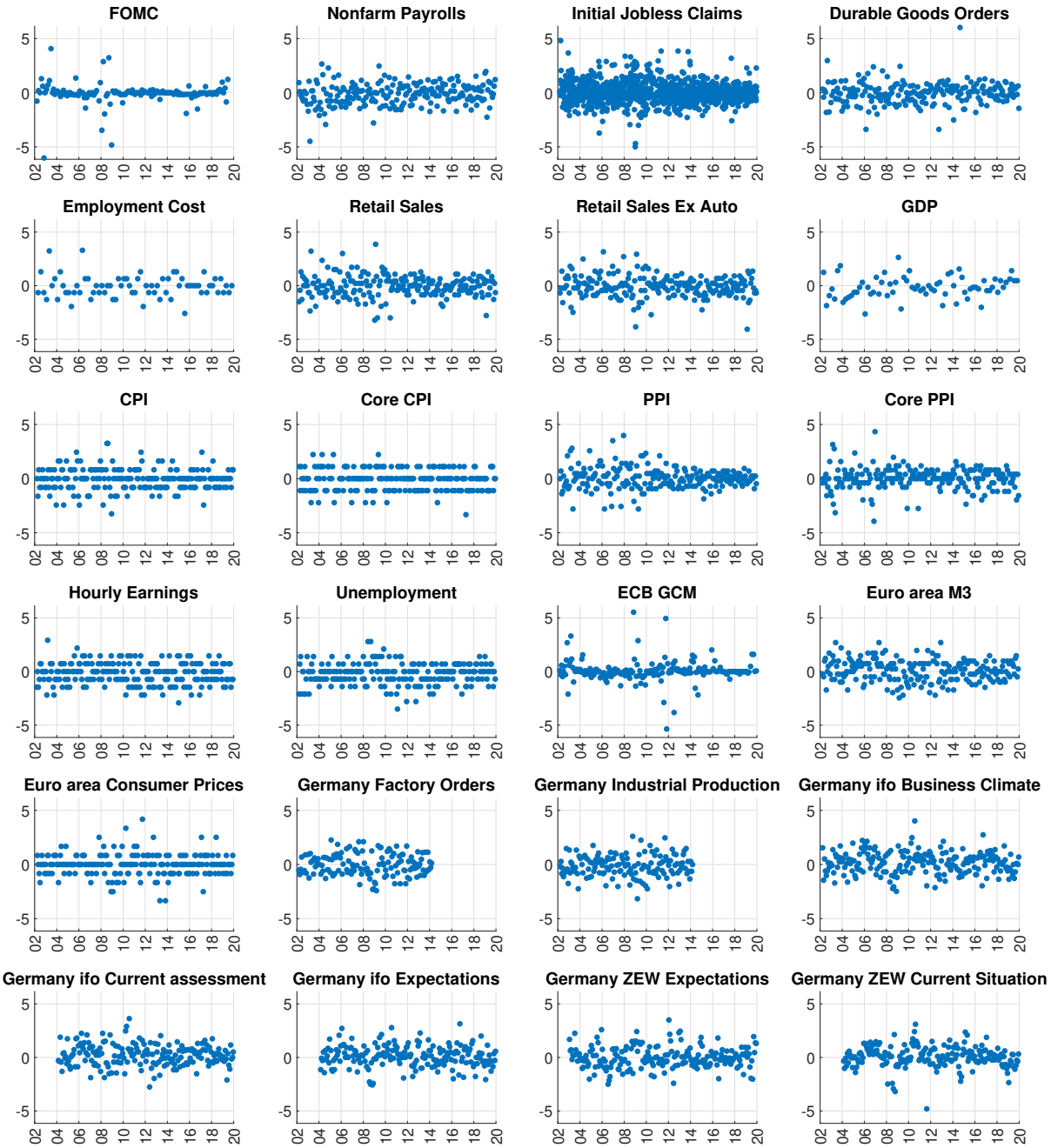
The diagonal elements refer to the number of releases per series. The off-diagonal elements show how often each pair of series was released simultaneously.

Table A4: Overview of Event and Control Windows

	US	EA	US & EA
control window	1817	2176	0
event window	1736	1118	178
Total: 7025			

The start of ECB press conferences regularly coincides with the release of US initial jobless claims, hence we have 178 windows with both US and EA news.

Figure A2: Macroeconomic surprises



Macroeconomic surprises, standardized to mean zero and unit variance. Surprises are defined as the difference between the actual release and its median forecasted value. German factory orders and industrial production surprises end in March 2014, when the intraday release time changed from noon to 8 a.m. local time.

Figure A3: Standardization of Macroeconomic surprises

The vertical axis refers to our measure of surprises, defined as the difference between the actual release and its median forecasted value. The horizontal axis refers to an alternative measure of surprises common in the literature, namely the difference between the actual release and its median forecasted value, divided by the standard deviation of forecasts. In both cases, surprises are standardized to mean zero and unit variance.

Appendix B Further Results

B.1 Heteroskedasticity-based Identification

This section confirms Gürkaynak et al. (2020)'s finding that heteroskedasticity-based point estimates are generally much larger than OLS estimates. Table B1 shows results for the domestic euro area model from Section 4.1. Table B2 shows results for the two country model from Section 4.2. Figure B1 shows the latter results graphically.

Table B1: Heteroskedasticity-based Estimates in EA model

	3-Month	1-Year	2-Year	5-Year	10-Year	30-Year
ECB GCM	9.11***	12.14***	9.53***	9.92***	9.64**	17.79
	(2.74)	(3.65)	(2.86)	(2.92)	(3.83)	(18.31)
Euro area M3	0.82*	1.46***	1.78**	2.72**	2.24*	2.85
	(0.47)	(0.56)	(0.75)	(1.24)	(1.17)	(1.89)
Euro area Consumer Prices	0.62	1.47	1.34**	2.09**	1.28	0.89
	(1.08)	(0.97)	(0.64)	(1.05)	(1.22)	(1.26)
Germany Factory Orders	0.17	0.69	0.36	0.67	0.21	0.19
	(0.82)	(0.51)	(0.70)	(0.63)	(0.46)	(0.76)
Germany Industrial Production	0.13	0.23	1.36	2.05	2.57	-279.28
	(1.09)	(0.96)	(1.09)	(1.83)	(3.92)	(51535.61)
Germany ifo Business Climate	1.86***	3.18***	2.68***	2.67***	1.95***	1.62***
	(0.45)	(0.47)	(0.41)	(0.41)	(0.33)	(0.42)
Germany ZEW Expectations	1.88*	1.64***	1.39***	1.67***	1.25***	1.15**
	(0.96)	(0.30)	(0.26)	(0.33)	(0.31)	(0.49)

Heteroskedasticity-based estimates of euro area news effects on euro area yields. Three macro releases that frequently coincide with other releases are omitted from the estimation (ZEW current situation, ifo current assessment and expectations, see Table A3).

Figure B1: OLS vs. Heteroskedasticity-based Estimates

(a) US Yields

(b) EA Yields

OLS-based point estimates from Table **??** are in blue, heteroskedasticity-based estimates from Table B2 in red. If point estimates are statistically significant at the 10% level, they are shown as filled circles, otherwise as empty circles.

Table B2: Heteroskedasticity-based Estimates in US/EA model

(a) US yields

	3-Month	1-Year	2-Year	5-Year	10-Year	30-Year
FOMC	5.65***	23.20*	26.70*	40.42	46.48	124.09
	(0.87)	(13.11)	(15.17)	(25.17)	(36.01)	(168.11)
Nonfarm Payrolls	5.80***	11.53***	8.89***	9.53***	7.45***	6.45***
	(0.76)	(0.80)	(0.62)	(0.57)	(0.43)	(0.38)
Initial Jobless Claims	-4.43***	-6.12***	-5.30***	-6.16***	-5.40***	-6.47***
	(1.57)	(0.99)	(0.75)	(0.82)	(0.70)	(0.97)
Durable Goods Orders	7.07*	5.35***	3.96***	4.46***	3.76***	3.61***
	(3.89)	(0.98)	(0.76)	(0.75)	(0.67)	(0.84)
Employment Cost	-60.30	94.79	44.93	24.05	20.26	23.00
	(596.37)	(424.66)	(107.78)	(24.25)	(20.04)	(25.04)
Retail Sales Ex Auto	3.68***	6.29***	5.09***	5.51***	4.75***	4.34***
	(1.32)	(1.32)	(0.82)	(0.84)	(0.71)	(0.71)
GDP	0.79	5.75***	4.40***	5.15***	4.29***	4.20***
	(0.73)	(1.34)	(0.99)	(1.03)	(0.87)	(0.84)
Core CPI	2.65***	5.78***	4.66***	5.00***	4.03***	4.18***
	(0.55)	(0.77)	(0.57)	(0.58)	(0.48)	(0.63)
Core PPI	0.78	4.76**	5.24***	6.13***	5.09***	5.11***
	(2.69)	(2.00)	(1.82)	(2.09)	(1.44)	(1.49)
ECB GCM	-5.78	-3.25	-17.27	-5.14	-2.85	1.62
	(5.85)	(4.04)	(14.68)	(5.47)	(3.62)	(7.68)
Euro area M3	0.99	0.85	0.51	0.87	0.95	1.39
	(1.58)	(0.53)	(1.42)	(0.54)	(0.92)	(1.31)
Euro area Consumer Prices	-23.85	-2.42	-0.50	0.07	-0.18	-0.52
	(142.27)	(2.76)	(0.88)	(0.72)	(0.77)	(0.97)
Germany Factory Orders	-0.21	0.58	-0.00	-0.15	0.13	-0.11
	(0.36)	(0.69)	(0.94)	(0.38)	(0.31)	(0.35)
Germany Industrial Production	2.75	-6.28	-3.01	-3.24	-12.77	2.19
	(9.05)	(7.39)	(2.92)	(3.83)	(35.26)	(4.08)
Germany ifo Business Climate	0.45	0.59*	0.42	0.46*	0.61***	0.71***
	(1.47)	(0.33)	(0.26)	(0.24)	(0.24)	(0.27)
Germany ZEW Expectations	-1.69	-0.16	0.93	0.37	0.37	0.33
	(1.42)	(0.87)	(0.63)	(0.27)	(0.29)	(0.29)

