Does Central Bank Tone Move Asset Prices?*

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Abstract

We explore whether the *tone* of central bank communication matters for asset prices. Using press conference statements by the ECB, which was the first central bank to establish live press conferences after meetings of its Governing Council, we find that tone changes have a statistically and economically significant effect on equity returns. Stock prices increase when ECB tone becomes more positive and vice versa. The return differential associated with positive versus negative tone changes is around 60 basis points on press conference days and increases to more than 100 basis points until the next press conference. Moreover, we find that positive tone changes are associated with increasing government bond yields, lower implied equity volatility, lower variance risk premia, and lower corporate credit spreads. Since we also show that tone changes are unrelated to current and future economic fundamentals, these results support the conjecture that central bank tone matters for asset prices through a risk-based channel. Our main findings also apply to U.S. markets, where stock prices and Treasury yields increase when the Fed chair's tone in the Congressional Testimony becomes more positive.

JEL Classification: G10, G12, E43, E44, E58

Keywords: Central bank communication, stock returns, return predictability, bond yields, monetary policy shocks, textual analysis

"I don't think I'm stepping up my rhetoric on inflation, Draghi said [...]. Financial market analysts nonetheless detected a shift in tone if not in substance of monetary policy."

Reuters, April 4th, 2012

"All eyes will be on the ECB this afternoon. If the tone is clearly dovish, then it could maybe stop the bleeding on the market." Reuters, August 7th, 2014

"This time, it's very hard to predict [...] the tone in the press conference, and investors are quite anxious." Reuters, November 2nd, 2014

Given the uncertainty, how Ms. Yellen frames what the Fed is doing will be as important as what the Fed actually does." WSJ, September 16th, 2015

1. Introduction

Central bank communication shapes market expectations and has become an integral part of the monetary policy toolkit.[1] As such, central bank (CB) communication is closely followed by market participants, extensively covered in the financial press, and central banks evaluate the media coverage of their statements to gauge the effectiveness of their communication. To accommodate the rising importance of communication, numerous central banks nowadays hold live press conferences, so that information becomes available to all market participants at the same time. At these press conferences, market participants do not only pay attention to the content but also, as the above quotes illustrate, closely follow the *tone* of central bank statements.

This paper explores how the *tone* of CB press conference statements affects prices in equity and government bond markets. To quantify CB tone, we employ standard techniques of textual analysis. First, we use the financial dictionary developed by Loughran and McDonald (2011) to identify *negative* words in a CB statement.[2] Second, we evaluate

[1] For an overview of the literature on central bank communication see, e.g., Woodford (2005) and Blinder et al. (2008).

[2] This dictionary has already proven useful in different financial contexts (see the survey of Loughran and McDonald, 2014) but we are the first to apply it to central bank statements.

the tone of the statement by assessing the prevalence of negative words in its text and construct a measure of tone such that higher values reflect a more positive tone of the CB and vice versa. By repeating this procedure and scoring each press conference statement individually, we construct a time-series of CB tone that we use to study if and how CB tone affects prices. To the best of our knowledge, we are the first to use such an objective and systematic approach to measure the *tone* of CB statements and its impact on financial markets.[3]

In our empirical analysis, we focus on press conferences held by the European Central Bank (ECB), because the ECB was the first CB to set up comprehensive press conferences directly after meetings of its Governing Council. These press conferences are broadcasted live and thus represent a source of real-time information for market participants.[4] We evaluate the tone of the ECB president's statement during these press conferences from January 1999 to October 2014. Given that ECB press conferences take place on Thursdays in the early afternoon (14:30 CET), any information revealed during the press conference can affect financial market prices directly on the same day. Our empirical results show that ECB tone indeed has a statistically and economically significant effect on equity and government bond prices on the day of the press conference and that this effect propagates beyond the release day through the cycle to the next ECB press conference.

Our first main result is that changes in ECB tone have a significant effect on stock prices on the day of the press conference (PC). When ECB tone becomes more positive compared to the previous PC, equity prices increase by about 25 basis points (bp) whereas a more negative tone is associated with a return of -35 bp on that day. This differential of about 60 bp is highly significant, both, statistically and economically, and very similar

[3]Related papers typically aim at measuring the *content* rather than the *tone* of central bank communication, use textual analysis or narrative approaches that require double usage of data, and/or subjective judgements. For instance, Romer and Romer (2004) apply a narrative approach to central bank documents to identify monetary policy shocks. Rosa and Verga (2007) and Rosa (2011) construct a proxy for tone but use a narrative approach and self-defined dictionaries, which are subjective and relatively narrow in scope. Lucca and Trebbi (2009) analyze the content of FOMC statements by semantic orientation scores that are computed from a extremely large set of information obtained through search engines. Our approach exclusively focuses on the text of the CB statement itself and measures tone directly from this statement. We choose an exogenous dictionary and use a simple tone metric to provide a transparent measure of tone in a real-time setting that avoids hindsight bias from using the data twice (e.g., for first constructing a dictionary or training an algorithm that is subsequently applied in the empirical analysis).

[4]We discuss these features and their usefulness for our empirical analysis in more detail in Section 2.1.

for a broad stock market index (MSCI EMU), a highly liquid index of large stocks (Eurostsoxx50), as well as value and growth stocks (MSCI value and growth indices for the Eurozone, respectively). With approximately twelve ECB press conferences per year, the tone-related return differential of 60 bp annualizes to around 7% in absolute value which seems economically large. Similarly, regression evidence suggests that a one-standard deviation shock to tone translates into an equity return of ± 30 bp on PC days, depending on whether ECB tone becomes more positive or negative.

Second, we show that the effect of tone on equity prices is not confined to PC days but persists beyond the day of the press conference. The PC-day return differential of around 60 bp increases to more than 100 bp over the cycle to the next press conference. This finding suggests that the effect of tone changes on equity prices is not quickly reversed after PC days but rather that the information conveyed by CB tone gradually diffuses into equity prices over time. More generally, we show that all of the cumulative equity return over our sample is earned during periods when the most recent tone change was positive whereas cumulative returns are close to zero or negative after PCs with a negative tone change. These findings prevail even when removing PC-day effects and suggest that the equity premium is generated in times associated with positive ECB tone. Furthermore, we corroborate our results by documenting that tone changes have very similar effects on all individual EMU countries' stock returns, which implies that our results for aggregate stock returns in the Eurozone are not driven by a few countries.

A natural explanation for our findings could be that central bank tone affects market expectations about interest rates, which, in turn, affect equity prices. We therefore also explore whether ECB tone matters for the shape of the government bond yield curve and we find that it does. However, our results are do not support a channel where more positive tone drives up equity returns via lowering yields. In fact, we show that more positive CB tone is associated with increasing yield levels on PC-days as well as over PC-cycles and that the hump in the yield curve becomes more pronounced until the next PC (because medium-term yields increase more than short- and long-term yields). In general, yields with shorter maturities are most sensitive to CB tone changes, which is consistent with the view that central banks control the short end of the yield curve.

Another explanation for our findings could be that ECB tone simply aggregates information about economic fundamentals and that more positive tone drives up equities and yields because it indicates stronger economic growth. Contrary to this notion, we find that changes in ECB tone are largely unrelated to current and and future real-time macroeconomic fundamentals, thereby ruling out that ECB tone predicts stock returns because it forecasts future economic developments. We also provide evidence suggesting that ECB tone changes mostly do not reflect a response to recent economic and financial market developments. The only significant driver of ECB tone change is the preceding change in the curvature of the yield curve, which, however, accounts for only 7% of the time-variation in tone changes. All these results imply that tone changes convey generic information that is largely unrelated to economic fundamentals measured in real-time.

Since tone does not seem to drive equities because of its impact on yields or because it forecasts growth, we investigate whether our findings are consistent with the notion that central bank tone affects asset prices through a risk-based channel, as discussed in previous research that finds monetary policy (announcements) to affect risk premia embedded in market prices (see, e.g., Shiller et al., 1983; Hanson and Stein, 2014; Morris and Shin, 2014; Gertler and Karadi, 2015; Hattori et al., 2015). If a more positive tone drives down the risk aversion of market participants, one expects to find precisely the positive link between tone changes and, both, stock returns and bond yields documented in our empirical results. We provide further support for this view by examining the link between tone and the VSTOXX (an index of option-implied equity volatility), which is commonly viewed as a proxy for uncertainty and risk aversion (e.g., Bekaert et al., 2013; Miranda-Agrippino and Rey, 2014). Specifically, we find that changes in the VSTOXX-implied risk aversion are significantly related to changes in ECB tone such that more positive tone is associated with lowered risk aversion the market. Additionally, we provide support for the risk-based channel by showing that corporate credit spreads, which are viewed as particularly sensitive to changes in market participants' risk appetite, decrease when tone becomes more positive.

We also present evidence that central bank tone matters for asset prices in the U.S. While the Fed has introduced press conferences comparable to those of the ECB only recently (in April 2011), data on the Fed Chair's Testimonies to the U.S. Congress is

available from 1996. An interesting feature of these hearings is that the Fed Chair's report on monetary policy does not coincide with actual monetary policy decisions (as is the case for ECB press conferences which take place after Governing council meetings). Nonetheless, we find that the relation between U.S. asset prices and Fed tone at these hearings is qualitatively identical to the reaction of EMU market prices to changes in ECB tone at press conferences: a more positive central bank tone is associated with higher equity returns and higher bond yields compared to changes in asset prices when central bank tone becomes more negative. These results provide further evidence that central bank tone contains generic information for asset prices.

To corroborate our conclusions, we conduct various additional empirical exercises. For example, our findings remain unchanged when controlling for actual changes in the stance of monetary policy or unconventional monetary policy announcements by the ECB. We also generate a time-series of "CB tone shocks" and find that using these unexpected tone changes yields virtually the same results as using simple tone changes.

On a general level, our work relates to previous research that analyzes the effect of monetary policy on asset prices and risks (e.g., Rigobon and Sack, 2004; Bjornland and Leitermo, 2009; Buraschi et al., 2014; Campbell et al., 2015). We also contribute to the literature that quantifies monetary policy shocks in terms of market prices (e.g., Kohn and Sack, 2004; Guerkaynak et al., 2005; Brand et al., 2010; Krishnamurthy and Vissing-Jorgensen, 2011; Hanson and Stein, 2014; Chodorow-Reich, 2014). In these papers, monetary policy shocks are measured as the price change of financial variables (e.g., bond yields) in a short window around a monetary policy announcement. Our results show that tone changes affect both the sign and size of monetary policy shocks measured in this way and are thus informative about the source of monetary policy shocks. Our paper also relates to studies that explore equity returns around policy meetings and over cycles between policy meetings (e.g. Lucca and Moench, 2015; Cieslak et al., 2014).

Our contribution is to highlight that the *tone* with which a central bank chooses to communicate its monetary policy affects asset prices. To this end, our empirical results support the idea that the ECB can, at least to a certain extent, manage market expectations and risk appetite through central bank communication (e.g., Woodford, 2005; Blinder et al.,

2008) by signaling more optimism or pessimism (e.g., Born et al., 2013).

The rest of the paper unfolds as follows. Section 2 describes the setup of our empirical analysis and Section 3 details the data and presents descriptive statistics. Sections 4 and 5 contain the main empirical results on the relation between CB tone, equity returns and bond yields, respectively. Section 6 presents results on potential drivers of tone and Section 7 presents results for the U.S. Section 8 provides additional results and robustness checks. Section 9 concludes.

2. Empirical Setup

This section describes our empirical approach to measuring the effect of central bank tone on asset prices. We first discuss potential data sources for measuring CB tone. Next, we specify our approach to constructing a measure of CB tone based on press conference statements. Third, we describe the timing of returns and price changes to gauge the direct effect of CB tone on asset prices and the link between tone and future prices. Finally, we sketch the econometric setup for our analysis.

2.1. Discussion of potential data sources for measuring central bank tone

Our goal is to measure the impact of CB tone on asset prices. This requires the use of CB statements with a precise timing, i.e. it needs to be clear when these statements become publicly available to market participants. In this respect, press conferences by the European Central Bank (ECB) provide an ideal setup. Following the meetings of the Governing Council (which are scheduled well in advance), the ECB holds press conferences that begin with a statement by the president. This statement is drafted in advance and serves to inform the general public about the council's decisions, why these decisions have been made, how they have been reached, and a general outlook. With the press conferences taking place on Thursdays in the early afternoon at 2:30pm CET, any new information revealed during the press conference can affect financial market prices on the same day. ECB press conferences are broadcasted live, are thus available in real time to all market participants, and the ECB makes transcripts publicly available on its website.

Moreover, we focus on ECB press conferences because the ECB provides the longest time series of press conferences that have been available to market participants in real time (since the introduction of the Euro in 1999). By contrast, other central banks have only started to introduce similar live press conferences in recent years and a reliable empirical study is not feasible due to the low number of observations. For instance, the U.S. Fed held its first comparable press conference on April 27, 2011 and at the time of writing this paper only 14 press conferences have been held. Likewise, other central banks have introduced press conferences only recently and at lower frequency; for example, the Swiss National Bank has adopted a news conference setting in 2011 that takes place in July and December only.

Alternative sources of communication could be the minutes of CB meetings such as FOMC meetings or the Minutes of the Bank of England's Monetary Policy committee. However, these minutes are only available with a time lag and are edited transcripts of actual discussions at these meetings and therefore, by their nature, not designed as a device to directly communicate with market participants.[5] Moreover, several CBs issue statements about decisions (e.g. Fed statements released after FOMC meetings). Compared to the president's statement at ECB press conferences, these are typically much shorter. As an example, the average number of words in FOMC statements since the 1990s is lower than that of the shortest ECB statement in our whole sample. For the U.S., a further source of information could be Testimonies to the U.S. Congress given by the Fed Chair. Transcripts for these testimonies are available from July 1996 and, given that the Fed Chair typically testifies to Congress twice a year, this provides a series of 37 transcripts up to fall 2014 (the end of our sample period). The low frequency suggests that the immediacy and news component embedded in Fed Testimonies is relatively small.

Given these considerations, it seems fair to conclude that statements released at ECB press conferences provide the most suitable laboratory to study the impact of CB tone on asset prices: These statements present real-time news about monetary policy decisions, contain fresh information about ECB views, and are made available to all market partici-

[5]Besides, a substantial portion of the content refers to administrative aspects such as listing the names of participants in particular decisions which is not very informative.

pants at the same time. In Section 7, we provide evidence on relation between U.S. asset prices and Fed tone measured from Congressional testimonies.

2.2. Measuring the tone of central bank statements

To quantitatively measure CB tone, we prepare the transcripts of ECB press conferences for further textual analysis as follows: we (i) convert all words to lower case, (ii) remove numbers, (iii) remove punctuation, (iv) remove English stop words (e.g., for, very, and, of, are, etc.), and (v) strip whitespace as is common in the textual analysis literature. After preparing the text files, we construct a proxy for CB tone using the financial dictionary developed by Loughran and McDonald (2011). More specifically, we use this dictionary to identify words that can be classified as *negative* in financial contexts.[6] We then count the number of negative words in each (cleaned) transcript and compute the ratio of the number of negative words (N) to the total number of words (T), N/T. We define CB tone (τ) as

$$\tau = 1 - N/T \tag{1}$$

such that lower values reflect more negative CB tone and higher values imply a more positive (or less negative) tone. In our empirical analysis, we focus on *changes in tone*, $\Delta\tau$, measured as the first difference in τ between two subsequent press conference. Accordingly, we interpret increases in τ as tone becoming more positive and decreases in τ as tone becoming more negative.[7]

A few words on this procedure are in order. Our choice of scoring the tone of CB statements based on the Loughran and McDonald (2011, LM) dictionary is driven mainly by two considerations. First, we want to rely on a dictionary to classify words as being negative that is based on prior work and not subject to our own choice of what is negative or not. The alternative would be to build our own dictionary of CB language, either based on just selecting words as being negative based on common sense or based on some

[6] We only use negative words because the usefulness of positive words for measuring tone is very limited, as discussed by Loughran and McDonald (2011) and also noted by others before. The main reason is that positive words are frequently negated. By contrast, negation of negative words is far less common.

[7] Similarly, we may use expressions like "improving tone" or "ameliorating tone" to refer to $\Delta\tau > 0$ and "worsening tone", "deteriorating tone", etc. when $\Delta\tau < 0$.

statistical procedure where certain words are classified as being negative based on the market's reaction to the occurrence of these words. However, defining negative words ourselves would mean that we essentially determine the outcome of our empirical analysis later in the paper. Using a statistical procedure would require using the same data to build the dictionary that we then use in our tests for the effect of tone on asset prices which leads to a hindsight bias. Employing the LM-dictionary alleviates the need of data double-usage by using an exogenous word list. Second, the LM dictionary is explicitly designed to be informative for financial documents, in contrast to, e.g., the widely used Harvard Dictionary. The LM dictionary was originally designed for 10-K filings but has proven useful in other financial contexts as well (see, e.g., Gurun and Butler, 2012; Hillert et al., 2014, for recent papers) and the survey of Loughran and McDonald (2014) more generally. However, it seems likely that central bank language differs from the typical language used in 10-K filings to a certain extent. Such misclassification will work against us in our empirical analyses, though, and will only raise the hurdle to find a link between tone and asset prices. Similarly, we choose to measure tone by means of simple words counts rather than more elaborate approaches such as term weighting, because more elaborate approaches would require to look ahead through all documents before starting the actual empirical analysis; this would provide us with many more degrees of freedom to find significant effects of tone on asset prices in our empirical work. Hence, to avoid all these potential biases, we choose simplicity and transparency over more elaborate alternatives.