(b) EA yields

	3-Month	1-Year	2-Year	5-Year	10-Year	30-Year
FOMC	2.51**	9.49**	8.41*	11.96*	16.45	11.96
	(0.99)	(4.75)	(4.80)	(7.21)	(12.55)	(11.73)
Nonfarm Payrolls	3.25***	7.51***	6.03***	5.60***	4.19***	3.76***
	(0.88)	(1.82)	(1.67)	(0.79)	(0.29)	(0.38)
Initial Jobless Claims	-12.34***	-12.47***	-10.47***	-8.76***	-6.77***	-6.98***
	(3.04)	(2.39)	(1.97)	(1.37)	(1.18)	(1.89)
Durable Goods Orders	2.38**	2.50***	2.25***	2.35***	1.97***	2.96*
	(1.14)	(0.59)	(0.61)	(0.48)	(0.45)	(1.68)
Employment Cost	409.64	-7.69*	-8.28	-30.72	19.62	9.21
	(107805.42)	(4.05)	(5.43)	(68.57)	(36.59)	(15.01)
Retail Sales Ex Auto	3.80	7.19**	4.69***	4.94***	4.23***	2.76***
	(2.70)	(2.89)	(1.62)	(1.56)	(1.20)	(0.74)
GDP	0.74	3.92**	2.81***	3.83**	2.63***	2.62***
	(2.74)	(1.63)	(1.05)	(1.64)	(0.86)	(0.98)
Core CPI	2.75	3.94***	3.73***	3.10***	2.98***	3.26***
	(1.83)	(1.33)	(1.20)	(0.64)	(0.62)	(1.02)
Core PPI	8.24	7.83**	6.51*	5.34**	4.70**	3.23**
	(8.66)	(3.93)	(3.52)	(2.25)	(2.10)	(1.53)
ECB GCM	7.17***	11.55***	9.15***	9.98***	9.83**	22.58
	(1.85)	(3.56)	(2.82)	(2.94)	(4.13)	(30.56)
Euro area M3	0.82*	1.46***	1.78**	2.72**	2.24*	2.85
	(0.47)	(0.56)	(0.75)	(1.24)	(1.17)	(1.89)
Euro area Consumer Prices	0.62	1.47	1.34**	2.09**	1.28	0.89
	(1.08)	(0.97)	(0.64)	(1.05)	(1.22)	(1.26)
Germany Factory Orders	0.16	0.69	0.36	0.67	0.20	0.19
	(0.83)	(0.51)	(0.70)	(0.63)	(0.46)	(0.76)
Germany Industrial Production	0.13	0.23	1.36	2.05	2.57	-279.28
	(1.09)	(0.96)	(1.09)	(1.83)	(3.92)	(51535.61)
Germany ifo Business Climate	1.86***	3.18***	2.68***	2.67***	1.95***	1.62***
	(0.45)	(0.47)	(0.41)	(0.41)	(0.33)	(0.42)
Germany ZEW Expectations	1.88*	1.64***	1.39***	1.67***	1.25***	1.15**
	(0.96)	(0.30)	(0.26)	(0.33)	(0.31)	(0.49)

Heteroskedasticity-based estimates of Equation (1). Eight macro releases that frequently coincide with other releases are omitted from the estimation (Retail Sales, CPI, PPI, Hourly Earnings, Unemployment, ZEW current situation, ifo current assessment and expectations, see Table A3).

B.2 Release-Specific and Ever-Present Factor in EA Model

Table B3 shows that the results from our preferred factor model specification also hold in the domestic EA model from Section 4.1.

Table B3: Factor model with release-specific & ever-present factors

	3-Month	1-Year	2-Year	5-Year	10-Year	30-Year
ECB GCM	1.70**	1.95***	1.80***	1.37***	0.59***	0.20
Euro area M3	0.10***	0.26***	0.14***	0.12**	0.09**	0.07
Euro area Consumer Prices	0.08*	0.25**	0.20**	0.22**	0.16**	0.13**
Germany Factory Orders	0.09*	0.25***	0.15**	0.20**	0.17***	0.13*
Germany Industrial Production	0.05	0.13**	0.14**	0.10	0.05	0.02
Germany ifo Business Climate	0.04	0.26	0.27	0.21	-0.03	-0.38
Germany ifo Current assessment	0.33**	0.71***	0.56***	0.64***	0.59***	0.67**
Germany ifo Expectations	0.02	0.12	-0.00	0.09	0.20	0.31
Germany ZEW Expectations	0.16**	0.42***	0.37***	0.42***	0.37***	0.27***
Germany ZEW Current Situation	0.11	0.03	-0.02	0.04	0.05	-0.03
F ECB GCM	0.50*	2.18***	2.21***	2.65***	1.31***	0.08
F ECB GCM	3.04***	3.34***	2.65***	1.48***	-0.00	-0.53*
F ECB GCM	1.87***	2.26***	1.80***	2.24***	2.41***	2.01***
F Euro area M3	0.15***	0.27***	0.22***	0.08	-0.06	-0.19**
F Euro area Consumer Prices	0.29***	0.47***	0.26*	0.19	0.02	-0.10
F Germany Factory Orders	0.22***	0.34***	0.28***	0.27**	0.10	-0.16**
F Germany Industrial Production	0.13**	0.23**	0.22**	0.11	-0.04	-0.20
F Germany ifo Business Climate	0.53***	1.14***	0.92***	0.79***	0.43***	0.21**
F Germany ZEW Expectations	0.45**	0.44***	0.13	0.02	-0.09	-0.20*
Ever-present Factor	0.25***	0.75***	0.72***	0.94***	0.82***	0.68***
R^2 no factor	0.16	0.14	0.16	0.12	0.07	0.03
R^2 release-specific factors	0.93	0.87	0.86	0.81	0.72	0.61
R^2 all factors	0.93	0.94	0.96	1.00	0.98	0.90

Estimated effect of euro area news on euro area yields, for the model with release-specific and an ever-present factor as in equation (5).

B.3 Anchoring of Long-Term Inflation Expectations

Tables B4-B5 shows the full regression results underlying the F-tests shown at the top of Table 5.

Table B4: Response of US Market-Based Inflation Expectations to (Un)Observable News

	US 5y5y	US 9y1y
Core CPI	0.80*	1.09**
Durable Goods Orders	-0.39	-0.24
Employment Cost	-0.32	-0.18
GDP	1.30*	1.66*
Initial Jobless Claims	-0.54***	-0.69***
Nonfarm Payrolls	0.37	0.48
Core PPI	0.46	0.37
Retail Sales	0.91*	1.47**
Unemployment	0.26	-0.30
Hourly Earnings	0.69	0.42
PPI	0.36	-0.18
Retail Sales Ex Auto	0.09	-0.07
CPI	0.45	0.67
F CPI	1.19**	0.83
F Durable Goods	-0.03	0.02
F Employment Cost	0.33	0.46
F GDP	-1.56	-0.67
F Initial Jobless Claims	-0.23	-0.20
F Nonfarm Payrolls	-0.20	-0.10
F PPI	1.14	-0.51
F Retail Sales	-0.84	-0.49
Ever-present Factor	0.81***	0.74***
R^2	0.05	0.03

Detailed results for the full sample regression shown in Table 5. Each column refers to a regression of changes in daily market-based inflation expectations onto observable surprises, release-specific factors, and an ever-present factor. All regressors are cumulated to daily frequency and then standardized to mean zero and unit variance.

Table B5: Response of EA Market-Based Inflation Expectations to (Un)Observable News

	EA 5y5y	EA 9y1y
Euro area M3	0.14	1.53**
Euro area Consumer Prices	0.56**	0.16
Germany Factory Orders	-0.22	-0.55
Germany Industrial Production	-0.08	-0.08
Germany ifo Business Climate	-0.35	-4.88
Germany ifo Current assessment	0.27	3.92*
Germany ifo Expectations	0.60	3.53
Germany ZEW Expectations	0.34	0.62
Germany ZEW Current Situation	-0.25	-0.15
F Euro area M3	-0.18	1.10
F Euro area Consumer Prices	0.38	1.87**
F Germany Factory Orders	-0.86**	-1.68
F Germany Industrial Production	-0.36	0.49
F Germany ifo Business Climate	-0.08	-0.06
F Germany ZEW Expectations	-0.00	-0.03
Ever-present Factor	0.02	0.01
R^2	0.01	0.00

Detailed results for the full sample regression shown in Table 5. Each column refers to a regression of changes in daily market-based inflation expectations onto observable surprises, release-specific factors, and an ever-present factor. All regressors are cumulated to daily frequency and then standardized to mean zero and unit variance.

B.4 Response of Economic Survey Expectations

Table B6 checks how survey participants revise their economic outlook in response to observable and unobservable news. In particular, we regress revisions in constant-horizon one year ahead expected GDP growth and CPI inflation onto observable surprises and the factors that we have estimated.[9] Since the survey data comes from monthly surveys by Consensus Economics, we cumulate all regressors to monthly frequency.

We see that survey participants revise their short-term outlook mostly in response to observed – rather than unobserved – and mostly in response to domestic – rather than foreign – news. The main exception are unobservable EA news, which affect GDP growth expectations in both the US and EA.

Table B6: Response of Economic Survey Expectations to (Un)Observable News

	US CPI	US GDP	EA CPI	EA GDP
US Observable News	8.09***	7.15***	0.03	1.46
US Unobservable News	0.96	0.03	0.59	0.19
EA Observable News	3.93**	0.01	15.28***	4.64**
EA Unobservable News	0.22	4.30**	0.01	2.26
Background Noise	-0.01	-0.03**	-0.01	-0.01

Each column refers to a regression of monthly survey revisions onto the same set of regressors as in Table 3, i.e. 14 observable US news, 11 unobservable US news (the release-specific factors), 10 observable EA news, 9 unobservable EA news and background noise (the ever-present factor). All regressors are cumulated to monthly frequency and then standardized to mean zero and unit variance. Each cell refers to an F-test statistic of the null hypothesis that all regressors mentioned at the beginning of the row are jointly zero. For the background noise, the cells contain the coefficient estimates of the ever-present factor, i.e. the survey revisions (in percentage points) to a one standard deviation shock in the ever-present factor.

[9] We construct the constant-horizon one year ahead forecasts as a weighted average of the forecasts for the current and next year. Unfortunately we cannot use forecasts for longer horizons, since these are only collected twice per year.

B.5 Intraday Market Reaction to Latent Factors

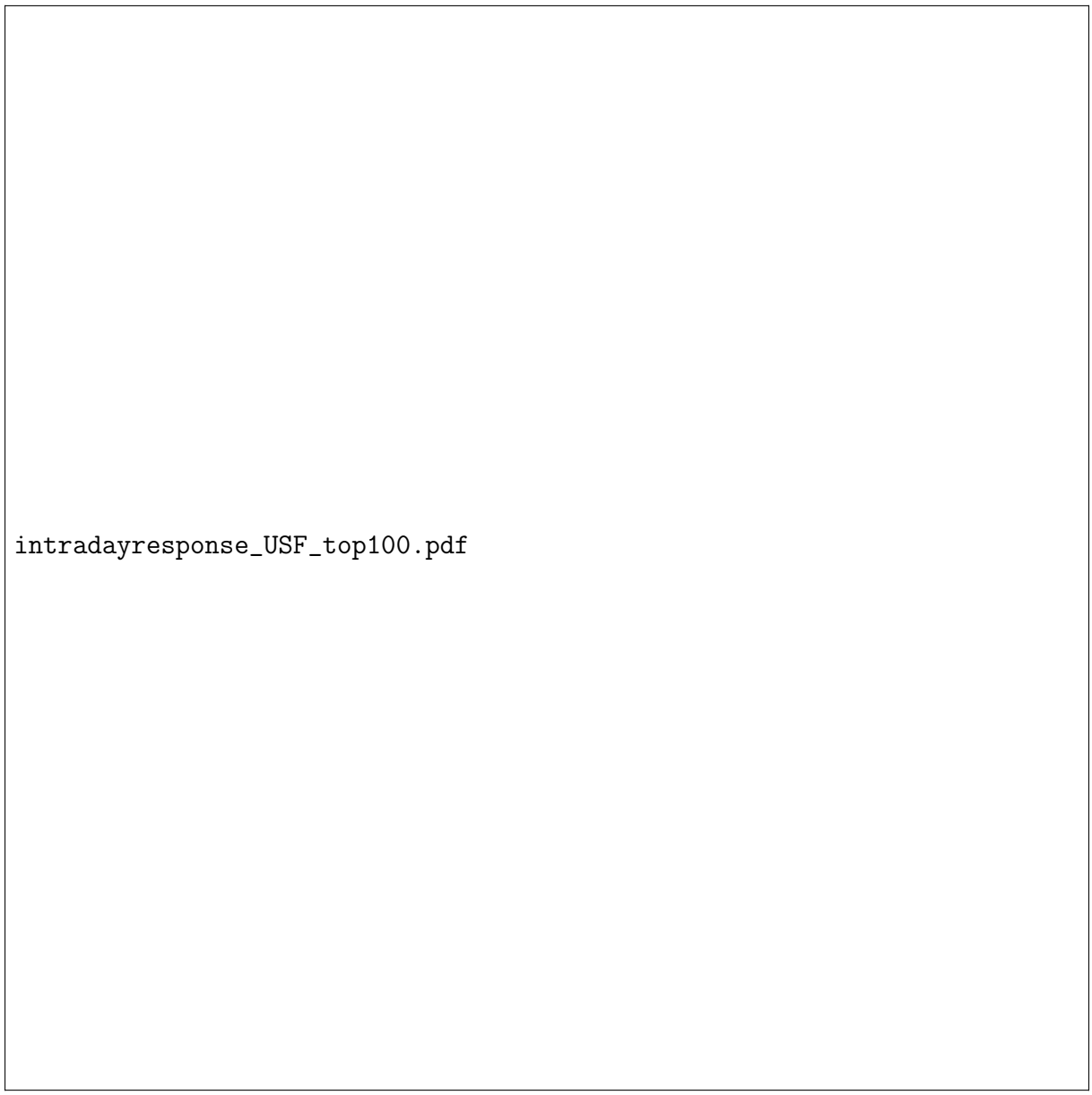
This section studies how markets behave immediately before and after our selected intraday windows.

Figure B2 shows market movements around large realizations of the US release factor from Table **??**. According to our interpretation, these large realizations capture times when unobservable "non-headline" news were particularly important. Hence, we would expect market reactions to be permanent. If, on the other hand, these episodes merely capture times when risk or liquidity premia changed, one might expect that the initial market reactions dissipate quickly after the news events. Figure B2 shows no sign of overreactions, in line with our interpretation of the latent factors capturing unobserved news. Furthermore, the figure shows that (i) markets react quickly, in line with our narrow event window choice, (ii) there is no sign of asymmetric reactions to positive and negative news and (iii) domestic yields react stronger than foreign yields to unobserved domestic news.

Figure B3 replicates the exercise for the EA release factor, reaching broadly similar conclusions with a few exceptions: US short-term yields barely react at all to unobserved EA news, markets react somewhat slower, and the response to positive news is slightly larger than to negative news.

Figure B4, lastly, performs the analogous exercise for large realizations of the ever-present "background noise" factor from Table 3 during control windows, i.e. when no major scheduled macro news were released but markets moved nonetheless. As before, these episodes exhibit no sign of market reversals either. Instead, market responses (i) are rather smooth and continuous, compared to the discrete jumps around US news and (ii) responses are of the same size in the US and EA. In this sense, the ever-present factor may capture "global drifts", whereas the country-level announcement factors capture "news-induced jumps".