2.3. Identification and timing of returns

In our empirical analysis, we explore how changes in CB tone affect market prices of financial assets. We now discuss how previous research on monetary policy shocks guides our identification strategy to gauge the immediacy and persistence of CB tone-related effects on asset prices.

A standard approach to measuring monetary policy shocks is to compute asset price changes around monetary policy meetings (see, e.g., Guerkaynak et al., 2005; Hanson and Stein, 2014, among others). The key idea is that any price reaction in a short time window is likely to be caused by information about (unexpected) changes in monetary policy and

that this information swamps other information about returns. We rely on this idea when we compute *PC-day price changes* to measure the immediate effect of CB tone on asset prices. Furthermore, we compute changes in asset prices beyond the PC date to assess whether CB tone has a persistent effect on asset prices. In other words, we analyse whether information conveyed through CB tone is absorbed by asset prices immediately or whether information diffuses gradually. Longer-term price changes exclusive of PC-day effects will be informative in this respect and also alleviate potential concerns about reverse causality. Below, we define how we measure price changes, specifically their time dimension, to gauge the immediacy and durability of tone-related effects on asset prices. Figure 1 illustrates the timing convention for *PC-day returns* and *PC-cycle returns*.

PC-day returns. To explore the contemporaneous effect of CB tone on stock and bond markets on a particular PC day t, we compute the one-day equity returns and yield changes using the closing prices of the day preceding PC_t and the day on which PC_t takes place. We denote these *PC-day returns* by r_t.

Returns beyond PC days. To gauge the tone-asset price relation beyond the PC day, we also compute cumulative returns over k days (starting with the PC day) and denote them by $r_{t,k}$. For $k = 0$, $r_{t,0}$ just corresponds to the PC-day return r_t and for $k = 10$, for instance, $r_{t,10}$ specifies cumulative equity returns and yield changes from the day preceding PC_t up to ten trading days after PC_t (i.e. a total of 11 trading days).

PC-cycle returns. When we are interested in returns over the full PC cycle, i.e. returns from PC_t to PC_{t+1}, we use the closing prices of the day preceding PC_t to the day preceding PC_{t+1} (see the illustration of "PC cycle" in Figure 1). We thereby capture the whole period from one PC up to the next PC but exclude information only revealed at the day of the next PC. We denote these *PC-cycle returns* by $r_{t,t+1}$. Additionally, we compute returns over PC cycles excluding the PC-day itself, as illustrated by "PC cycle (ex PC day)" in Figure 1. We measure returns from the closing prices of the day on which PC_t takes place to the day preceding PC_{t+1} and denote these returns by $r_{t,t+1}^{exPC_t}$. Given that $r_{t,t+1}^{exPC_t}$ only reflects the information content of CB-tone for non-PC days, this measure is more akin to

an out-of-sample perspective and alleviates potential concerns about reverse causality.

2.4. Econometric setup

Before exploring the asset price effect of CB tone, we check more generally whether changes in asset prices are systematically different on days when press conferences take place relative to other days in our sample. We use the following dummy regression setup for daily price changes r_s,

$$r_s = b^{noPC} \times D_s^{noPC} + b^{PC} \times D_s^{PC} + u_s, \tag{2}$$

where $D_s^{PC} = 1$ ($D_s^{noPC} = 0$) on days when a press conference takes place and $D_s^{PC} = 0$ ($D_s^{noPC} = 1$) otherwise. The coefficient-estimates for b^{noPC} and b^{PC} correspond to the mean price changes on non-PC and PC days, respectively. This setup allows to use standard t- and F-tests to assess whether coefficients are significantly different from zero and significantly different from each other, i.e. to check for a *PC-day effect*.[8]

To evaluate the effect of CB tone on asset prices, we run regressions of r_i on measures of tone changes, where r_i represents either an equity return or yield (factor) change with i specifying the timing convention discussed above, $r_i \in \{r_t, r_{t,k}, r_{t,t+1}, r_{t,t+1}^{exPC_t}\}$. To compare mean returns on PC days when CB tone becomes more positive (indicated by $\Delta\tau > 0$) to returns when tone becomes more negative ($\Delta\tau < 0$), we run the dummy regression

$$r_i = b^{\Delta\tau>0} \times D_t^{\Delta\tau>0} + b^{\Delta\tau<0} \times D_t^{\Delta\tau<0} + u_i \tag{3}$$

and test for the significance of differences in asset price changes conditional on improving or deteriorating CB tone. As a related exercise, we regress r_i on the *sign of tone changes*,

$$r_i = a + b \times \text{sign}\left[\Delta\tau_{t-1,t}\right] + u_t. \tag{4}$$

to test for a general effect of more positive or negative tone on asset prices. Finally, to assess whether the magnitude of the tone change matters for asset prices beyond its sign,

[8] A recent literature shows that FOMC meetings in the U.S. have a strong effect on U.S. stock returns at the day of the meeting (Lucca and Moench, 2015) and even weeks after a meeting (Cieslak et al., 2014).

we regress returns on tone changes,

$$r_i = a + b \times \Delta\tau_{t-1,t} + u_t. \tag{5}$$

Following this setup, we present empirical results for the relation of changes in CB tone to returns in equity markets and changes in government yield curves using the data described in the next section.

3. Data and Descriptive Statistics

In this section, we describe the data that we use in our empirical analysis to gauge the relation between central bank tone and asset prices. We first present descriptive statistics for CB tone and then move on to describe the asset price data used in our empirical analysis.

3.1. ECB press conferences: Descriptive statistics

The ECB makes transcripts of its press conferences publicly available on its website.[9] We obtain these transcripts, starting with the introduction of the Euro, for a total of 185 press conferences between January 7, 1999 and October 2, 2014. From these transcripts, we extract the opening statement of the ECB president and process the text as described in Section 2.2.

Table I presents some descriptives statistics, first showing that ECB press conferences take place regularly but not at equidistant intervals. The average PC cycle is around 22 trading days, with the range spanning 10 to 50 days for the shortest and longest intervals, respectively. The second column summarizes statistics for the ratio of the number of negative words to the number of total words (N/T), which we use to compute tone measure defined in Equation (1). On average, the ratio of negative to total words is around 2.7% but it is associated with substantial variability within the range of 0.4% and 5.7%. The third column presents the properties of tone changes, $\Delta\tau$, measured as difference in tone

[9]See, for instance, the following link for transcripts of all ECB press conferences held in 2014: ECB Press Conferences in 2014.

between two subsequent PCs in percentage points. Tone changes are close to zero on average and at the median but show substantial variation in the range from -2.4% to +2% points and exhibit significant first-order autocorrelation over our sample period. Of the 184 ECB tone changes in our sample, we find that tone increases at 100 press conferences and deteriorates in 84 cases.

Figure 2 plots the time series of ECB tone, τ, and changes in ECB tone, $\Delta\tau$. The grey vertical lines mark the dates of the ECB press conferences. Panel (a) shows that ECB tone reaches its minimum at the end of 2008/beginning of 2009 during the financial crisis and Panel (b) illustrates the volatility of tone changes over time.

An interesting exercise is to take a closer look at the words that drive our measure of tone and Table II provides some insights in this respect. First, we present a list of the 20 negative words (as classified by Loughran and McDonald, 2011) with the highest number of occurrences across all ECB press conference statements and find that the most frequently used negative word-stems are "weak", "decline", and "imbalances".[10] To see whether certain negative words are recurrently used in specific contexts, we also present frequency counts for bigrams and trigrams (i.e. sequences of two and three adjacent words). While, for instance, the general notion of "global imbalances" seems to be a recurring theme, the much lower frequency counts for bi- and trigrams suggest that our measure of ECB tone captures how the ECB interprets and judges developments rather than hard facts associated with specific monetary policy, financial market, or macroeconomic topics. We provide more evidence in this respect in Section 6 where we show that our measure of CB tone is not related to macroeconomic fundamentals.

3.2. Asset price data

This section summarizes the data on equity prices and government bonds that we use in our core empirical analysis. Other financial market variables and macroeconomic data used for supplementary analyses are introduced in the corresponding Sections along with the results. Appendix A details sources and corresponding identifiers for all data.

[10]These counts are based on aggregating words by their word-stem; for example, the 361 occurrences we summarize for "weak" are the sum of occurrences for "weak" (166), "weaken" (6), "weakened" (18), "weakening" (47), "weaker" (78), "weakness" (44), and "weaknesses" (2).

Equities. We obtain daily data on equity indexes for the sample period covered by ECB press conferences, that is from January 1999 to October 2014. To explore the overall effect on EMU equity markets, we use the EuroStoxx 50 index (denoted "ESX50") which contains the 50 largest firms from the Eurozone.[11] We also use data on the MSCI EMU index (denoted "MSCI") that includes all countries that have adopted the Euro, accounting for the evolving membership of countries. The MSCI index has a broader coverage than the ESX50 and also includes smaller firms. Additionally, we use the MSCI sub-indices that specifically cover value- and growth stocks in the Eurozone, MSCI EMU Value (denoted "Value") and MSCI EMU Growth (denoted "Growth"). For our analysis on the individual country level, we include all EMU-members that have been covered by MSCI country indexes throughout our sample period: with the exception of Luxembourg, this includes the other ten of the eleven original member states: Austria, Belgium, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, and Spain. In our benchmark empirical analyses, we will look at simple stock returns (based on total return indices) and not excess returns since we do not want to confound the effect of tone on returns and yields. We provide robustness on this in Section 8 where we also report results for excess returns and find that our results are robust.

Term structure of government bond yields. To explore the effect of ECB tone on government bond markets we use the term structure of German yields (available from the Bundesbank) which is available over our full sample period. European yield data are available from the ECB but cover a substantially shorter sample from 2004 to 2014. However, the German yield curve is highly correlated with the ECB AAA yield curve over the period September 2004 to October 2014 where both data sets are available, providing virtually identically results in our empirical analysis for the period of joint coverage. The high correlation reflections the fact that the Germany is the largest EMU member state, subject to comparably very low sovereign risk, and is typically perceived as the engine of the EMU economy. As a consequence, German yields are viewed as a benchmark against

[11] Furthermore, there is a liquid market for options on the ESX50 and the VSTOXX, a volatility index constructed from ESX50 options, has become a benchmark measure for Eurozone equity market volatility that we use in some of our supplementary analysis.

which other EMU government yield curves are referenced. This line of reasoning follows that of earlier research that attributes a lead role to Germany, some already even prior to the introduction of the Euro during the existence of the European Monetary System (EMS) and the Exchange Rate Mechanism (ERM); see e.g. di Giovanni et al. (2009) and the references therein. We therefore use daily data of German government bond yields with maturities ranging from one to 20 years provided by Deutsche Bundesbank from January 1999 to October 2014.

4. ECB Tone and Equity Returns

In this section, we document a strong link between Eurozone stock prices and the *tone* of ECB press conference statements. A more positive (negative) tone compared to the previous press conference is associated with positive (negative) equity returns on the day of the press conference. These effects persist and strengthen over the cycle to the next conference and also hold for individual Euro-country equity markets.

4.1. Do ECB press conferences move equity markets?

As discussed above, ECB press conferences take place on Thursdays in the early afternoon (14:30 CET) so that any new information revealed during the press conference can affect equity prices on the same day. To assess whether ECB tone does affect stock prices, we first look at PC-day equity returns, i.e. the return from the trading close of the preceding day to the trading close of the press conference day. Figure 3 previews our main findings. Panel (a) shows that stock returns are close to zero across all PC days, i.e. there is no general PC-day effect akin to the FOMC effect documented by Lucca and Moench (2015).[12] At the same time, we find that returns on all four indices are negative on PC days when ECB tone becomes more negative compared to the previous PC (Panel b) and positive on PC days when tone becomes more positive (Panel c). The differential in average returns on PC days with positive and negative tone changes suggests that ECB tone affects stock

[12]More generally, Savor and Wilson (2013, 2014) show that asset prices (stocks, bonds, currencies) behave very differently on days with scheduled U.S. macro news announcements and that risky assets earn higher returns on announcement days.

markets and that this effect is very similar for large stocks (ESX50), all stocks (MSCI), as well as value and growth stocks.

Table III presents detailed regression results on the relation between tone changes and stock returns. We start by comparing equity market returns on PC days versus non-PC days, and Panel A shows that average ESX50 returns on non-PC and PC days are 1 bp (basis point) and −3 bp, respectively. Neither of these returns is statistically different from zero, and standard tests show that equity returns on PC compared to non-PC days are also not significantly different from each other. The same finding obtains for the MSCI index and value and growth stocks. Hence, stock returns are not unusually high or low on PC days (unlike the results for the U.S., see e.g. Lucca and Moench, 2015).

Instead, the return plots presented above suggest that stock returns on PC days are very different depending on whether the tone of the ECB becomes more positive or negative. Panel B of Table III shows that these large return differentials are significantly different from zero based on a standard F-test. On PC days with more positive tone, equity returns range from +19 bp (value stocks) to 26 bp (ESX50 and growth stocks) whereas a more negative tone is associated with equity returns of −38 bp (ESX50) to −35 bp (growth). These differences of around 60 bp are statistically significant and sizeable from an economic point of view: In a year with twelve press conferences, an average PC-day difference of 60 bp annualizes to about 7% p.a. which is of the order of the equity premium.

To evaluate the impact of positive versus negative tone changes on equity returns in more depth, we run sign regressions as specified in Equation (4), and present the results in Panel C. The estimates of the intercept a are not different from zero, confirming that there is no pure PC day-effect. The estimates of b are significantly positive and suggest that stock returns are about 30 bp higher or lower depending on whether tone becomes more positive or more negative, respectively. The R^2s are in the range of 3% to 4% and suggest sizeable explanatory power of ECB tone changes for the daily equity returns around press conferences. To take the magnitude of tone changes into account, we regress equity returns on tone changes, see the specification in Equation (5), and report very similar results in Panel D. To give an economic interpretation to the estimated b-coefficients, recall that the standard deviation of tone changes is around 0.80 (see Table I). Hence, a one-sigma

increase in tone translates into an ESX50 return of around 30 bp.

Given these results, it seems safe to conclude that changes in tone move equity markets. A natural next step is to investigate whether this effect is confined to PC days or whether it persists beyond to see how quickly tone changes are incorporated into prices.

4.2. Equity returns over ECB press conference cycles

As a first step in our analysis of tone changes and equity returns beyond PC days, we plot average cumulative k-day returns (defined as $r_{t,k}$ in Section 2.3) conditional on the last tone change being positive or negative in Figure 4. Panel (a) shows that the initial tone-related return differential (corresponding to k=0) persists beyond the PC day and widens over the next 15 trading days. Panel (b) of Figure 4 underpins the statistical significance of the relation between ECB tone changes and subsequent equity returns by presenting slope coefficients from regressions of cumulative k-day returns on preceding tone changes, along with 90% confidence bands. These plots confirm that the ECB tone-stock return link persists and strengthens over time. A one-sigma change in tone is associated with a stock return of more than 1% within the next three trading weeks, thereby suggesting that ECB tone conveys information to markets that is relevant beyond the PC day itself. This finding also makes it unlikely that the results for PC days documented above are due to simple short-term (liquidity) effects which would be associated with a reversion in equity prices and not a drift in the same direction.

To assess the link between tone changes and subsequent equity returns over full PC cycles, we regress the PC-to-PC equity returns (denoted by $r_{t,t+1}$ in Section 2.3 and "PC cycle" in Figure 1) on tone changes. More precisely, for press conferences taking place at times t and $t+1$, we compute the return from the closing price on the day before PC_t to the closing price on the day before PC_{t+1}. These returns capture the market impact of PC_t but exclude the impact of PC_{t+1}. The regression results in Panel A of Table IV show that slope coefficients for tone changes are all significantly positive and that R^2s are around 3%–3.5%. The estimated bs imply that a one-sigma tone change translates into an average PC-cycle return of about $\pm$ 100 basis points.

We repeat this PC-cycle exercise but now exclude the PC_t day return itself, i.e. we

compute the return from the close on the day at which PC_t takes place to the close price on the day prior to PC_{t+1}, denoted by $r_{t,t+1}^{exPC}$ in Section 2.3 and "PC cycle (ex PC Day)" in Figure 1. By excluding the direct impact of the PC-day, we can test whether returns are significantly related to tone changes after the PC day as well. This seems relevant as it tells us whether tone changes also forecast returns significantly when the contemporaneous correlation between tone changes and returns on PC days is removed from the regression. Results in Panel B on Table IV suggest that the estimates of b remain significant albeit at a lower level, and this similarly applies to the regression R^2s. Overall, these results corroborate that tone changes have a lasting effect on equity prices and have predictive ability for stock returns throughout PC cycles, even when excluding the PC day effect itself. In other words, CB tone conveys information that is gradually incorporated into prices over the cycle to the next press conference.