Figure B2: Market Reaction to Large Realizations of US Factor

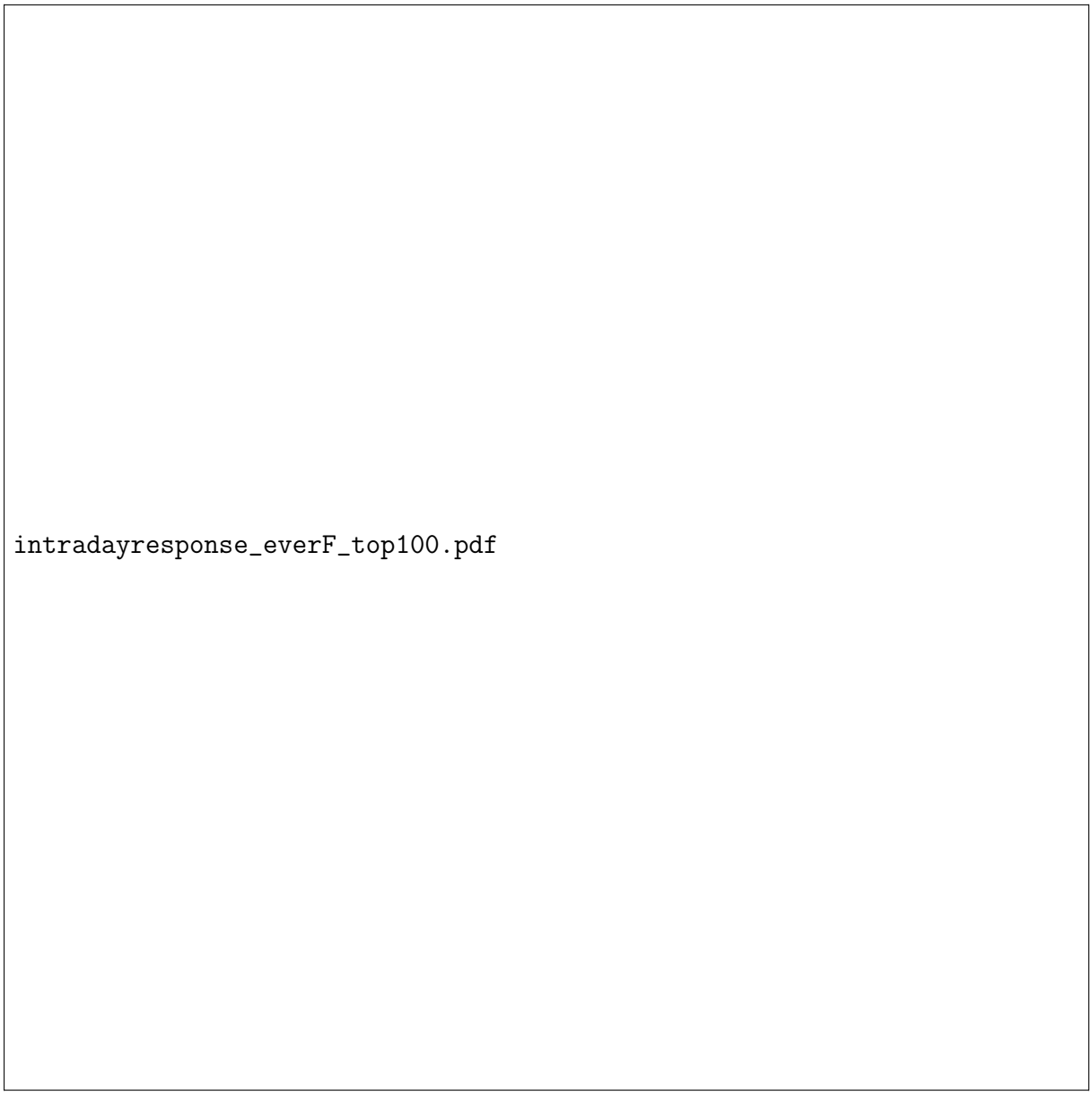


Market reactions to the 100 largest positive realizations (in blue) and 100 largest negative realizations (in red, sign reversed) of the US release factor from Table **??**. Lines refer to averages, shaded areas to ± two standard errors. Yield changes are in basis points, stock price changes in percent. The horizontal axis ranges from 20 minutes before till 60 minutes after news releases, vertical dashed lines mark the event window bounds at -5 and +15 minutes. Due to their longer event windows, central bank announcements that were followed by a press conference are not included.

Figure B3: Market Reaction to Large Realizations of EA Factor

Market reactions to the 100 largest positive realizations (in blue) and 100 largest negative realizations (in red, sign reversed) of the EA release factor from Table **??**, see Figure B2 for details.

Figure B4: Market Reaction to Large Realizations of Ever-present Factor



Market reactions to the 100 largest positive realizations (in blue) and 100 largest negative realizations (in red, sign reversed) of the ever-present factor from Table 3 around control windows. Lines refer to averages, shaded areas to ± two standard errors. Yield changes are in basis points, stock price changes in percent. The horizontal axis ranges from 20 minutes before till 60 minutes after "no-news" control events, vertical dashed lines mark the control window bounds at -5 and +15 minutes. Control windows that are longer than 20 minutes are not included.

B.6 Persistence

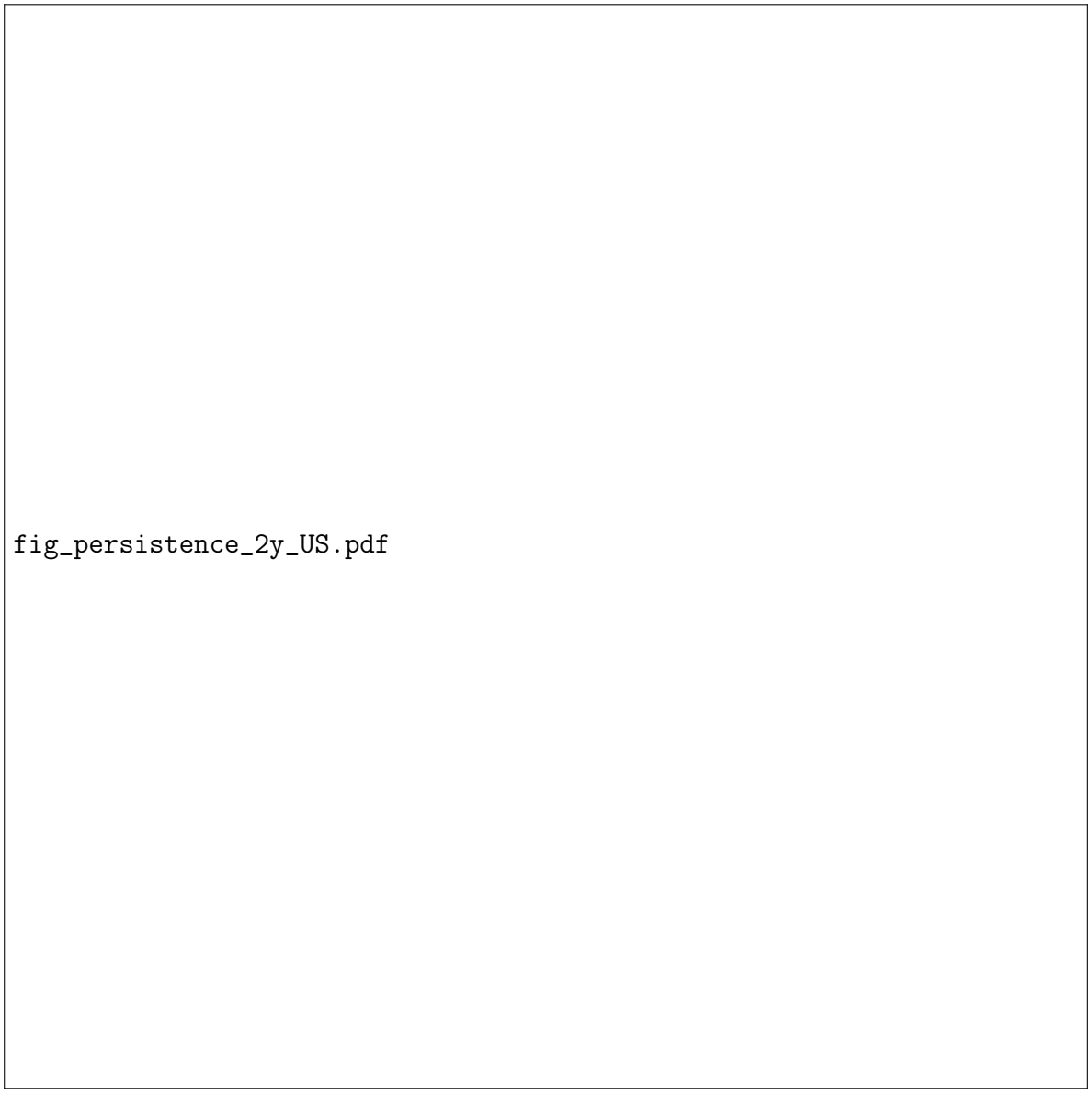
The previous section looked at the immediate intraday market response to unobserved news. But how persistent are the effects of latent factors on yields at longer horizons? Figures B5 and B6 show the answer to this question using 2-year and 10-year yields over a 60-day horizon, based on daily benchmark yields from Eikon.

For 2-year yields, shown in Figure B5, the effects of country-level factors are quite persistent, particularly domestically. The spillover effects, in contrast, are less persistent. The effect of unobserved US news on EA yields turn insignificant after about three weeks. In the opposite direction, the same happens after about one week. The effect of the ever-present factor, shown in panel (c), also dissipates quickly, within a few days. This is consistent with our interpretation that release factors capture unobserved news whereas the ever-present factor captures "background noise".