Dissecting stock returns. To better understand the economic significance of our results, we dissect cumulative equity returns based on regimes with positive and negative tone changes. The first row in Panel C of Table IV presents cumulative returns over all 4,076 trading days in our sample as the arithmetic sum of daily returns ("simple") as well as cumulative geometric returns to account for compounding effects ("comp."). For the four equity indices used in our analysis, cumulative simple and compound returns in EMU equity markets are in the range of 28.37% to 52.99% and −10.94% to 10.44%, respectively. Next, we dissect the sample into the 2,264 days that are associated with the latest ECB tone change having been positive and the 1,812 days associated with negative tone changes. The results show that the simple (compound) stock returns accumulate to 55.70% to 89.72% (43.00% to 92.41%) in more positive tone regimes whereas stock prices fall during more negative tone regimes with a total of −36.73% to −27.33% (−42.71% to −35.42%). These results demonstrate that EMU equity markets earn all of their cumulative returns during times associated with more optimistic ECB tone and that stock prices fall during periods following ECB press conferences with deteriorating tone.

Panel D reports the results of repeating this exercise in a generic out-of-sample setup by excluding returns on PC days. These results confirm the strikingly distinct performance

of EMU equity markets conditional on preceding ECB tone changes.

On the whole, our results suggest that changes in CB tone have a strong effect on equity returns over PC cycles, beyond returns generated on PC days. More generally, throughout our sample the equity premium in EMU markets accumulates following positive ECB tone changes whereas it diminishes after ECB press conferences that reveal more negative tone.

4.3. Individual country equity returns

We now turn to individual EMU member country stock markets and examine all countries for which MSCI provides coverage of comparable country indexes for the full sample period. Our sample of MSCI country indices contains 10 of the 11 original EMU member countries (all except Luxembourg) and we find that results are very similar across all countries. Figure 5 shows that average PC day returns are relatively small (i.e., there is no PC-day effect) but that PC-day returns are significantly different on days with more positive compared to more negative ECB tone. Panels A and B of Table V show that the these findings are statistically significant, except for Austria where the PC day differential of about 35 bp is associated with a p-value of 0.12. Panel C reports results for regressions of stock returns on tone changes on PC days and we find that the estimated slope coefficients are all positive and range from 0.24 (Ireland) to 0.70 (Finland). R^2s range from 1.08% (Ireland) to 4.19% (Finland). Overall, the estimated slope coefficients and R^2s are close to the values we found for the aggregate European stock market indexes above. Finally, Panel D reports results for regressions of returns on tone changes over the full PC cycle and shows that the link between tone changes and stock returns is not limited to the PC day itself but extends to the days after a press conference.

Overall, our results show that ECB tone conveys information for stock returns in the EMU as a whole but also for individual EMU-member stock markets. This also suggests that tone might be a driver of EMU stock market co-movement.

5. Tone and the term structure of government bond yields

Our results above suggest that there is a significant link between tone changes and stock returns. In this section, we investigate the link between tone changes and the term structure of yields to better understand (i) how tone affects asset prices in general and (ii) whether the effect of tone on equity prices operates via an opposing effect on yields (i.e. tone drives down yields and drives up equity prices).

One channel through which tone changes could affect equity markets is that CBs use communication to actively manage the market's expectation about future interest rates and that equity markets react to changing (expectations about) interest rates. Hence, we now extend our analysis to Eurozone government bond markets, using the term structure of German yields for maturities of one to 20 years provided by Deutsche Bundesbank as proxy for the EMU term structure of yields. We find that tone matters for the shape of the yield curve on PC days and over PC cycles, generally leading to an increase (decrease) in yield levels and curvature if tone becomes more positive (more negative). These findings are in line with the notion that CB communication aims for managing interest rate expectations and also suggest that the link between tone and equity markets uncovered above might at least partly be due to the effect of tone on yields.

5.1. Yield curve changes on press conference days

We present results for each of the twenty individual yields as well as for a parsimonious three factor characterization of the yield curve by its level, slope, and curvature that we estimate by a principal components analysis (see Litterman and Scheinkman, 1991). The level factor captures the average level of yields, slope captures the difference between long and short maturity yields, and curvature captures the difference between long and short maturities relative to medium-term maturities (i.e., the curvature factor is low when the yield curve is hump-shaped).

We start by comparing PC days to non-PC days. In contrast to equity markets, we find that there is a pronounced PC day-effect for bond yields (see Panel A in Figure 6): Unconditional yield changes on non-PC days are negative, small in magnitude, and very

similar across maturities, which just reflects generally decreasing interest rates over our sample period. By contrast, on PC days, all yields increase and more so for longer as compared to shorter maturities. One interpretation of this slope effect with the full yield curve shifting upwards may be that markets generally expect more easing before the PC compared to the actual outcome at the Governor Council's meeting such that yields tended to increase after the PC statement. Panel A of Table VI confirms the significant increase in the level and in the slope of the yield curve compared on PC compared to non-PC days.

When we separate PC days with positive and negative tone changes, we see a similar slope effect for both, but the level of yield changes is significantly different across all maturities (Panel (b) in Figure 6): when ECB tone becomes more positive, all yields increase and more so for longer maturities. When ECB tone becomes more negative, yields of shorter maturities decrease whereas yields of longer maturities increase on average. Panel B of Table VI shows that, as a consequence, the level of yields significantly increases on PC days with positive tone changes but is not affected when tone becomes more negative, which results in a significant difference. The slope effect is also only significant for positive tone changes but the difference compared to negative tone changes is not significant.

Regressing yield (factor) changes on the signs of tone changes (Panel (c) in Figure 6 and Panel C in Table VI), shows that the sign of tone changes affects yield across all maturities. In regressions using the yield factors, the slope coefficient is significant for yield level (with an R^2 of 4.59%) but not for slope and curvature. Moreover, the PC day-effects (independent of the signs of tone changes) manifest themselves through significant estimates of the intercepts a for the yield curve's level and slope. When taking the magnitude of tone changes into account by regressing yield (factor) changes on tone changes, ECB tone does not appear to matter much beyond PC-day effects captured by the intercepts a (Panel D in Table VI). Taking a look at Panel (d) in Figure 6, however, reveals that changes in yields with maturities of up to three years are significantly related to changes in ECB tone, which is consistent with the view that central banks control the short end of the yield curve (Blinder et al., 2008).

5.2. Yield curves over press conference cycles

Moving from PC-days to PC-cycles, we find an even stronger relation between bond yields and ECB tone changes. However, the nature of this relationship is quite different from the one discussed above for PC days itself. So far, we have documented that tone changes on the PC day almost exclusively matter for the level of the yield curve. Over the full PC cycle, however, we find that tone changes are related to both the level and curvature. Panel (a) in Figure 7 shows that PCs with a more negative tone are followed by a drop in the yield level and a pronounced inverted hump around shorter to medium-term maturities. The opposite pattern obtains for positive tone changes. Panel A in Table VII shows that these tone-related differences in curvature are highly significant.

When we run regressions of yield (factor) changes on changes in ECB tone, we find that the relation becomes stronger over PC cycles as compared to PC days. Panel (b) in Figure 7 shows that term structure of b-estimates exhibits a hump-shape as well and that coefficients are significantly different from zero for yield maturities up to seven years. The corresponding results in Panel B of Table VII show that the effect of tone on level and curvature is highly significant with R^2s of 2.17% and 6.04%, respectively. Thus, more positive CB tone is associated with a higher level and a more pronounced hump (i.e.more negative curvature) of the yield curve over the PC cycle.

Overall, our results indicate that CB tone changes matter for the level of yields on PC days and for the level and curvature of the yield curve over PC cycles. These results are largely consistent with our results for equities above. A more positive tone drives up both yields and equity prices and can thus be viewed as signalling "better times" for the economy. Moreover our findings appear consistent with the notion that changes in curvature reflect expected changes in risk premia (e.g., Cochrane and Piazzesi, 2008). We provide more evidence for such a risk-based channel below.

6. Why does central bank tone matter for asset prices?

The results reported above show that our measure of central bank tone τ contains information for stock prices and government bond yield curves. While we have already provided

some evidence that τ does not seem to be driven by specific contextual statements, we now provide further evidence indicating that τ contains generic information for asset prices that is not subsumed by macroeconomic or financial market variables. These results suggest that τ does not simply reflect an aggregation of macro fundamentals and that the extent to which tone changes may be driven by the ECB reacting to market conditions is limited. Instead, we provide evidence that the effect of tone changes on asset prices is consistent with a risk-based channel of monetary policy.

6.1. Real-time macro activity

We first explore, whether the relation between ECB tone and asset prices is driven by fundamental information about the economy. One potential channel is that the central bank acts as an aggregator of news about macro activity and that our tone measure is driven by the central bank's view of the current state of the business cycle. Such a channel would be consistent with our finding that more positive tone is associated with increases in equity prices and in yields.

Beber et al. (2015) construct real-time measures of economic activity ("Econ"), economic growth ("Growth"), and economic sentiment ("Sent") using a principal components analysis of macro news surprises. These indices represent the current state of the economy along different dimensions in real time (economic activity, growth, and sentiment, where the latter is based on survey expectation).[13] We regress changes in the real-time economic indices for the Eurozone on contemporaneous and lagged changes in ECB tone over the PC cycle (excluding the PC day itself) and Table VIII, Panel A, shows that all slope coefficients are insignificant and R^2s are very close to zero. Moreover, we further run predictive regressions of changes in these real-time macro indices on lagged tone changes for shorter and longer forecast horizons of $5, 10, ..., 250$ days and, judging from significant levels and predictive R^2s, again find that tone changes do not seem to forecast future macroeconomic conditions. Thus, it seems unlikely that tone changes predict equity returns and yields because of tone changes being highly correlated with current real-time economic devel-

[13] See Beber et al. (2015) for details on the construction of these indices. The authors also show that these indices forecast equity returns in several countries and can thus be viewed as containing relevant information for equity markets.

opments or because tone changes forecast changes in economic activity. These findings support our interpretation of Table II (see Section 3.1) that tone changes are not driven by "hard information".

6.2. Tone "reaction functions"?

In the spirit of the central bank literature on policy rules and reaction functions, we now study whether ECB tone changes simply reflect recent market conditions and whether the ECB can be viewed as following a reaction function to adjust its tone in response to such developments.[14]

Table IX reports results for regressions of tone changes on potential drivers of such a reaction function. As candidate variables, we consider lagged changes in the level, slope, and curvature of the yield curve, lagged stock returns (ESX50), lagged changes in (market expectations of) equity volatility (VSTOXX), and lagged changes in the real-time indices of Beber et al. (2015).[15] To avoid look-ahead biases, we set the timing such that we regress tone changes from one PC to the next on changes in the independent variables measured from the day after the previous PC to the day before the current PC.

Surprisingly, we find that the lagged change in curvature is the only significant driver of tone changes, whereas all other variables appear unrelated to future tone changes. Curvature has a significantly positive sign and generates an R^2 of about 7%. Since a low value of the curvature factor implies a more pronounced hump-shape of the yield curve, the positive coefficient implies that a growing hump forecasts ECB tone to become more negative the next press conference. As discussed above, this finding points towards a link between risk premia and tone changes. However, given that curvature changes only explain a small portion of the time-series variation in tone changes, and other variables do not seem to have any predictive ability at all, our results suggest that ECB tone mainly conveys information beyond recent market developments.

[14] There is a large literature that investigates whether central banks that follow some form of policy rule, like inflation targeting, *should* respond to asset price changes or asset price volatility at all and, if so, how (see, e.g., Bernanke and Gertler, 1999, 2001; Gilchrist and Leahy, 2002).

[15] The VSTOXX is a common measure of Eurozone option-implied stock volatility (see, e.g., Miranda-Agrippino and Rey, 2014). For the data of Beber et al. (2015), we only include the real-time economic activity and sentiment index as the growth index is highly correlated with the economic activity index and including them jointly leads to multicollinearity problems.

6.3. A risk-based channel?

Our empirical results so far show that tone changes are largely unrelated to economic fundamentals and that positive tone changes are associated with increases in stock prices and bond yields. These findings rule out a channel where stock prices increase because a more positive tone is associated with lower interest rates or higher growth expectations. Below, we provide evidence that our findings are in line with a channel where tone affects risk premia embedded in market prices (see, e.g., Shiller et al., 1983; Hanson and Stein, 2014; Morris and Shin, 2014; Gertler and Karadi, 2015; Hattori et al., 2015).

If central bank tone affects asset prices through a risk-based channel, in the sense that more positive tone induces more risk appetite by market participants, we should find that tone changes specifically matter for assets that are very sensitive to changes in risk premia. To measure market-implied risk aversion, we follow Bekaert et al. (2013) and decompose the VSTOXX into proxies for uncertainty and risk aversion. We estimate uncertainty as the expected stock market variance from regressing realized variance on the lagged squared VSTOXX and lagged realized variance. The variance risk premium, estimated as the difference between the squared VSTOXX and expected variance, serves as the proxy for risk aversion. Table X presents results for regressions of changes in uncertainty and risk aversion over PC cycles on changes in ECB tone. Both uncertainty and risk aversion are negatively related to tone changes, implying that a more positive tone is associated with lower expected stock market variance and lower risk aversion. While the slope coefficient is not significant for uncertainty, we find that risk aversion is significantly related to tone changes over PC cycles (also when excluding PC days) with R^2s of more than 5%.

Additionally, we investigate the link between tone changes and changes in corporate credit spreads, measured as the yield differential of BBB- and AAA-rated bonds, because these spreads are fairly sensitive to changes in the risk appetite of market participants. Figure 8 shows results for regressions of (cumulative) changes in credit spreads on dummies for positive and negative tone changes on the left and for regressions of credit spread changes on lagged tone changes on the right. As can be seen, a more positive (negative) tone is associated with a significant reduction (increase) in credit spreads, which lends

further credibility to the conjecture that central bank tone affects asset prices through a risk-based channel.

7. Fed Tone and U.S. Markets

Using a setup that is very different compared to the ECB press conferences explored above, we now provide evidence that central bank tone also matters for asset prices in U.S. markets. Specifically, we use data on the Fed Chair's Testimonies to the U.S. Congress, typically taking place twice a year with the Chair testifying to the U.S. House of Representatives and to the U.S. Senate on two subsequent days, in both cases delivering identical remarks. Given that the frequency of these testimonies is low and that the testimony dates do not concur with policy meetings of the Fed, the contextual news component embedded in the Chair's should be comparably small.[16]

Transcripts for these testimonies are available from July 1996, providing us with a series of 37 transcripts up to fall 2014 (the end of our sample period). Over this period, the average time interval between two testimonies is 130 days and the shortest interval is 52 days. Measuring the Fed tone of these testimonies, we find tone to become more positive (negative) compared to the previous testimony in 20 (16) cases and that tone matters for U.S. equity and government bond markets.

Figure 9 shows distinct patterns for equity returns and yield changes depending on whether Fed tone becomes more positive or negative. Over the two months following the testimony (corresponding to the shortest 52-day interval between any two consecutive testimonies), cumulative equity returns are around 3% when tone has become more positive compared to -1% when tone has become more negative. The slope coefficient from regressing cumulative stock returns on tone changes is positive and becomes increasingly significant with time passed since the last testimony. We also find that tone matters for changes in the U.S. government bond yield curve, both, around the days of testimonies to

[16] As detailed in Section 2.1, higher frequency data that allows to measure Fed tone in a way comparable to our analysis of the ECB has become available only very recently and the number of observations is very small. The Fed has introduced press conferences comparable to those of the ECB only recently (in April 2011). The statements released after FOMC meetings are generally very short and do not allow for a comprehensive textual analysis.

Congress and beyond. A more negative Fed tone is associated with a decrease in yields (across maturities up to 20 years) up to the day after the testimony to the U.S. Senate as well as over the next two months. By contrast, a more positive Fed tone is associate with an immediate increase in yields and a much smaller decrease in yields over the two-months following the testimonies. The difference in yield changes conditional on Fed tone becoming more positive or negative is largest for short-term yields, which appears consistent with the view that central banks control the short end of the yield curve.

One caveat is that we only have 36 observations available in this exercise. However, our findings on how U.S. equity and government bond markets relate to changes in Fed tone appear significant from an economic perspective. Qualitatively, the results are identical to those for ECB press conferences: a more positive central bank tone is associated with higher equity returns and higher bond yields compared to changes in asset prices when central bank tone becomes more negative.

8. Additional results and robustness checks

8.1. Controlling for actual policy changes

Our results suggest that they do not, in the sense that controlling for policy actions taken by the ECB does not render the role of tone insignificant. More specifically, we repeat the empirical analysis when excluding ECB press conferences at which actual interest rate changes and/or unconventional monetary policy actions (e.g. the covered bond purchase program) have been announced. Excluding either typ of action has some effect on the quantitative results but does not change the overall picture. The Internet Appendix contains results that corroborate our conclusions on the PC-day and PC-cycle relations between tone changes and equity returns (see Figure IA.1) and yield changes (see Figure IA.2).

8.2. Unexpected changes in ECB tone

Given that our measure of tone changes exhibits significant autocorrelation (see Table I in 3.1), one could argue that tone changes can be expected to some extent. To generate a series of serially uncorrelated 'tone shocks', we estimate an AR(1) process for ECB tone

changes and repeat our empirical analysis on the link to asset prices using the residuals of the AR(1) process. Using these AR(1) residuals rather than the tone changes themselves does not change our conclusions, as we show in more detail in the Internet Appendix for equity returns (see Figure IA.3) and yield changes (see Figure IA.4).

8.3. Option-implied equity volatility

In Section 6.3 we provide evidence for a strong link between changes in ECB tone and changes in market-implied risk aversion, measured from a decomposition of the VSTOXX into uncertainty and risk aversion. To complement these results, we now take a closer look at the term structure of market-implied volatility using the VSTOXX sub-indices for eight maturities ranging from one month to two years. Consistent with the notion that more positive ECB tone reduces uncertainty and risk aversion in equity markets, we find that all slope coefficients of regressing VSTOXX on tone changes are negative (see Figure IA.5). From a statistical perspective, the results are most pronounced for tone shocks on PC days. The PC-cycle results exhibit marginal statistical significance only for longer-term volatility but foster the economic intuition that more positive (negative) tone is associated with a decline (increase) in implied volatility. These results further support that central bank tone moves asset prices through a risk-based channel.

8.4. Equity excess returns

We also repeat the empirical analysis of how ECB tone affects stock prices using equity excess returns instead of raw returns. As a proxy for the risk-free rate, we use the 3-month interbank rate for the Eurozone (Datastream Mnemonic BBEUR3M). Using equity excess returns, our conclusions remain unchanged. In the Internet Appendix, Figure IA.6 reveals patterns that are very similar to those displayed in 4 above. On PC-days, there is an excess return differential depending on whether the ECB tone change is positive or negative. This differential wides on the days after the PC and regressing equity excess returns on tone changes yields significantly positive slope estimates.

9. Conclusion

We use a systematic and objective approach to measure the *tone* of central bank statements and evaluate its impact on asset prices. To quantify tone, we apply standard techniques of textual analysis from the recent finance literature. Our empirical analysis focuses on the European Central Bank (ECB), which has been the first major central bank to establish live press conferences as a communication channel after meetings of its General Council. These press conferences begin with a statement by the ECB president that presents real-time news about monetary policy decisions, contains fresh information about ECB views, and is made available to all market participants at the same time. Our sample covers a total of 185 press conferences between January 1999 and October 2014.

Our results document a strong link between ECB tone and equity returns. On the day of the press conference, a more positive (negative) tone, compared to the previous press conference, is associated with increasing (decreasing) stock prices. This effect is statistically significant, economically large, and persists over the cycle to the next press conference. Throughout our sample, the equity premium in European markets accumulates subsequent to positive tone changes whereas it diminishes when ECB tone becomes more negative. The same patterns prevail in the stock markets of individual Eurozone countries.

Changes in ECB tone also affect government bond prices, with more positive tone being related to a higher level and a more pronounced hump of the yield curve. Finding that ECB tone matters for yields is consistent with the notion that central banks use communication as a device to manage market expectations. However, since equity prices also increase when tone becomes more positive, our results suggest that tone affects asset prices through their risk premium component. More positive ECB tone appears to increase equity prices and bond yields because it lowers the risk-aversion and alters the risk-taking behaviour of market participants. In line with this conjecture, we find that tone changes are significantly related to asset prices that are very sensitive to changes in risk aversion such as variance risk premia and corporate credit spreads.

Our conclusions on how central bank tone matters for asset prices also apply to U.S. markets. Measuring the tone of the Fed chair's semiannual Congressional Testimonies, we

find that a positive change in Fed testimony tone is associated with increases in equity prices and increases in Treasury bond yields.

Our work is related and contributes to various strands of the literature by showing that *central bank tone* is a key communication feature that affects asset prices. Changes in central bank tone appear to matter for the risk-taking of market participants and for (the interpretation of) monetary policy shocks, which are typically measured by changes in market prices around policy meetings and announcements.

Appendix

A. Data sources and tickers

This Appendix details the sources of data used in the empirical analysis.

Equity data. We use data on stock returns for the EuroStoxx 50, the MSCI EMU All cap index, as well as the MSCI Value EMU and MSCI Growth EMU index. MSCI data for all three indices are obtained from Datastream and the mnemonics are MS1EMUL (MSCI All cap EMU), MSVEMUL (MSCI Value EMU), and MSGEMUL (MSCI Growth EMU). Historical data for the EuroStoxx 50 and corresponding implied volatilities (VSTOXX) at different maturities can be downloaded from here (EuroStoxx50 data) and here (VSTOXX implied volatilities), respectively.

Term structure of yields. We employ yield curve data for the term structure of German government bonds from 1 to 20 years provided by Deutsche Bundesbank. These series can be downloaded from here. The tickers of the series we use are: BBK01.WT3211, BBK01.WT3213, BBK01.WT3215, BBK01.WT3217, BBK01.WT3219, BBK01.WT3221, BBK01.WT3223, BBK01.WT3225, BBK01.WT3227, BBK01.WT3229, BBK01.WT3431, BBK01.WT3433, BBK01.WT3435, BBK01.WT3437, BBK01.WT3439, BBK01.WT3441, BBK01.WT3443, BBK01.WT3445, BBK01.WT3447, BBK01.WT3449.

Real-time macro indices. We employ real-time measures of economic activity ("Econ"), growth ("Growth"), as well as a real-time measure of economic sentiment ("Sent") for the Eurozone . These real-time measures are based on Beber et al. (2015) and we thank the authors for sharing these indices with us.

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Table I: The Tone of ECB Press Conference Statements

This table reports descriptive statistics for the 185 ECB press conferences between January 7, 1999 and October 2, 2014. The column 'Cycle' presents statistics on the length of the press conference (PC) cycle, i.e. the number of business days between PCs. N/T reports the ratio of the number of negative words divided by the total number of words in the president's opening statement at the PC (in percentage points). $\Delta\tau$ measures the change in tone τ compared to the tone at the previous PC, where $\tau = 1 - N/T$ as defined in Equation (1); reported numbers are the changes in percentage points. For the 184 realizations of $\Delta\tau$, we also report the coefficient of an AR(1) regression and the associated t-statistic. 'Obs $\Delta\tau > 0$' denotes the number of tone changes when tone becomes more positive and 'Obs $\Delta\tau < 0$' counts the observations when tone becomes more negative.

	Cycle [in days]	N/T [in %]	$\Delta\tau$
Mean	22.255	2.703	-0.002
Std dev	5.700	0.988	0.795
Min	10.000	0.361	-2.409
Q5	15.000	1.323	-1.419
Q25	20.000	1.990	-0.435
Median	20.000	2.616	0.047
Q75	25.000	3.230	0.445
Q95	30.000	4.799	1.271
Max	50.000	5.651	2.015
AR(1)			-0.424
t-statistic			[-6.36]
Obs $\Delta\tau > 0$			100.000
Obs $\Delta\tau < 0$			84.000

Table II: Which words drive tone?

This table presents descriptives statistics for the "negative" words (as classified by the dictionary of Loughran and McDonald, 2011) that are most prevalent in ECB press conference statements. The left panel, reports the 20 most frequently used negative words, ordered by the number of their occurrence across all ECB press conferences statements. The center and right panels show the context in which negative words are most frequently used by the ECB by presenting counts for bigrams and trigrams (i.e. sequences of two and three adjacent words), respectively. The analysis is based on 185 ECB press conference statements between January 7, 1999 and October 2, 2014.

Words	#	Bigrams	#	Trigrams	#
weak	361	global imbalances	86	correction global imbalances	38
decline	321	weaker expected	46	disorderly correction global	36
imbalances	216	correction global	38	global imbalances regard	36
concerns	205	fiscal imbalances	38	imbalances regard price	36
volatility	168	imbalances regard	37	possibility disorderly correction	26
negative	163	disorderly correction	36	pressures possibility disorderly	25
deficit	148	possibility disorderly	35	financial market volatility	23
unemployment	132	excessive deficit	30	high level unemployment	22
crucial	125	level unemployment	28	prolonged period low	22
dampened	112	prolonged period	26	financial market turmoil	21
challenges	107	disorderly developments	25	disorderly developments owing	20
downward	105	remain weak	25	owing global imbalances	20
slow	88	excessive deficits	24	balance sheet restructuring	18
adverse	81	market volatility	24	concerns remain relating	18
correction	80	financial turmoil	22	crucial social partners	18
disorderly	67	high unemployment	21	weaker expected domestic	17
restructuring	67	market turmoil	21	insufficient implementation structural	16
excessive	61	revised downwards	21	unemployment euro area	16
turmoil	61	short-term volatility	21	excessive deficit procedure	15
protracted	45	address challenge	20	negative feedback loop	15

Table III: Equity Returns on ECB Press Conference Days

This table reports results for the returns of Eurozone equity indexes on days on which the ECB holds a press conference (PC). We use data for the EuroStoxx 50 (ESX50), the MSCI EMU (MSCI), the MSCI Value EMU (Value), and the MSCI Growth EMU (Growth). We compute returns from the closing prices on the day preceding the PC and the day on which the PC is held. For each index, our sample includes a total of 184 returns between the 185 ECB press conferences from January 7, 1999 to October 2, 2014. *Panel A* reports average returns across PC days and non-PC days, respectively. Values in brackets are t-statistics and p[F] reports the p-value of an F-test for equal means. *Panel B* reports average returns separately for the 100 (84) observations at which the tone of the ECB becomes more positive (negative) compared to the previous PC, along with t-statistics and p-values of F-tests for equal means. *Panels C and D* present results of regressing PC-day equity returns on the signs of ECB tone changes and on ECB tone changes, respectively. Values reported for a and b represent estimates of the intercept and slope coefficients. All t-statistics are based on Newey and West (1987) standard errors.

Panel A. PC versus Non-PC Days

	No PC	PC	p[F]
ESX50	1.03	-3.26	0.70
	[0.50]	[-0.27]	
MSCI	1.16	-4.02	0.62
	[0.59]	[-0.36]	
Value	1.66	-6.24	0.47
	[0.78]	[-0.54]	
Growth	0.81	-1.63	0.81
	[0.42]	[-0.14]	

Panel B. Positive versus Negative Tone Changes

	$\Delta\tau > 0$	$\Delta\tau < 0$	p[F]
ESX50	26.43	-38.59	0.01
	[1.57]	[-2.56]	
MSCI	23.00	-36.18	0.01
	[1.47]	[-2.60]	
Value	19.23	-36.57	0.02
	[1.17]	[-2.77]	
Growth	26.52	-35.13	0.01
	[1.75]	[-2.23]	

Panel C. Regressions on Signs of Tone Changes

	a	b	R^2
ESX50	-0.61	32.51	3.79
	[-0.56]	[2.76]	
MSCI	-0.66	29.59	3.72
	[-0.66]	[2.71]	
Value	-0.87	27.90	3.09
	[-0.84]	[2.57]	
Growth	-0.43	30.82	3.97
	[-0.42]	[2.65]	

Panel D. Regressions on Tone Changes

	a	b	R^2
ESX50	-0.00	0.38	3.26
	[-0.29]	[2.19]	
MSCI	-0.00	0.35	3.30
	[-0.39]	[2.21]	
Value	-0.00	0.30	2.22
	[-0.59]	[1.81]	
Growth	-0.00	0.40	4.21
	[-0.15]	[2.49]	

Table IV: Equity Returns over Press Conference Cycles

This table present results on how changes in ECB tone revealed at the most recent ECB press conference (PC_t) affect equity returns. Using data for the EuroStoxx 50 (ESX50), the MSCI EMU (MSCI), the MSCI Value EMU (Value), and the MSCI Growth EMU (Growth), we compute returns from the closing prices on the day preceding PC_t and the day preceding PC_{t+1}. Results excluding PC-day return effects are based on returns computed from the closing prices of the day of PC_t to the day preceding PC_{t+1}. For each index, our sample covers a total of 184 PC-cycle returns (including or excluding PC-days) between the 185 ECB press conferences held from January 7, 1999 to October 2, 2014. *Panels A and B* present results of regressing PC-cycle equity returns on ECB tone changes including the PC-day return and excluding the PC-day return, respectively. Values reported for a and b represent estimates of the intercept and slope coefficients with associated t-statistics i n brackets. All t-statistics are based on Newey and West (1987) standard errors. In *Panels C and D*, we present results for decomposing the full sample period ('all'), at a daily frequency, into periods where the latest PC revealed an improvement or a deterioration in ECB tone as indicated by '$\Delta\tau > 0$' and '$\Delta\tau < 0$', respectively. For each equity index, we compute cumulative returns as the arithmetic sum of daily returns ("simple") as well as cumulative geometric returns to account for compounding effects ("comp."). Results in Panel C (D) include (exclude) PC-day returns.

Panel A. PC Cycle Regressions

	a	b	R^2
ESX50	0.00	1.26	3.06
	[0.28]	[2.77]	
MSCI	0.00	1.32	3.52
	[0.40]	[2.95]	
Value	0.00	1.40	3.26
	[0.56]	[2.73]	
Growth	0.00	1.25	3.45
	[0.27]	[3.09]	

Panel B. Regressions excluding PC days

	a	b	R^2
ESX50	0.00	0.89	1.78
	[0.31]	[2.03]	
MSCI	0.00	0.97	2.25
	[0.46]	[2.28]	
Value	0.00	1.10	2.34
	[0.68]	[2.24]	
Growth	0.00	0.85	1.90
	[0.26]	[2.21]	

Panel C. Dissecting Aggregate Equity Returns

		ESX50		MSCI		Value		Growth	
	obs	simple	comp.	simple	comp.	simple	comp.	simple	comp.
all	4076.00	33.98	-10.94	37.81	-0.22	52.99	10.44	28.37	-7.66
$\Delta\tau > 0$	2264.00	69.96	55.44	71.15	64.46	89.72	92.41	55.70	43.00
$\Delta\tau < 0$	1812.00	-35.98	-42.71	-33.34	-39.33	-36.73	-42.60	-27.33	-35.42

Panel D. Dissecting Aggregate Equity Returns over Non-PC Days

		ESX50		MSCI		Value		Growth	
	obs	simple	comp.	simple	comp.	simple	comp.	simple	comp.
all	3892.00	39.97	-2.99	45.20	9.79	64.48	26.78	31.36	-2.74
$\Delta\tau > 0$	2164.00	43.53	21.32	48.15	32.51	70.49	61.33	29.18	11.08
$\Delta\tau < 0$	1728.00	-3.56	-20.04	-2.95	-17.14	-6.01	-21.41	2.18	-12.44

Table V: Individual Country Equity Returns

This table reports results for PC-day and PC-cycle returns of individual Euro-member country equity indexes. The PC-day results in *Panels A, B, and C* are presented in the same way as the Eurozone results in Table III (Panels A, B, and D), the PC-cycle results in *Panels D* are presented as described in Table IV for Panel A.

Panel A. PC versus Non-PC Days

	No PC	PC	p[F]
Austria	1.00	3.53	0.83
	[0.42]	[0.31]	
Belgium	0.12	5.28	0.62
	[0.06]	[0.51]	
Finland	1.40	20.77	0.24
	[0.43]	[1.04]	
France	1.68	-5.95	0.48
	[0.85]	[-0.50]	
Germany	2.02	-8.11	0.37
	[0.91]	[-0.66]	
Ireland	-1.56	4.74	0.62
	[-0.62]	[0.35]	
Italy	0.29	-10.88	0.31
	[0.14]	[-0.88]	
Netherlands	1.26	-1.82	0.77
	[0.62]	[-0.18]	
Portugal	-1.44	-4.90	0.70
	[-0.74]	[-0.53]	
Spain	1.59	-0.16	0.88
	[0.72]	[-0.01]	

Panel B. Positive versus Negative Tone Changes

	$\Delta\tau > 0$	$\Delta\tau < 0$	p[F]
Austria	19.78	-15.83	0.12
	[1.36]	[-0.97]	
Belgium	33.77	-28.63	0.00
	[2.27]	[-2.13]	
Finland	58.47	-24.12	0.04
	[2.77]	[-0.74]	
France	24.73	-42.47	0.00
	[1.50]	[-2.94]	
Germany	17.37	-38.45	0.02
	[0.97]	[-2.81]	
Ireland	35.49	-31.88	0.01
	[1.56]	[-2.23]	
Italy	15.37	-42.13	0.02
	[0.92]	[-2.69]	
Netherlands	20.96	-28.93	0.02
	[1.49]	[-2.31]	
Portugal	10.01	-22.65	0.08
	[0.79]	[-1.78]	
Spain	25.32	-30.48	0.03
	[1.43]	[-1.70]	

Panel C. PC Day Regressions

	a	b	R^2
Austria	0.00	0.26	1.79
	[0.36]	[1.89]	
Belgium	0.00	0.28	2.49
	[0.59]	[1.67]	
Finland	0.00	0.70	4.19
	[1.12]	[2.64]	
France	-0.00	0.36	3.26
	[-0.57]	[2.14]	
Germany	-0.00	0.32	2.39
	[-0.69]	[1.97]	
Ireland	0.00	0.24	1.08
	[0.41]	[0.96]	
Italy	-0.00	0.35	2.71
	[-0.98]	[2.14]	
Netherlands	-0.00	0.28	2.48
	[-0.19]	[1.93]	
Portugal	-0.00	0.26	2.74
	[-0.57]	[2.31]	
Spain	-0.00	0.34	2.50
	[-0.01]	[1.77]	

Panel D. PC Cycle Regressions

	a	b	R^2
Austria	0.00	0.92	1.11
	[0.40]	[1.73]	
Belgium	0.00	1.21	2.43
	[0.17]	[2.22]	
Finland	0.00	1.81	2.04
	[0.67]	[2.69]	
France	0.00	1.29	3.56
	[0.55]	[2.88]	
Germany	0.00	1.53	3.47
	[0.66]	[2.81]	
Ireland	-0.00	1.02	1.48
	[-0.61]	[1.83]	
Italy	-0.00	0.93	1.51
	[-0.16]	[1.93]	
Netherlands	0.00	1.40	4.06
	[0.48]	[2.92]	
Portugal	-0.00	0.80	1.17
	[-0.67]	[1.69]	
Spain	0.00	1.11	2.02
	[0.64]	[2.26]	

Table VI: Yield Changes on ECB Press Conference Days

This table reports results for changes in yield curve factors on days that the ECB holds a press conference. We measure level, slope, and curvature as the first three principal components of the yield curve. Then, we compute changes in level, slope, and curvature from the closing prices on the day preceding the PC and the PC day. In total, we have 184 changes for each factor between the 185 ECB press conferences held from January 7, 1999 and October 2, 2014. *Panel A* presents average changes on PC days and non-PC days. Values in brackets are t-statistics and p[F] reports the p-value of an F-test for equal means. *Panel B* reports average changes separately for the 100 (84) observations at which the tone of the ECB becomes more positive (negative) compared to the previous press conference, along with t-statistics and p-values of F-tests for equal means. *Panels C and D* present results of regressing PC-day yield factor changes on the signs of ECB tone changes and on ECB tone changes, respectively. Values reported for a and b represent estimates of the intercept and slope coefficients. All t-statistics are based on Newey and West (1987) standard errors.