For 10-year yields, shown in Figure B6, results are similar. Unobserved news have persistent effects domestically, but rather transitory effects abroad. The effect of the ever-present factor, however, barely dissipates over time for 10-year yields.

Figure B5: Persistence of 2-Year Yield Responses

(a) US Factor



(b) EA Factor

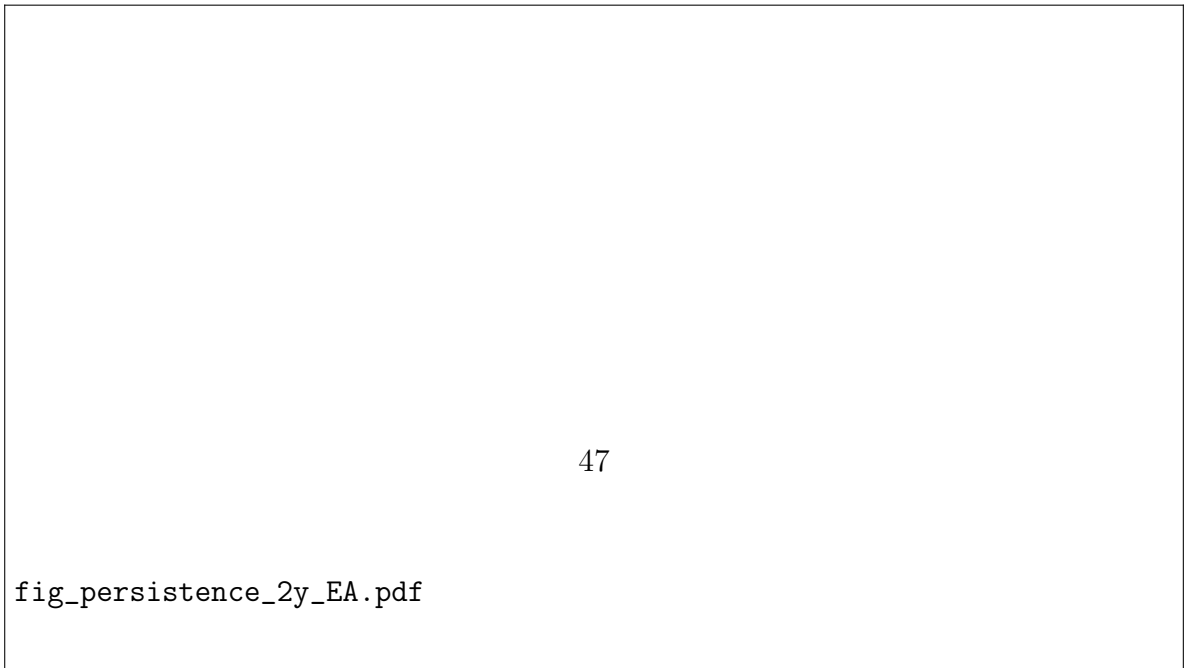
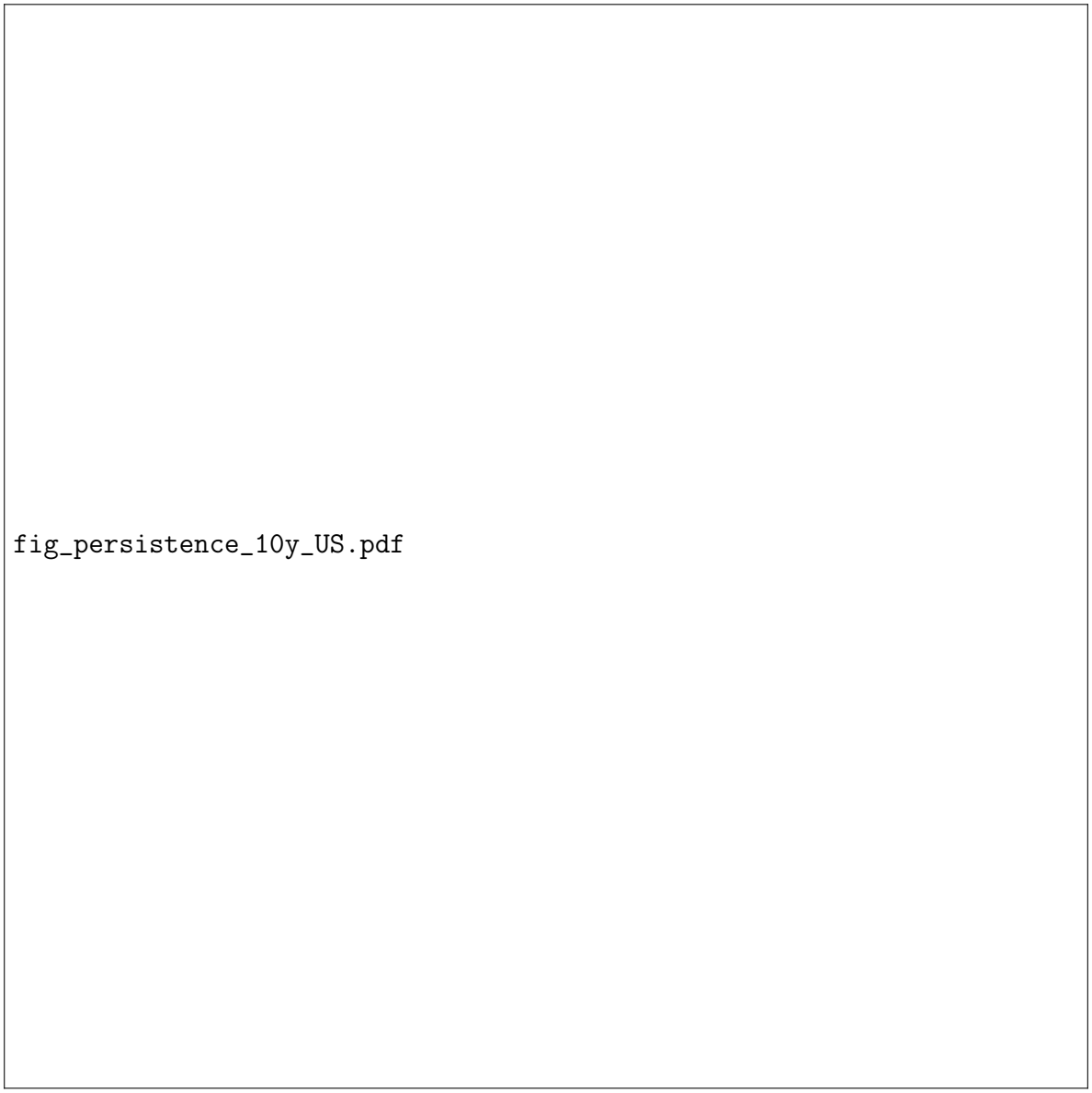
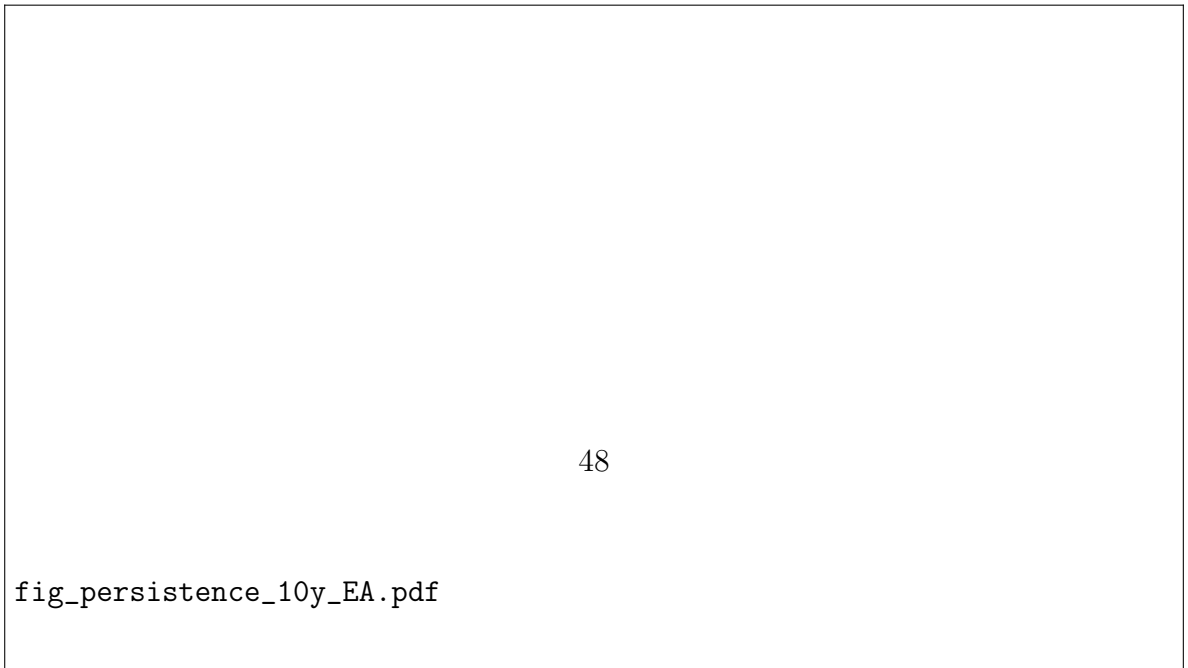