Panel A. PC versus Non-PC Days

	No PC	PC	p[F]
Level	-0.11	0.66	0.02
	[-1.61]	[2.37]	
Slope	-0.00	0.02	0.01
	[-0.90]	[2.63]	
Curvature	-0.00	-0.00	0.99
	[-0.17]	[-0.05]	

Panel B. Positive versus Negative Tone

	$\Delta\tau > 0$	$\Delta\tau < 0$	p[F]
Level	1.40	-0.22	0.00
	[3.30]	[-0.61]	
Slope	0.04	0.01	0.15
	[2.49]	[0.84]	
Curvature	-0.00	0.00	0.73
	[-0.31]	[0.23]	

Panel C. Regressions on Signs of Tone Changes

	a	b	R^2
Level	0.06	0.81	4.59
	[2.25]	[2.72]	
Slope	0.00	0.01	1.12
	[2.59]	[1.36]	
Curvature	-0.00	-0.00	0.06
	[-0.02]	[-0.36]	

Panel D. Regressions on Tone Changes

	a	b	R^2
Level	0.00	0.00	1.03
	[2.39]	[1.25]	
Slope	0.00	-0.00	0.94
	[2.65]	[-1.23]	
Curvature	-0.00	-0.00	0.31
	[-0.06]	[-0.64]	

Table VII: Yield Changes over ECB Press Conference Cycles

This table reports results for yield factor changes over the cycle of ECB press conferences (PCs), with level, slope, and curvature estimated as the first three principal components of the yield curve. We compute changes in level, slope, and curvature from the closing prices on the day before a PC takes place to the day preceding the next PC. In total, we have 184 PC-cycle changes for each factor between the 185 ECB press conferences between January 7, 1999 and October 2, 2014. *Panel A* reports average changes separately for the 100 (84) PCs at which the tone of the ECB becomes more positive (negative) compared to the previous PC along with t-statistics and p-values of F-tests for equal means. *Panel B* present results of regressing PC-cycle yield factor changes on ECB tone changes. Values reported for a and b represent estimates of the intercept and slope coefficients. All t-statistics are based on Newey and West (1987) standard errors.

Panel A. Positive versus Negative Tone

	$\Delta\tau > 0$	$\Delta\tau < 0$	p[F]
Level	0.41	-4.15	0.15
	[0.16]	[-2.01]	
Slope	0.00	-0.03	0.68
	[0.09]	[-0.42]	
Curvature	-0.02	0.02	0.01
	[-1.96]	[1.79]	

Panel B. Regressions on Tone Changes

	a	b	R^2
Level	-0.00	0.04	2.17
	[-0.90]	[2.12]	
Slope	-0.00	-0.00	0.39
	[-0.25]	[-0.69]	
Curvature	-0.00	-0.00	6.04
	[-0.26]	[-2.49]	

Table VIII: Regressions of real-time macro growth on tone changes

This table reports results for regressions of changes in real-time macro indices on changes in tone ($\Delta\tau$) over PC cycles (Panel A) and for predictive regressions of changes in real-time macro indices on tone changes for fixed forecast horizons ranging from 5, 10, ..., 250 trading days. The left part of Panel A reports results for contemporaneous regressions (changes from one press conference to the next) and the right part presents results for regressions of changes in real-time macro indices on lagged changes in tone (i.e. tone changes from the previous press conference cycle). We only report slope coefficients and R^2s in both panels. The real-time macro indices employed in these regressions correspond to "economic activity" (Econ), "sentiment" (Sent), and "growth" and are taken from Beber et al. (2015). We report t-statistics based on standard errors following Newey and West (1987) in brackets. We standardize the independent variable (tone changes) in all regressions for ease of interpretability. R^2s are reported in parentheses. The sample covers 184 tone changes between the 185 ECB press conferences held from January 7, 1999 and October 2, 2014.

Panel A. Tone changes and real-time macro over PC cycles							
	Contemporaneous				Predictive		
	Econ	Sent	Growth		Econ	Sent	Growth
$\Delta\tau$	0.04	0.08	0.04	$\Delta\tau$	0.00	0.01	0.03
	[0.43]	[1.05]	[0.47]		[0.07]	[0.13]	[0.11]
R^2(%)	(0.20)	(0.72)	(0.20)	R^2(%)	(0.00)	(0.01)	(0.00)
Panel B. Tone changes and real-time macro for fixed forecast horizons							
horizon	Econ	Sent	Growth	*horizon*	Econ	Sent	Growth
5 days	-0.04	-0.03	-0.03	60 days	0.03	0.00	0.04
	[-0.49]	[-1.70]	[-0.41]		[0.58]	[-0.01]	[0.69]
	(0.10)	(1.41)	(0.07)		(0.09)	(0.00)	(0.13)
10 days	-0.05	0.04	-0.04	120 days	0.10	-0.04	0.10
	[-0.84]	[0.92]	[-0.74]		[1.72]	[-0.77]	[1.83]
	(0.21)	(0.27)	(0.17)		(0.96)	(0.16)	(1.01)
30 days	0.02	0.02	0.02	250 days	0.07	-0.06	0.07
	[0.43]	[0.40]	[0.47]		[1.59]	[-1.02]	[1.49]
	(0.04)	(0.02)	(0.05)		(0.49)	(0.40)	(0.49)

Table IX: What drives tones changes?

This table reports results for regressions of tone changes on potential drivers, such as changes in the level, slope, and curvature of the yield curve, VSTOXX changes, lagged stock returns (EuroStoxx 50), and changes in real-time macro indices ("economic activity" " and sentiment", denoted RT Econ and RT Sent, respectively). The latter are based on Beber et al. (2015)). The timing in this regression is such that we regress changes in tone ($\Delta\tau$) from the previous to the current press conference on changes in the independent variables from the previous press conference until the day before the current press conference. We report t-statistics based on standard errors following Newey and West (1987) in brackets. The sample covers 184 tone changes between the 185 ECB press conferences held from January 7, 1999 and October 2, 2014.

	(i)	(ii)	(iii)	(iv)
ΔLevel	0.48			0.21
	[1.53]			[0.51]
ΔSlope	-18.77			-11.42
	[-1.74]			[-1.01]
ΔCurvature	252.96			271.95
	[3.59]			[3.68]
ΔVSTOXX		-2.06		-1.63
		[-0.99]		[-0.80]
Lagged returns		-1.14		-0.40
		[-0.70]		[-0.22]
RT Econ			0.12	0.17
			[0.46]	[0.61]
RT Sent			0.09	0.13
			[1.14]	[1.64]
R^2(%)	7.33	-0.33	-0.44	8.32

Table X: Uncertainty and Risk Aversion

This table shows results for regressions of *changes* in uncertainty and risk aversion on lagged tone changes over PC cycles. We follow Bekaert et al. (2013) and compute uncertainty as the expected stock return variance (under the physical measure) and risk aversion as the difference between the risk-neutral and physical expectation of future stock variance). To estimate the expected stock return variance (following Bekaert et al. (2013)), based on daily data from January 1999 to June 2015, we run a regression of squared daily stock returns (RVAR) on the (22 business days) lagged squared VSTOXX and (22 business days) lagged squared stock returns, which yields

$$RVAR_t = 0.0003 + 0.6289 \cdot VSTOXX^2_{t-22d} + 0.1643 \cdot RVAR_{t-22d} + e_t,$$

with an R^2 of 49.52%. The fitted value from this regression is our measure of uncertainty. Risk aversion is then given by the difference between the squared VSTOXX and uncertainty. The sample covers 184 tone changes between the 185 ECB press conferences held from January 7, 1999 and October 2, 2014.

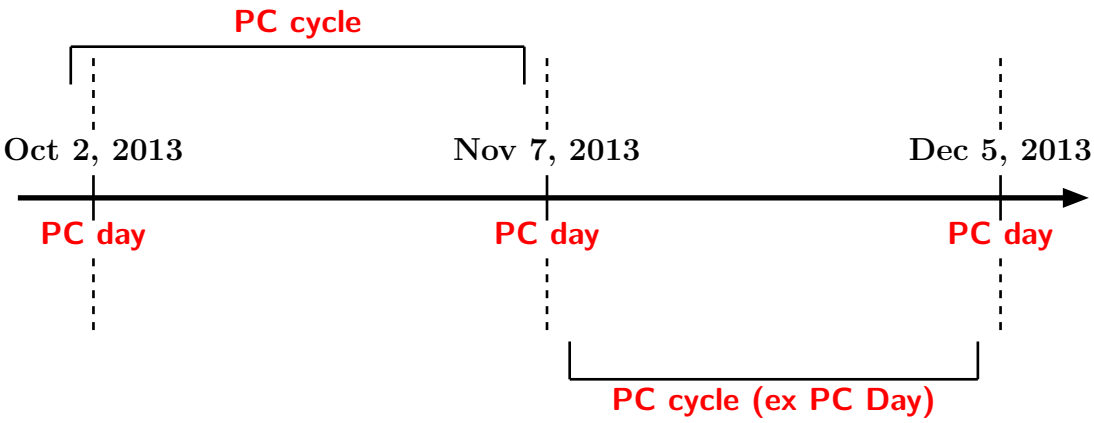
PC Cycles

	a	b	R^2
Uncertainty	-0.00	-2.34	0.45
	[-0.01]	[-0.80]	
Risk aversion	0.00	**-2.94**	5.39
	[0.10]	**[-2.35]**	

PC Cycles (ex PC days)

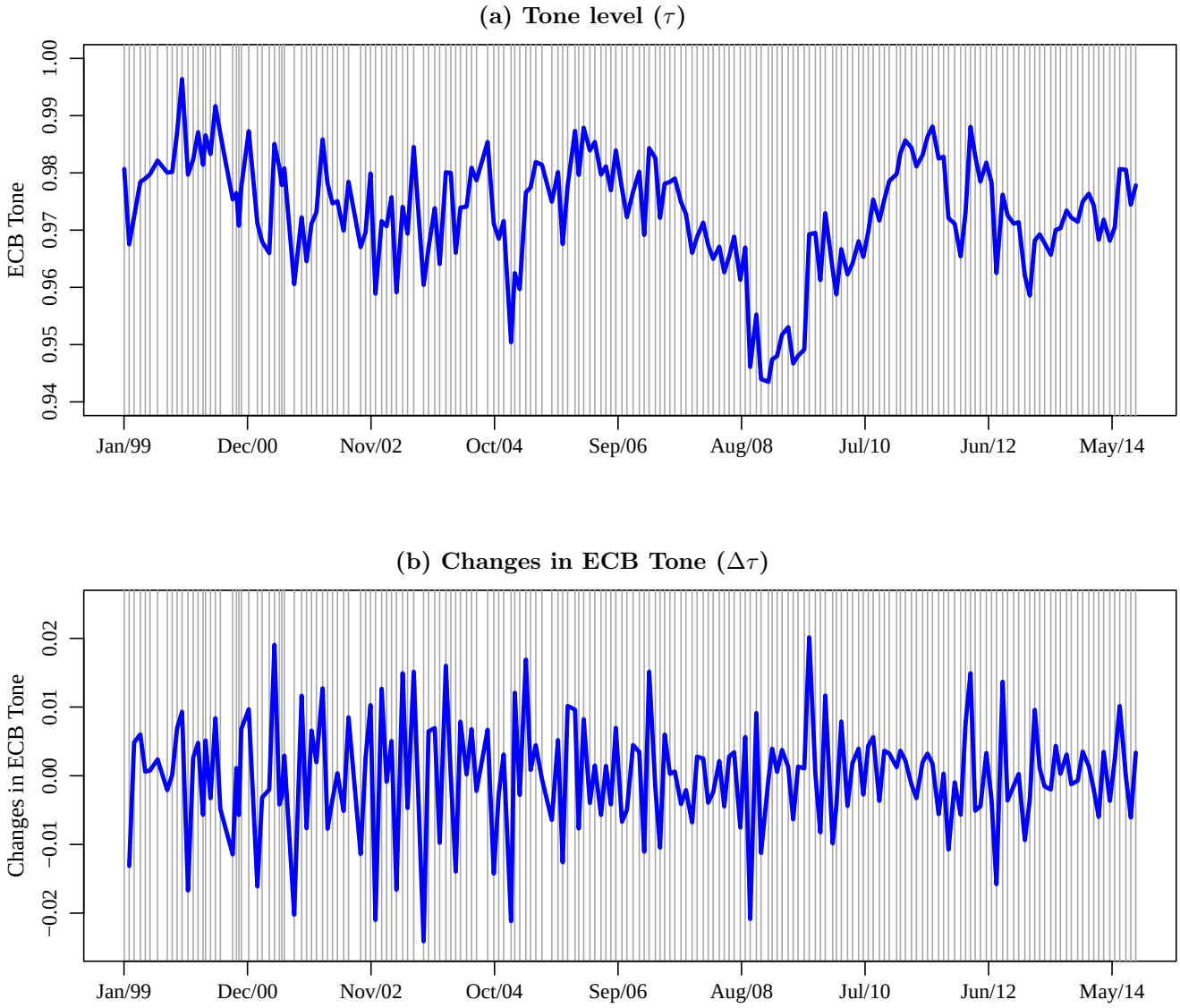
	a	b	R^2
Uncertainty	-0.00	-3.21	0.93
	[-0.01]	[-1.10]	
Risk aversion	-0.00	**-3.20**	5.18
	[-0.13]	**[-2.02]**	

Figure 1: Press conference days and timing of returns



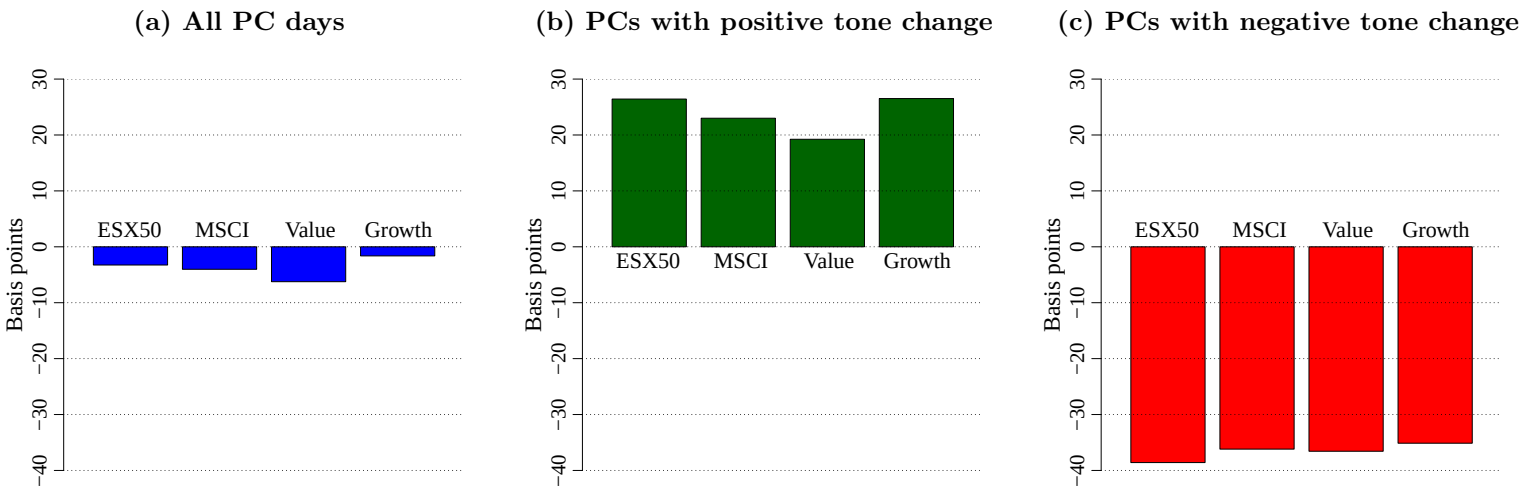
This figure illustrates the timing of our different return measures using three subsequent ECB press conferences. Returns on press conference (PC) days are measured as the return from the close of the day preceding the PC to the close of the day on which the PC takes place. Returns over the "PC cycle" are measured as the return from the close of the day preceding a PC to the close of the day preceding the next PC. Returns over PC cycles that exclude the PC day itself ("PC cycle (ex PC)") are computed from the close of the day on which a PC takes place to the close of the trading day preceding the next PC. Since ECB press conferences are held on Thursday afternoon before European equity market close, the "PC cycle (ex PC day)" window does not contain any PC event.

Figure 2: The Tone of ECB Press Conference Statements



This figure plots the time-series of ECB tone, τ, and changes in ECB tone, $\Delta\tau$, in Panels (a) and (b), respectively. Tone is defined as $\tau = 1 - N/T$, see Equation (1), where N and T denote the number of negative words and the total number of words in a press conference statement. $\Delta\tau$ is measured as the difference in τ of two subsequently held press conferences. Tone is measured form the ECB president's opening statements at the 185 ECB press conferences between January 7, 1999 and October 2, 2014. The solid vertical lines mark these 185 press conferences.

Figure 3: Equity Returns on Press Conference Days



This figure plots the returns of Eurozone equity indexes on days on which the ECB holds a press conference (PC). We use data for the EuroStoxx 50 (ESX50), the MSCI EMU (MSCI), the MSCI Value EMU (Value), and the MSCI Growth EMU (Growth). We compute returns from the closing prices on the day preceding the PC and the day on which the PC is held. For each index, we have a total of 184 returns between the 185 ECB press conferences held from January 7, 1999 to October 2, 2014. Panel (a) refers to average PC-day returns across all PCs. Panels (b) and (c) plot average returns separately for the 100 (84) observations at which the tone of the ECB becomes more positive (negative) compared to the previous PC.

Figure 4: Equity Returns following ECB Press Conferences

(a) Equity returns following press conferences

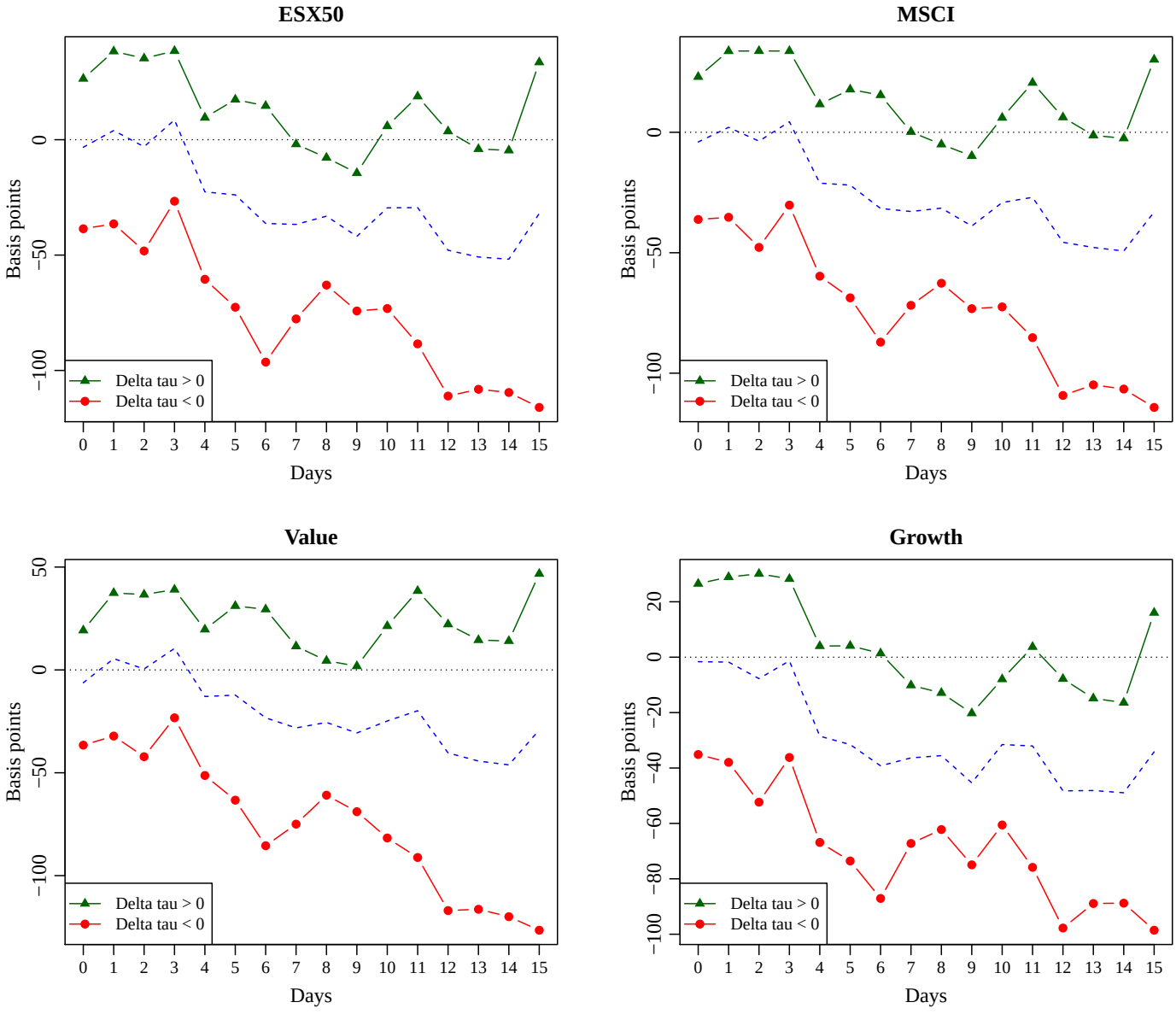


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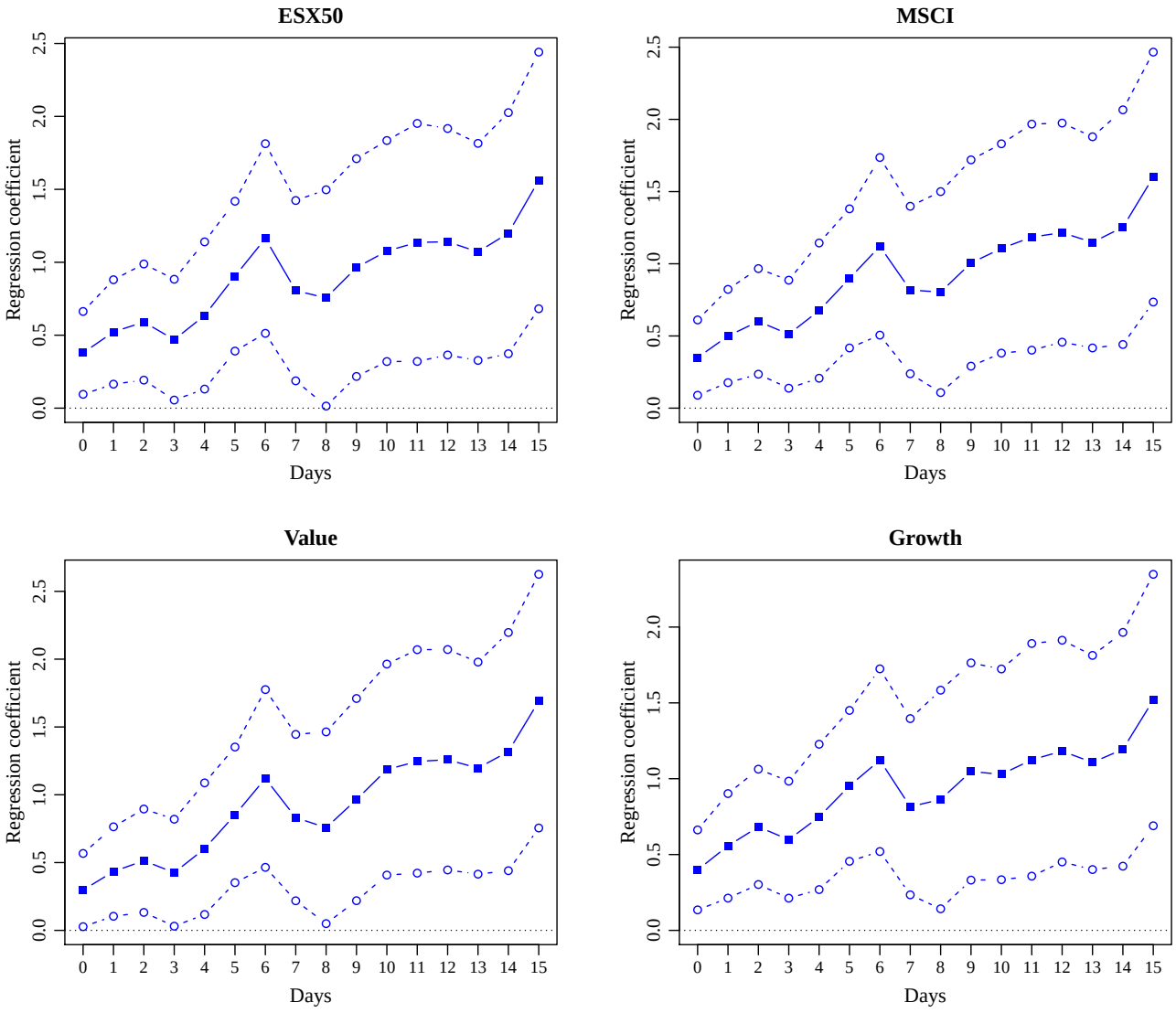
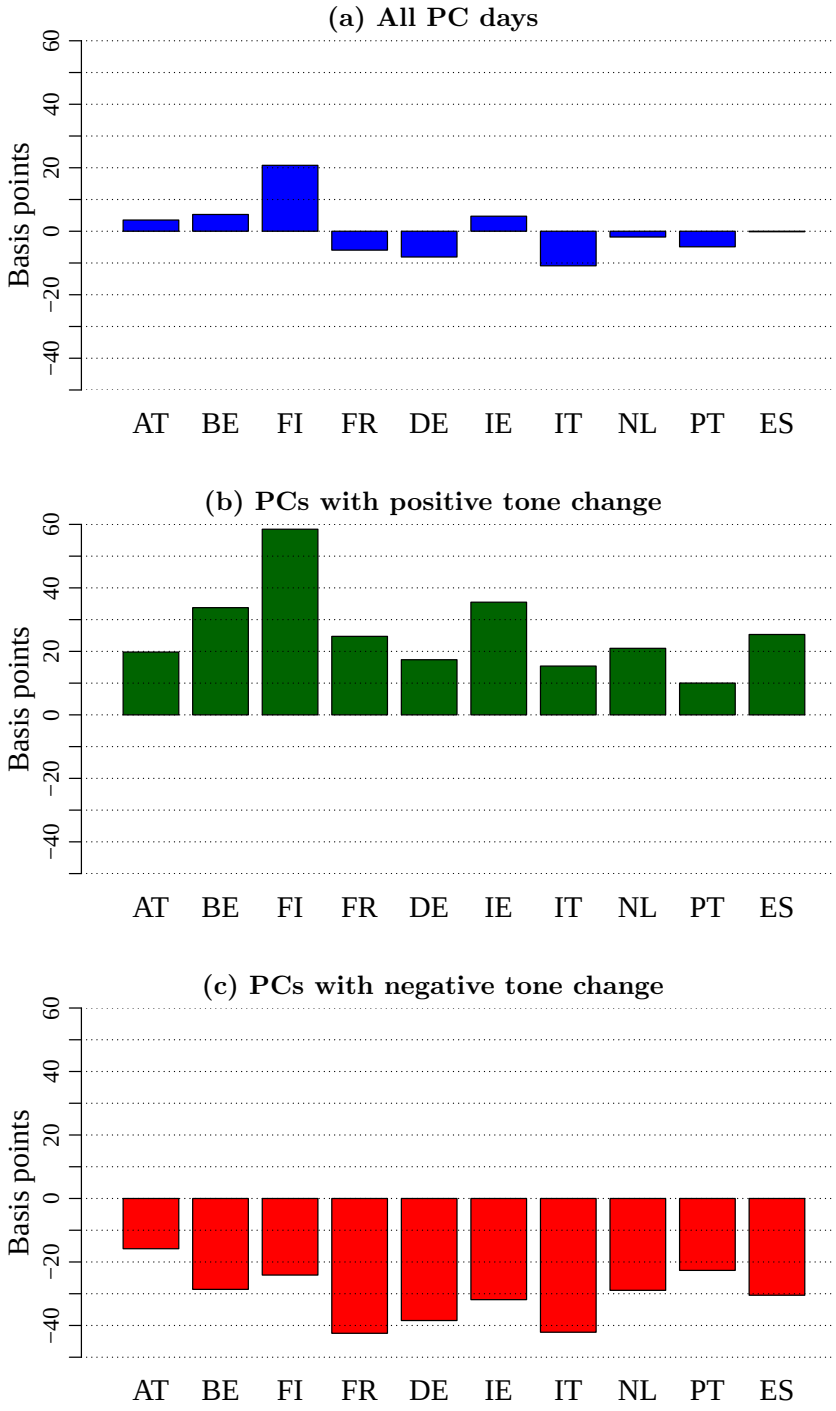
Figure 4 *(continued)*

(b) Coefficients of regressing equity returns on tone changes



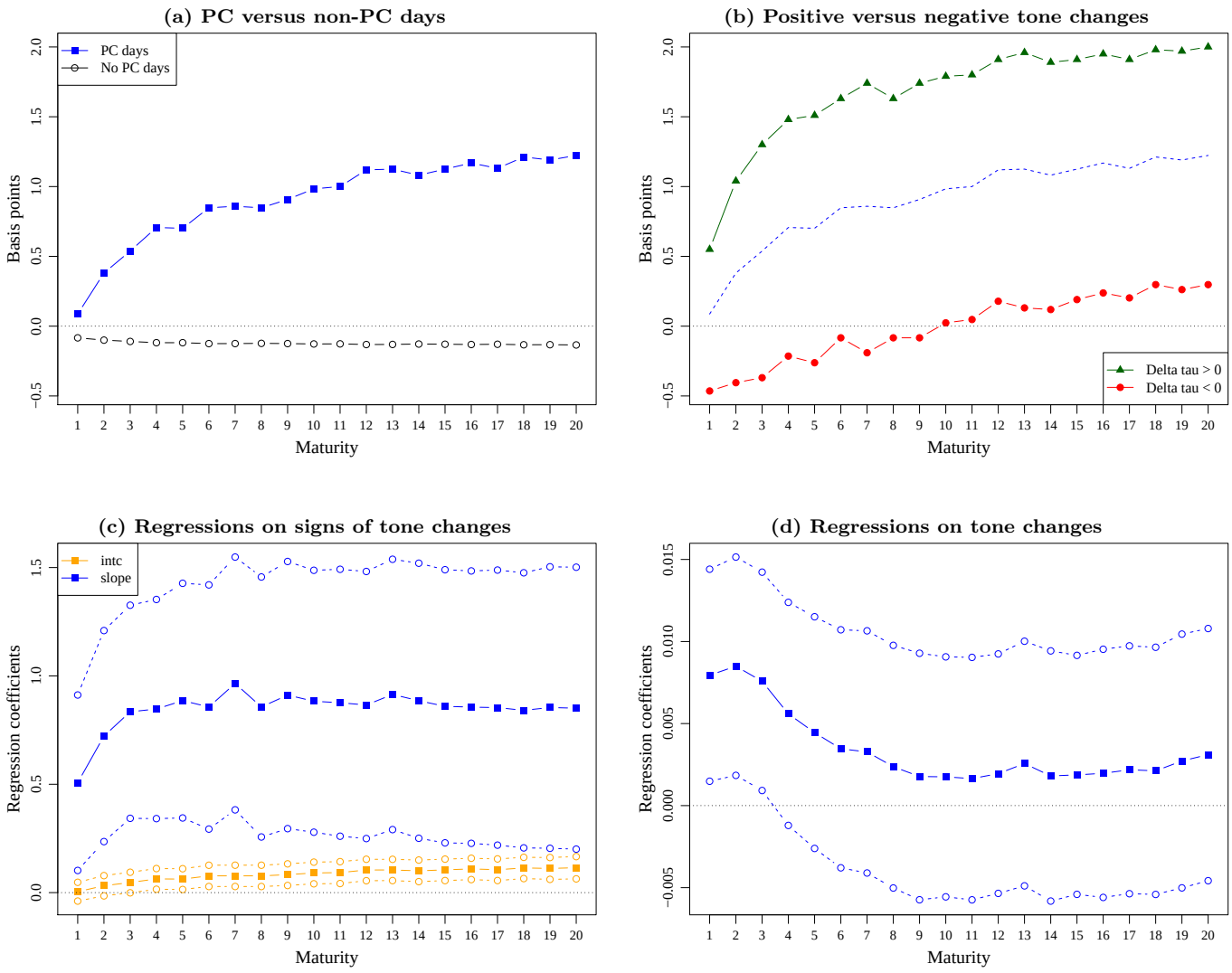
This figure shows how changes in ECB tone revealed at the most recent ECB press conference (PC) affect equity returns. In Panel (a), we plot the average k-day cumulative equity returns from $k = 0$ (representing the PC-day return) up to $k = 15$. The green (red) lines plot the average cumulative returns on the k-th day after the PC, conditional on the tone being revealed at the press conference having been more positive (negative) compared to the previous one; values are reported in basis points. The dashed blue line represents the average return accumulating up to day k after the PC. Panel (b) plots the coefficients (and 90% confidence bands based on Newey and West (1987) standard errors) for regressing k-day cumulative returns on changes in tone revealed at the preceding press conference. The sample spans a total of 184 tone changes from 185 ECB press conferences between January 7, 1999 and October 2, 2014.