Figure B6: Persistence of 10-Year Yield Responses

(a) US Factor



(b) EA Factor

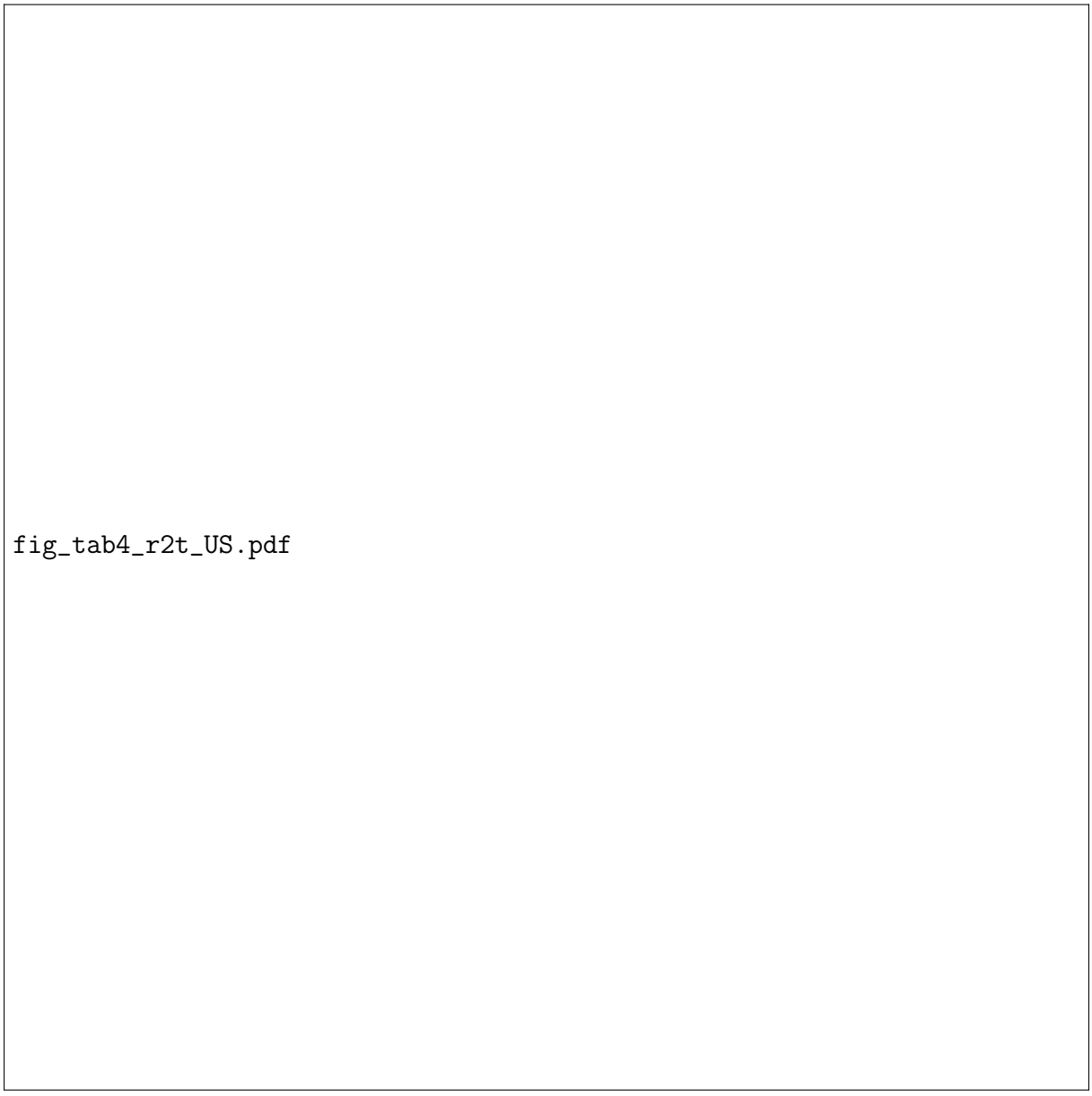


B.7 Explanatory Power over Time

Figure B7 shows the explanatory power of observable surprises and the latent factors from Table **??** over time. The figure refutes the conjecture that the lower R^2s for EA yields is driven by the sovereign debt crisis period. The figure does show, though, that the low R^2s for short-term US rates is driven by the effective lower bound period (2009-2014).

Figure B7: Explanatory Power over Time

(a) US Yields



(b) EA Yields

Adjusted R^2 values of observable surprises (left panel) and observable surprises plus the latent release-specific factors (right panel, from Table 3). Regressions are run separately for each calendar year.

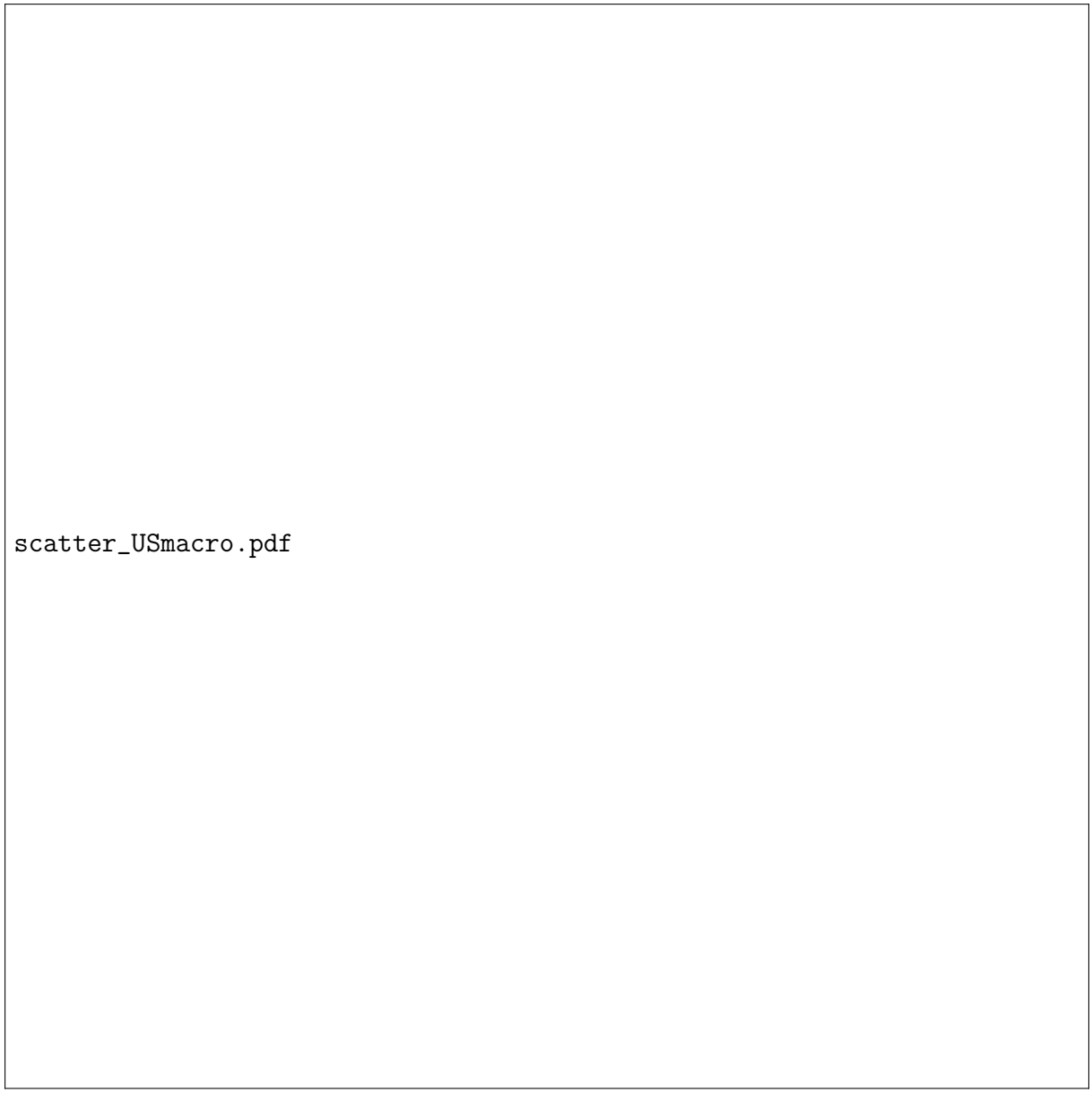
B.8 Spillovers between US and EA yields

Figures B8-B12 provide scatter plots of US and EA yield changes around five types of different windows, namely US macroeconomic data releases, US monetary policy announcements, EA macroeconomic data releases, EA monetary policy announcements, and control windows.