Figure 5: Individual Country Equity Returns on Press Conference Days



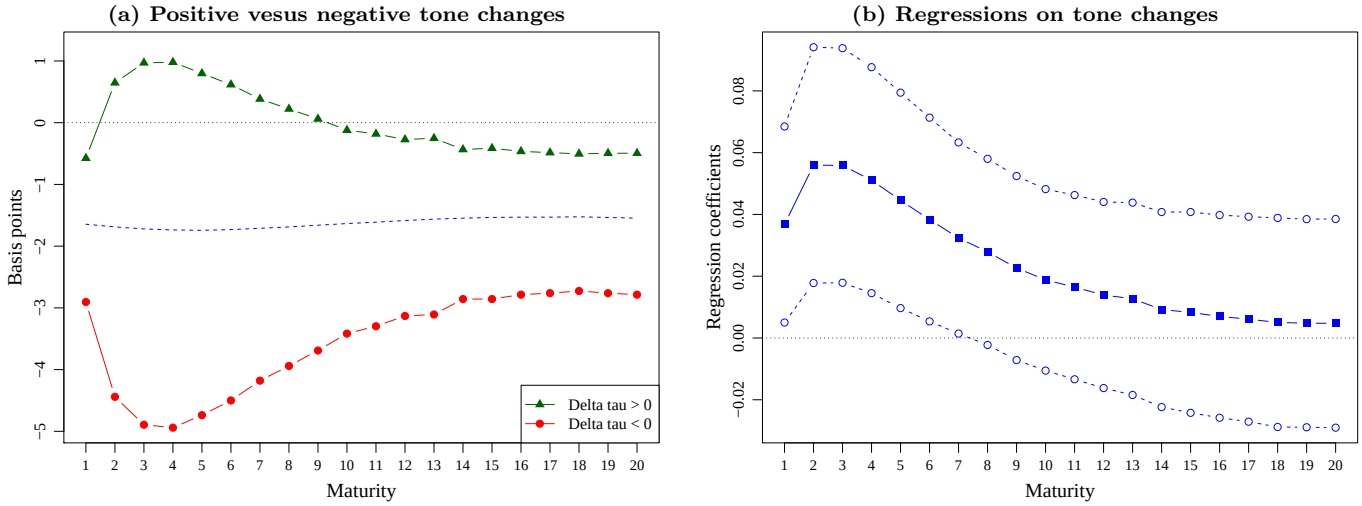
This figure plots the press conference (PC)-day returns of individual Eurozone country MSCI equity indexes. We compute returns from the closing prices on the day preceding the PC and the day on which the PC is held. We compute a total of 184 returns between the 185 ECB press conferences between January 7, 1999 and October 2, 2014. Panel (a) refers to average PC-day returns across from all PCs. Panels (b) and (c) plot average returns separately for the 100 (84) observations at which the tone of the ECB becomes more positive (negative) compared to the previous PC. The countries covered are Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (DE), Ireland (IE), Italy (IT), Netherlands (NL), Portugal (PT), and Spain (ES).

Figure 6: Yield Changes on ECB Press Conference Days



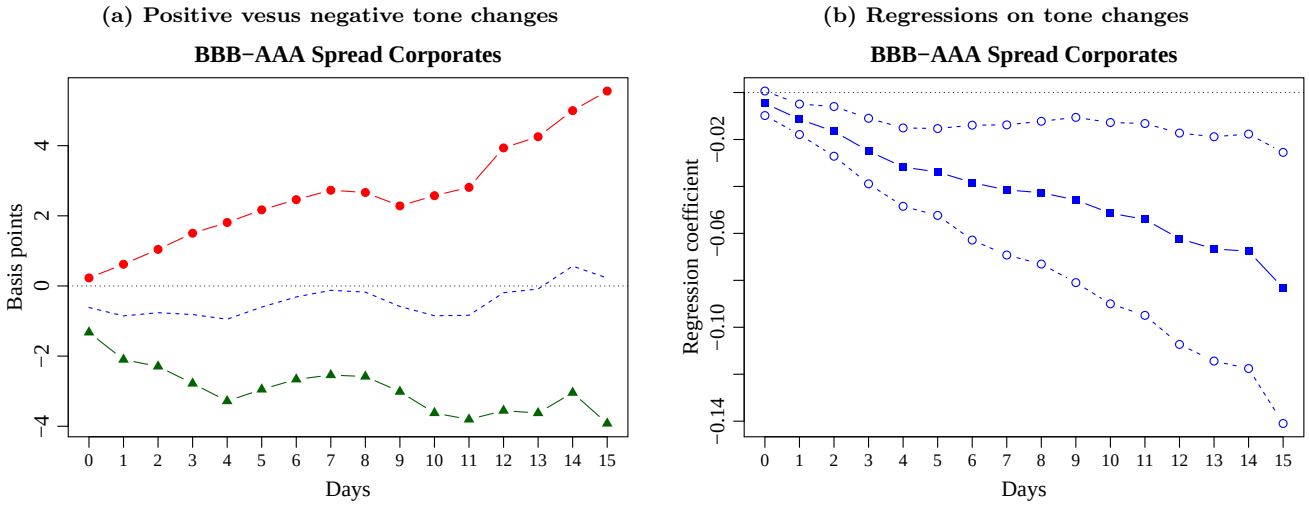
This figure presents results on changes in the yield curve (for maturities ranging from one to 20 years, x-axis) on days that the ECB holds a press conference. Panel (a) plots average daily yield changes on PC days (blue boxes) compared to non-PC days (black circles). Panel (b) presents average PC-day yield changes conditional on ECB tone becoming more positive (green) or negative (red). Panel (c) plots intercept- and slope coefficients from regressing yield changes (of individual maturities) on the sign of the tone change revealed at the press conference, i.e. on the sign of $\Delta\tau$, in orange and blue respectively; the dotted lines represent 90% confidence bands (based on Newey and West (1987) standard errors). Panel (d) plots slope coefficients of regressing yield changes on changes in ECB tone along with 90% confidence bands. The sample spans a total of 184 tone changes from 185 ECB press conferences between January 7, 1999 and October 2, 2014.

Figure 7: Yield Changes over Press Conference Cycles



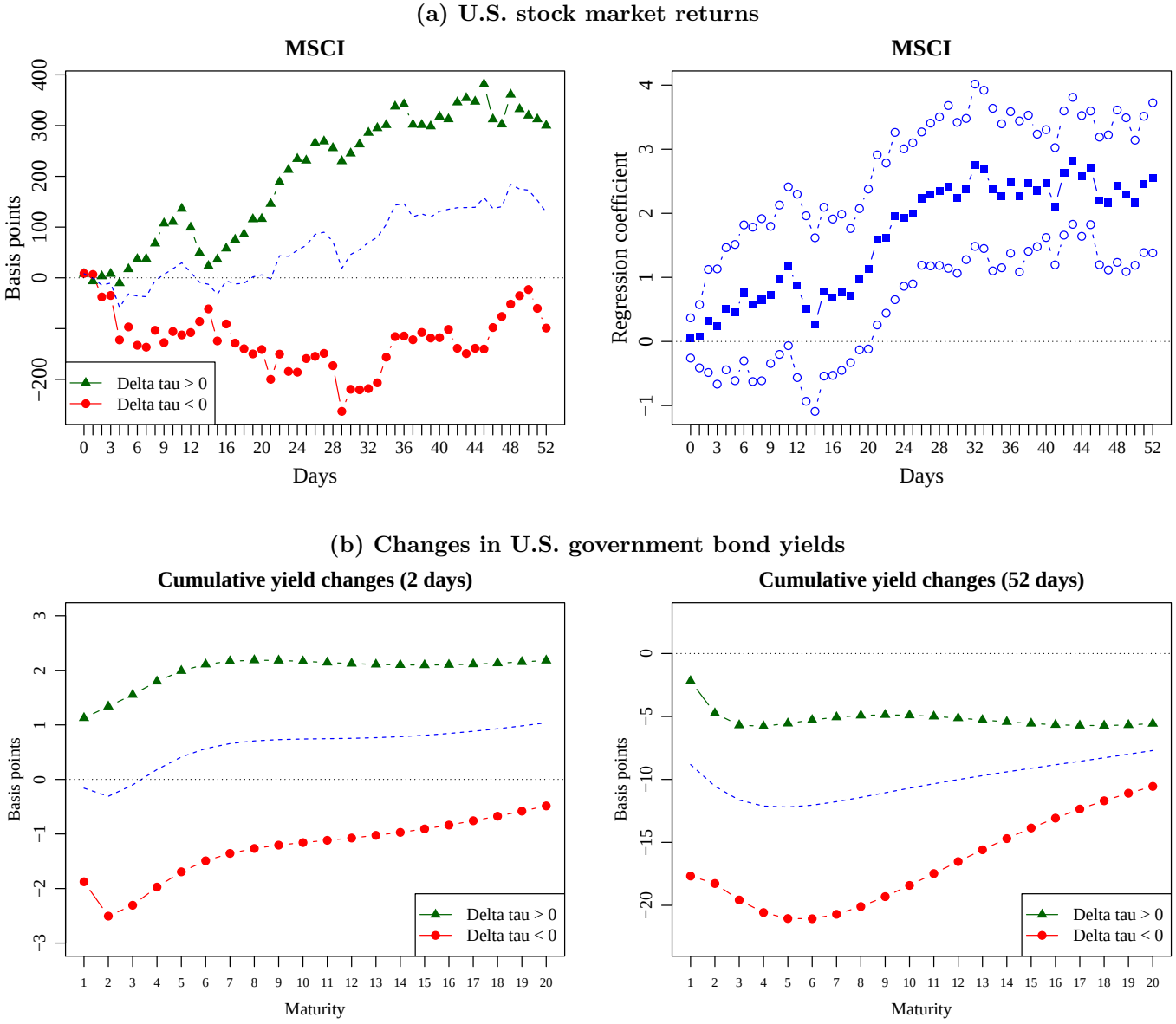
This figure presents results on changes in the yield curve (for maturities ranging from one to 20 years, x-axis) over cycles of ECB press conferences (PCs). Panel (a) presents average PC-to-PC yield changes conditional on the tone changes at the most recent PC having been positive (green) or negative (red). Panel (b) plots the slope coefficients from regressing yield changes (of individual maturities) on changes in ECB tone ($\Delta\tau$), along with 90% confidence bands (based on Newey and West (1987) standard errors). The sample spans a total of 184 tone changes from 185 ECB press conferences between January 7, 1999 and October 2, 2014.

Figure 8: Corporate credit spread changes



This figure presents results for regressions of changes in corporate credit spreads (BBB-AAA rated corporate bonds) on tone changes. Panel (a) presents the average cumulative change in the credit spread conditional on tone changes at the most recent PC having been positive (green) or negative (red). Panel (b) plots the slope coefficients from regressing credit spread changes on changes in ECB tone ($\Delta\tau$), along with 90% confidence bands (based on Newey and West (1987) standard errors). The sample spans a total of 184 tone changes from 185 ECB press conferences between January 7, 1999 and October 2, 2014.

Figure 9: U.S. Markets following Congressional Testimonies of the Fed Chair



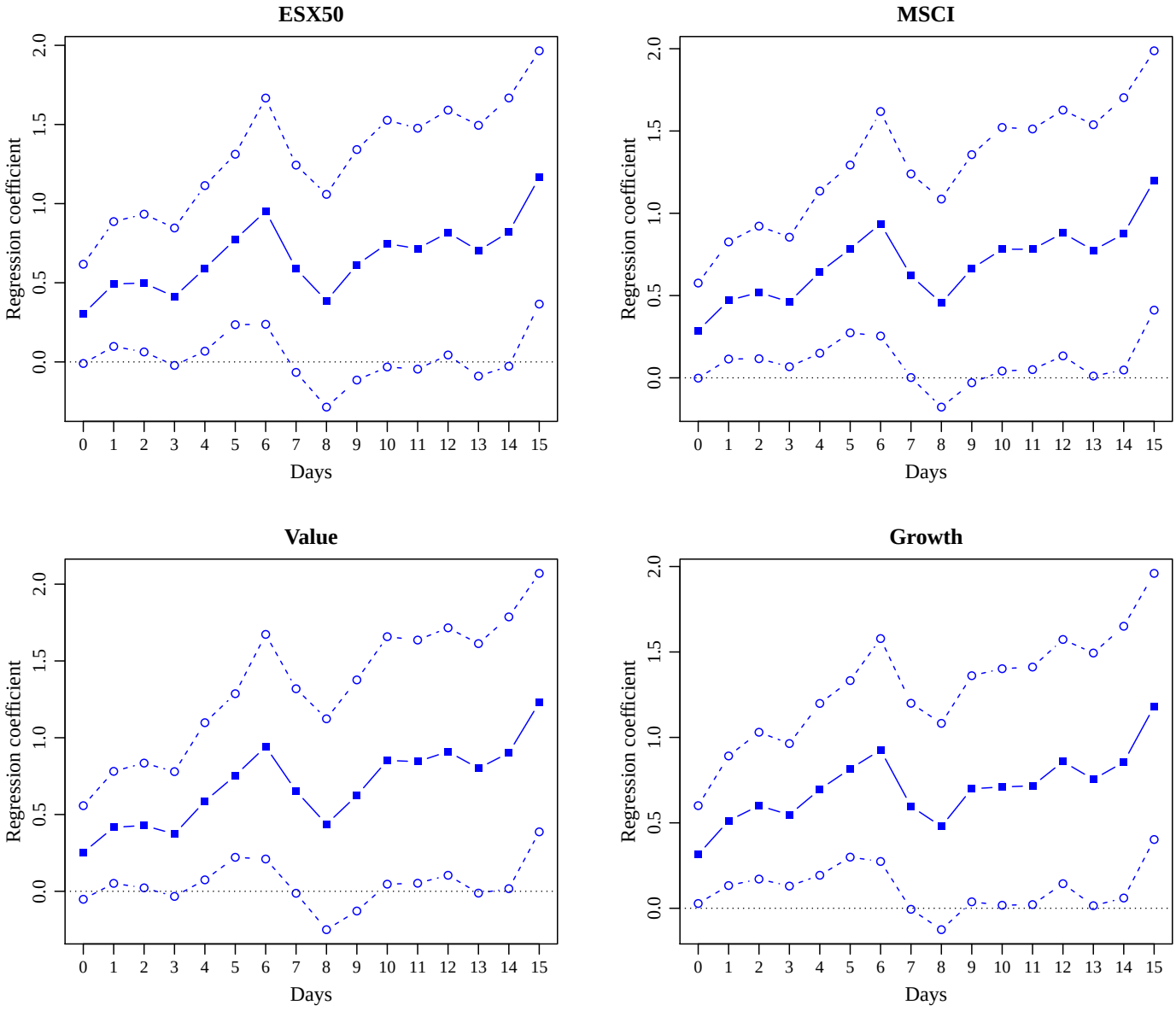
This figure shows how changes in Fed tone revealed at the Chair's most recent Congressional Testimony affect U.S. stock market returns and U.S. government bond yield changes. In Panel (a), present results for equity returns. On the left, we plot the average k-day cumulative equity returns from $k = 0$ (representing the date of the testimony) up to $k = 52$. The green (red) lines plot the average cumulative returns on the k-th day after the testimony, conditional on the tone being revealed at the testimony having been more positive (negative) compared to the previous one; values are reported in basis points. The dashed blue line represents the average return accumulating up to day k after the testimony. On the right, we plot the coefficients (and 90% confidence bands based on Newey and West (1987) standard errors) for regressing k-day cumulative returns on changes in tone revealed at the preceding testimony. Panel (b) presents results on cumulative changes in U.S. government bond yields (for maturities ranging from one to 20 years, x-axis) over 2 days and 52 days from the testimony on the left and right, respectively. We present yield changes conditional on Fed tone becoming more positive (green) or negative (red), and the dashed blue line represents average cumulative yield changes up to day k after the testimony. The sample spans a total of 36 tone changes from 37 testimonies from 1996 to 2014.

Internet Appendix for

Does Central Bank Tone Move Asset Prices?