We see that yields are tightly linked around all US news, i.e. both macro news and monetary policy news, and that the link generally gets tighter at longer maturities. At the three month maturity, EA yields move 25-40% as much as US yields, but this share rises to over 50% at the 10-year maturity. Around EA news, the link is generally weaker, but still considerable. In control windows, i.e. at times without major economic news, lastly, the link between US and EA yields is visibly looser, with yield changes being much more dispersed.

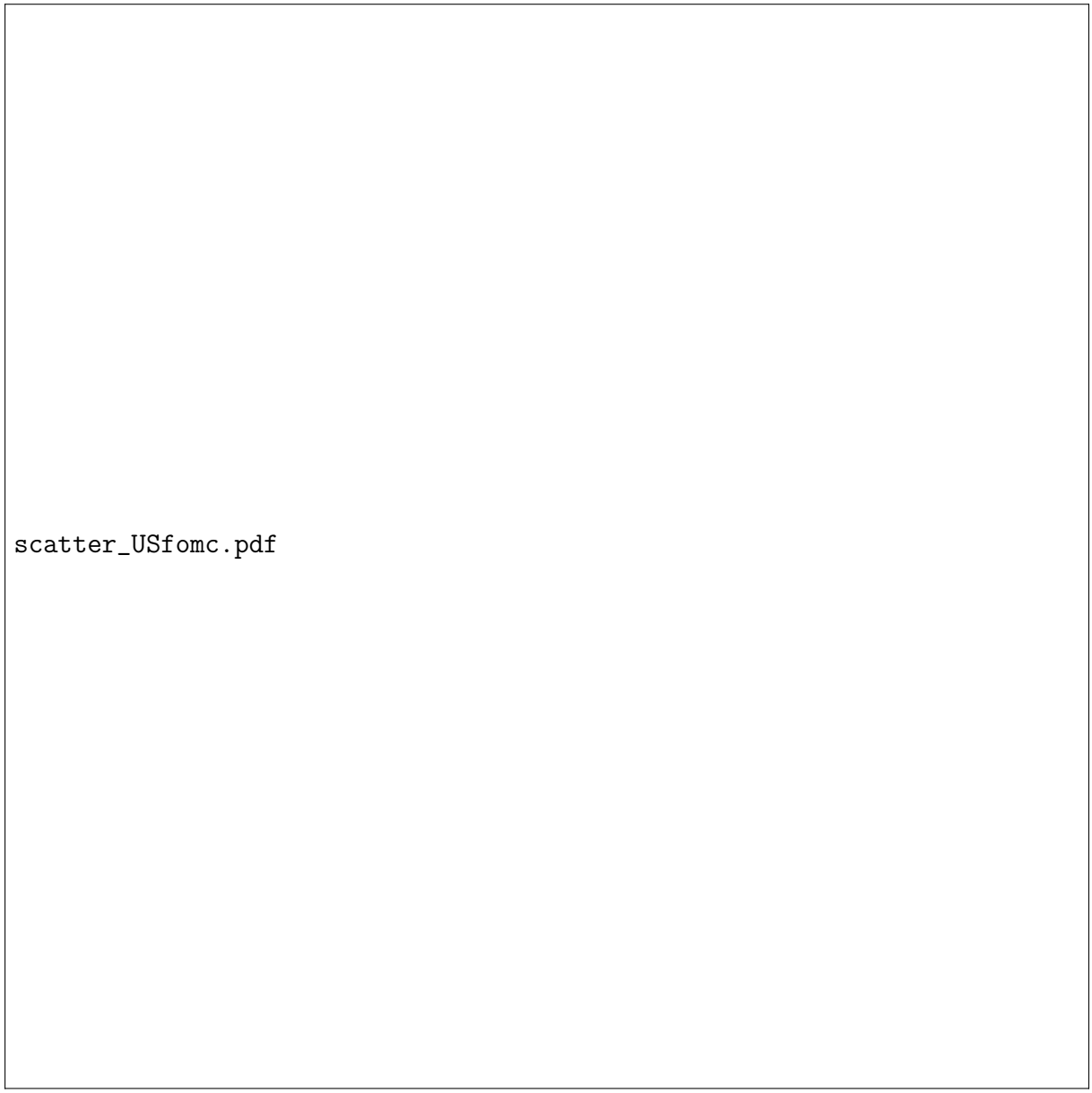
Figure B13 provides an overview. The estimated *average* "spillover" between US and EA yields does not increase all that much around news compared to control windows (left panel). But the precision of that estimate rises substantially, particularly around US news releases (right panel).

Figure B8: Comovement of US and EA Yields around US Macro Releases



Each scatter plot compares yield changes of a given maturity in the US (on the horizontal axis) and the euro area (on the vertical axis) around US macro releases. The grey lines, the beta coefficients and the R^2 values refer to OLS estimates. US initial jobless claim releases that coincide with ECB press conferences are omitted.

Figure B9: Comovement of US and EA Yields around FOMC Announcements

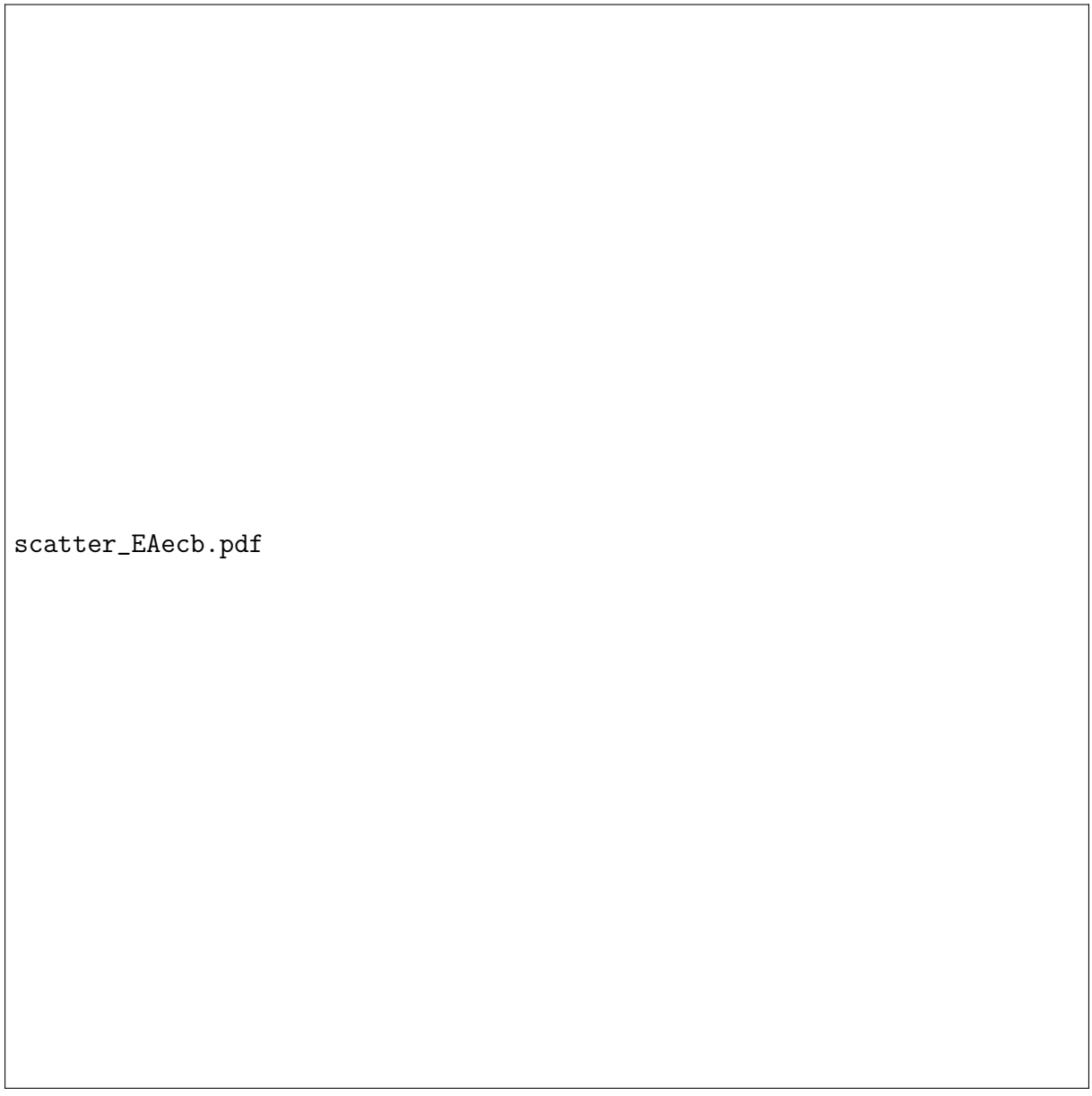


Each scatter plot compares yield changes of a given maturity in the US (on the horizontal axis) and the euro area (on the vertical axis) around FOMC announcements. The grey lines, the beta coefficients and the R^2 values refer to OLS estimates.

Figure B10: Comovement of US and EA Yields around EA Macro Releases

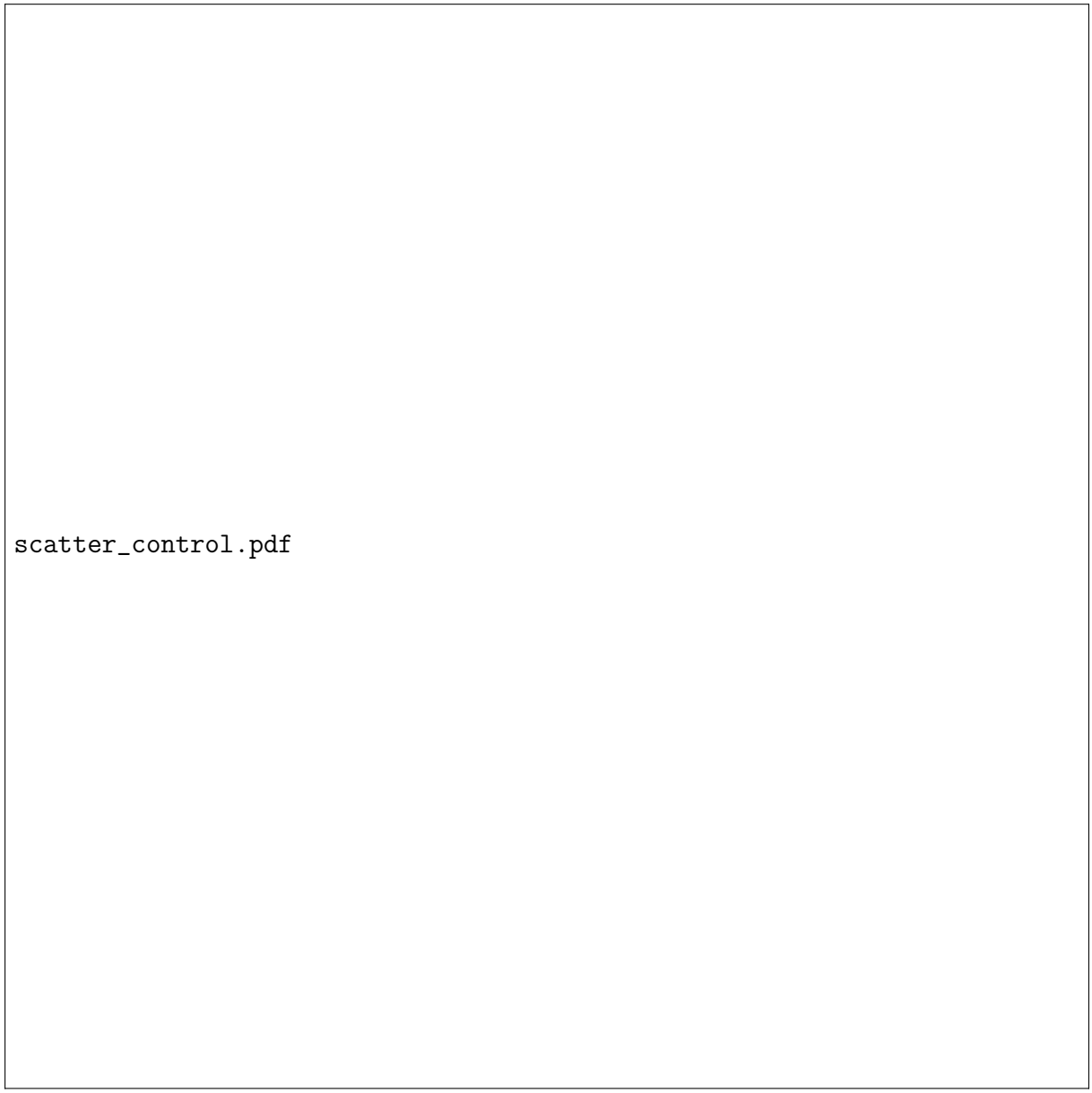
Each scatter plot compares yield changes of a given maturity in the euro area (on the horizontal axis) and the US (on the vertical axis) around EA macro releases. The grey lines, the beta coefficients and the R^2 values refer to OLS estimates.

Figure B11: Comovement of US and EA Yields around ECB Announcements



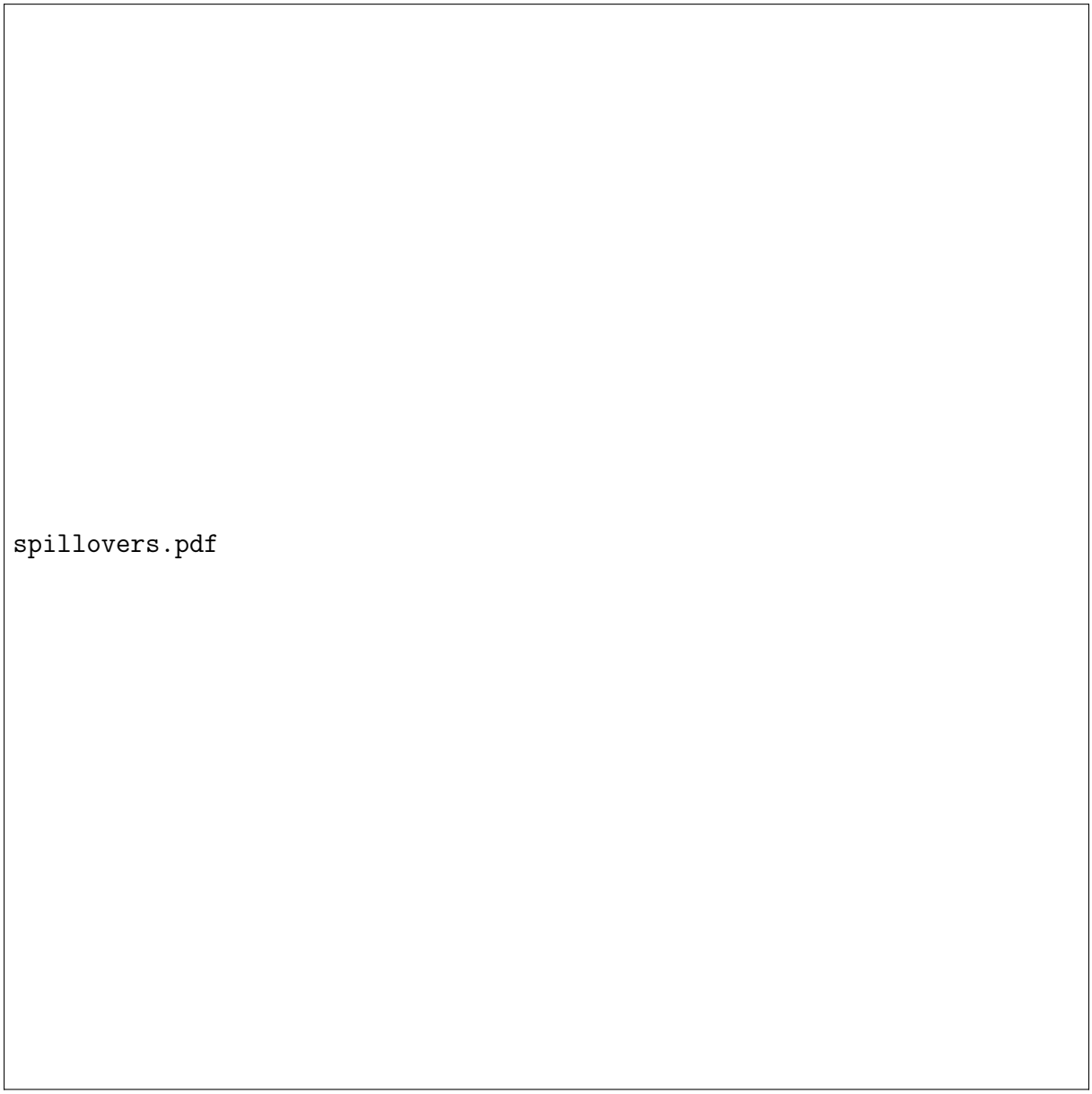
Each scatter plot compares yield changes of a given maturity in the euro area (on the horizontal axis) and the US (on the vertical axis) around ECB announcements. The grey lines, the beta coefficients and the R^2 values refer to OLS estimates. Note that ECB event windows also capture the effect of US initial jobless claim releases, which coincide with ECB press conferences.

Figure B12: Comovement of US and EA Yields around Control Windows



Each scatter plot compares yield changes of a given maturity in the US (on the horizontal axis) and the euro area (on the vertical axis) around control windows. The grey lines, the beta coefficients and the R^2 values refer to OLS estimates.

Figure B13: Overview of Comovement between US and EA Yields



Summary of Figures B8-B12. The left panel shows the estimated "spillover coefficients" b. For US and control windows, b is the average fraction of yield changes spilling over from US to euro area yields. For EA windows, b refers to spillovers from the euro area to the US. The right panel shows the adjusted R^2 values of the respective regressions.