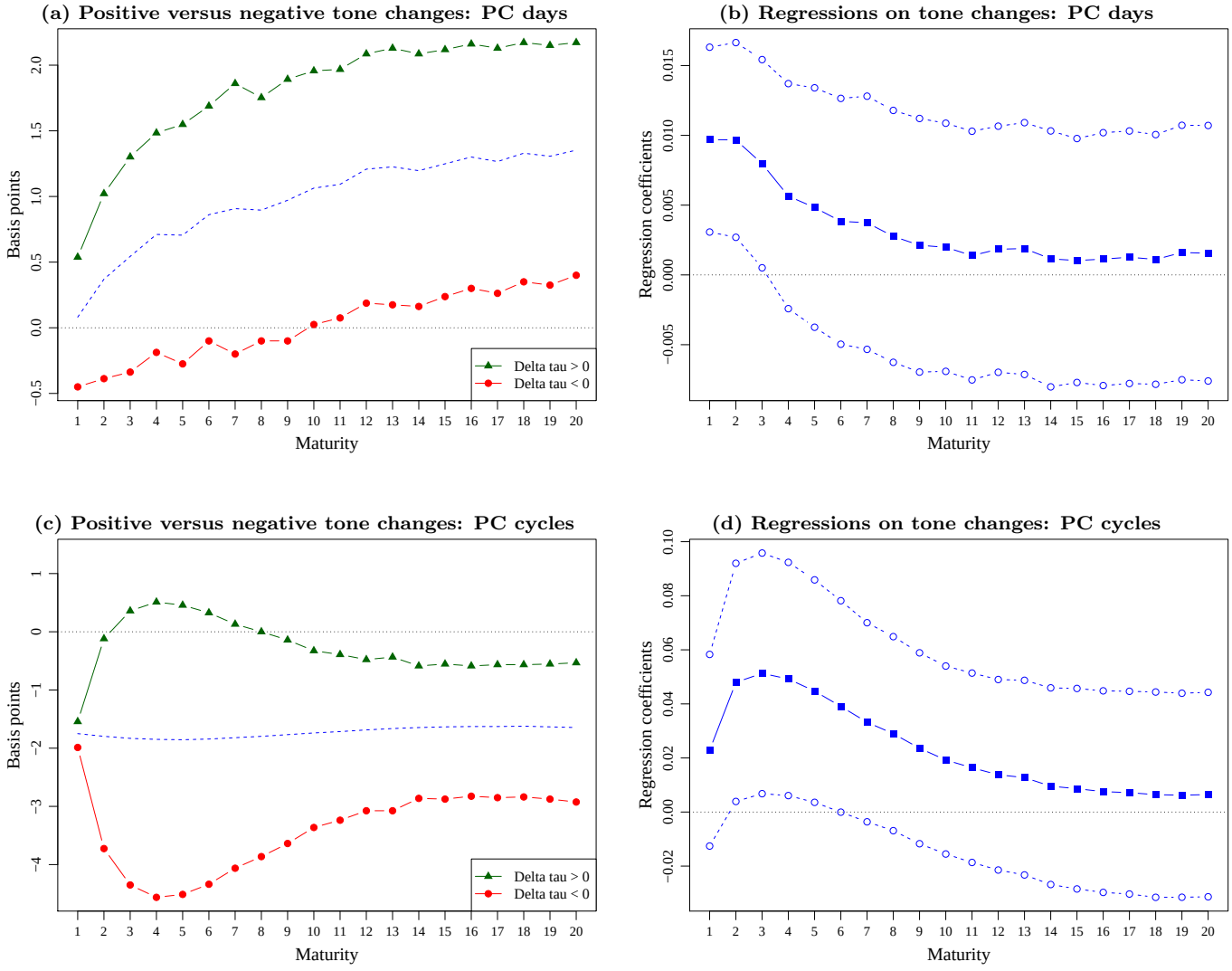
(not for publication)

Figure IA.1: Equity Returns following Press Conferences: Controling for Policy Actions



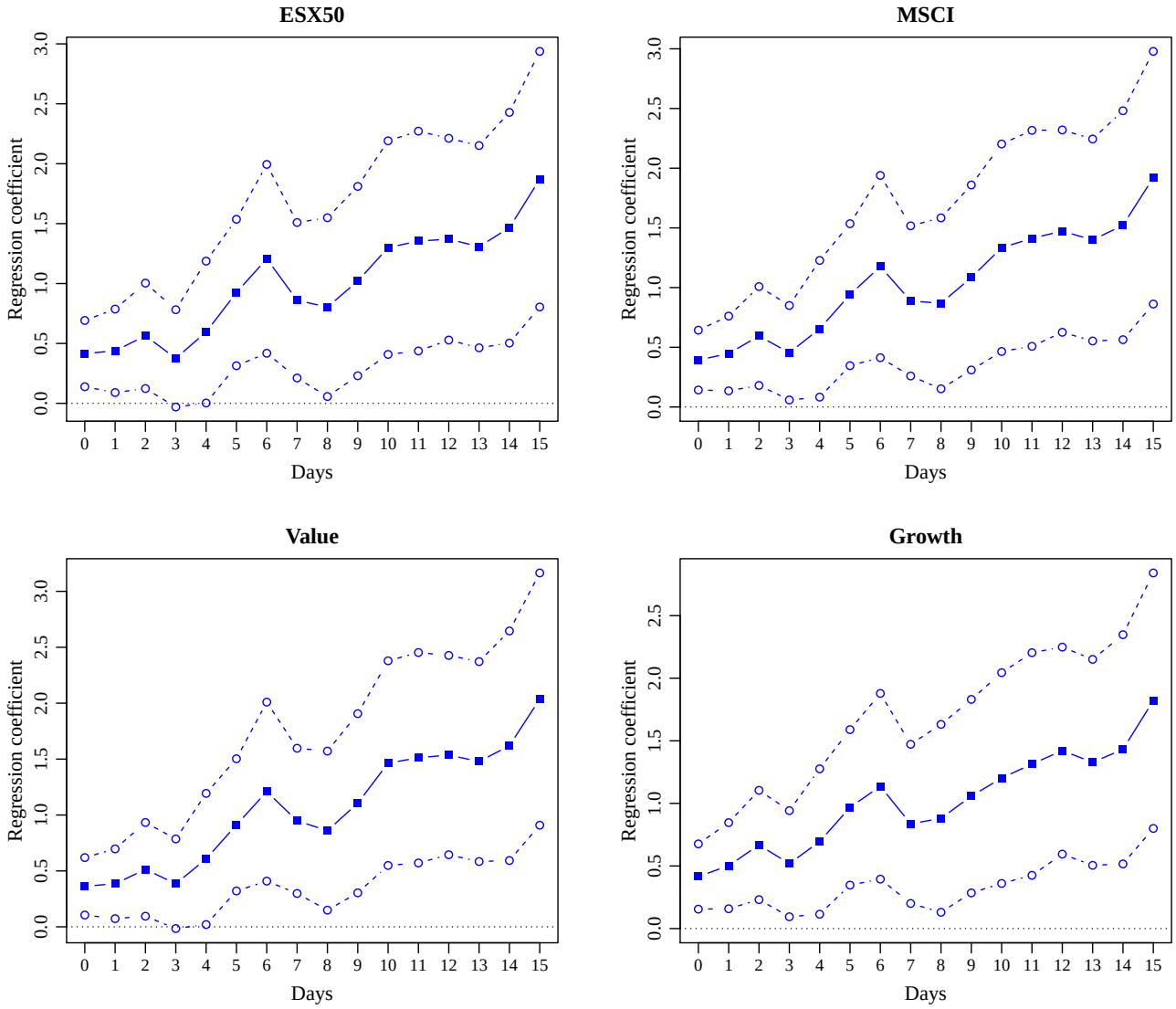
This figure shows how changes in ECB tone revealed at the most recent ECB press conference (PC) affect equity returns when controlling for policy actions. Our initial sample spans a total of 184 tone changes from 185 ECB press conferences between January 7, 1999 and October 2, 2014. From this sample, we remove press conferences at which actual rate changes or unconventional policy measures have been announced. We plot the coefficients (and 90% confidence bands, based on Newey and West (1987) standard errors) for regressing k-day cumulative returns on changes in tone revealed at the preceding press conference. We evaluate the returns of four Eurozone equity indexes: EuroStoxx 50 (ESX50), the MSCI EMU (MSCI), the MSCI Value EMU (Value), and the MSCI Growth EMU (Growth).

Figure IA.2: ECB Tone and Yield Changes: Controling for Policy Actions



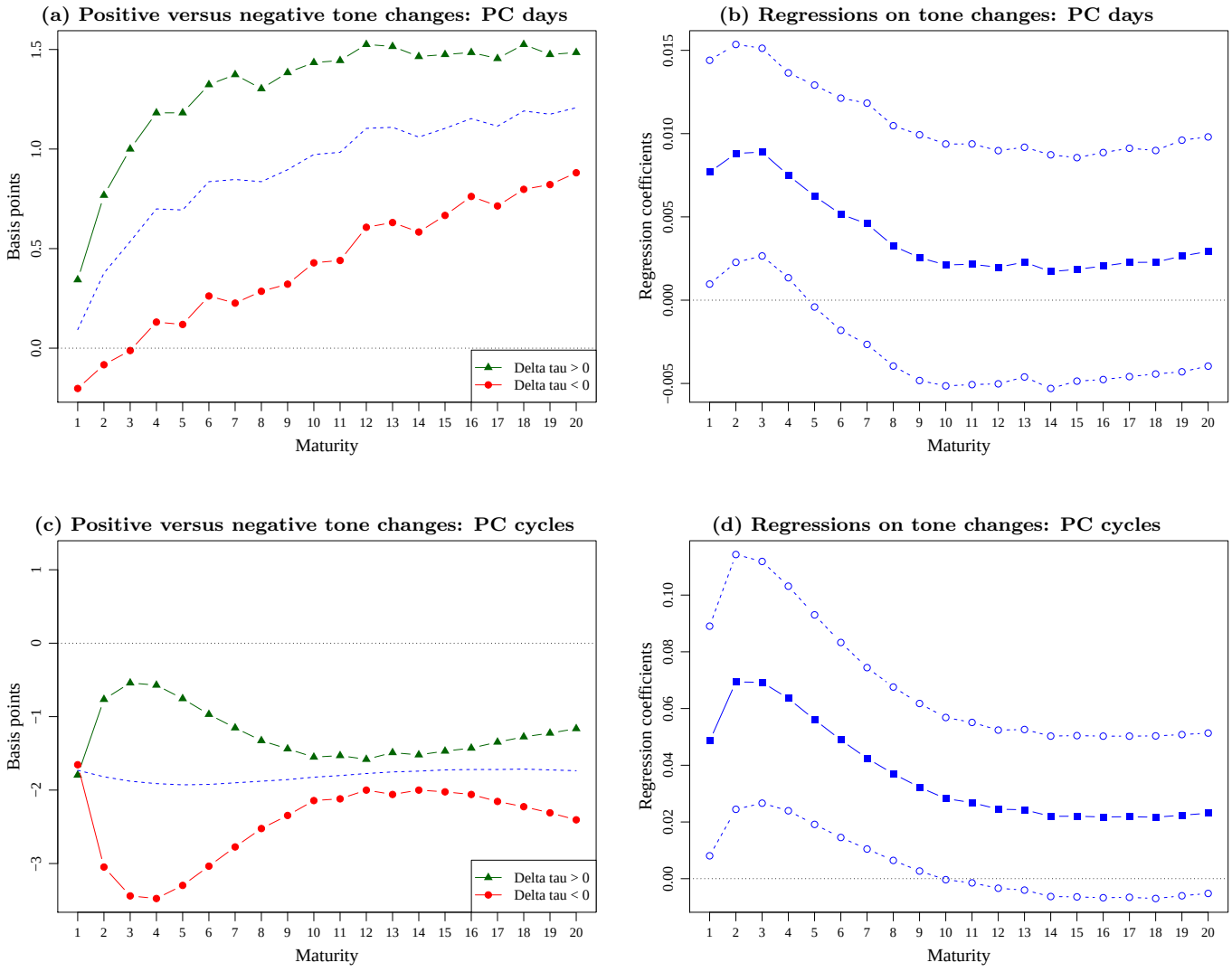
This figure presents results on how changes in ECB tone affect the yield curve when controlling for policy actions. Our initial sample spans a total of 184 tone changes from 185 ECB press conferences (PCs) between January 7, 1999 and October 2, 2014. From this sample, we remove press conferences at which actual rate changes or unconventional policy measures have been announced. We evaluated the affect on yields with maturities ranging from one to 20 years (x-axis) on PC-days and over PC-cycles. Panel (a) presents average PC-day yield changes conditional on ECB tone becoming more positive (green) or negative (red). Panel (b) plots slope coefficients of regressing PC-day yield changes on changes in ECB tone along with 90% confidence bands (based on Newey and West (1987) standard errors). Panels (c) and (d) present analogue results for yield changes over PC-cycles.

Figure IA.3: Equity Returns following ECB Press Conferences: 'Tone Shocks'



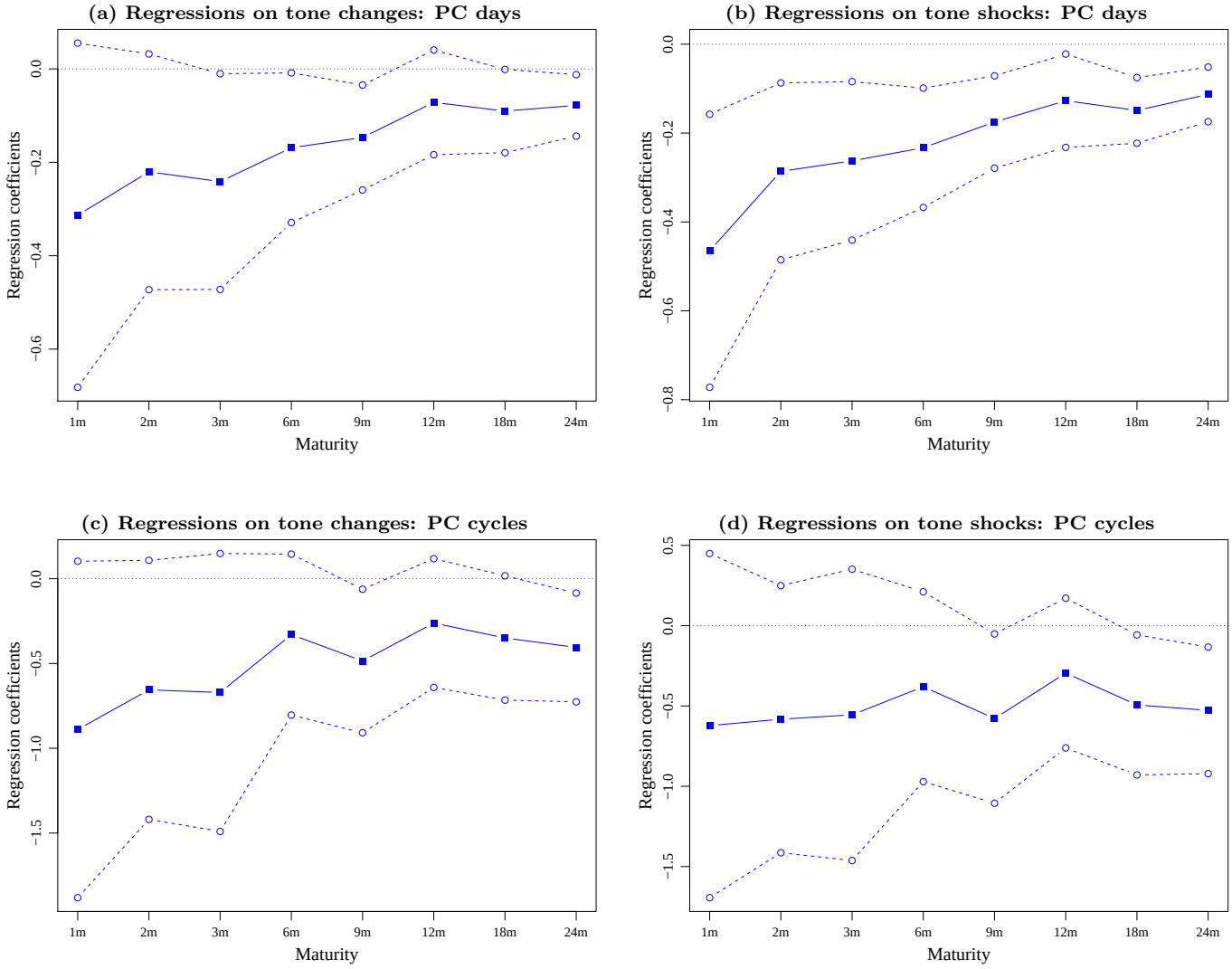
This figure shows how changes in ECB tone revealed at the most recent ECB press conference (PC) affect equity returns when using 'tone shocks' instead of raw tone changes. From our sample of 184 tone changes from 185 ECB press conferences between January 7, 1999 and October 2, 2014, we compute the time series of tone changes, and measure tone shocks as the residuals from an AR(1)-regression. Using these tone shocks, we plot the coefficients (and 90% confidence bands, based on Newey and West (1987) standard errors) for regressing k-day cumulative returns on tone shocks revealed at the preceding press conference. We evaluate the returns of four Eurozone equity indexes: EuroStoxx 50 (ESX50), the MSCI EMU (MSCI), the MSCI Value EMU (Value), and the MSCI Growth EMU (Growth).

Figure IA.4: ECB Tone and Yield Changes: 'Tone Shocks'



This figure presents results on how ECB tone 'shocks' affect the yield curve. . From our sample of 184 tone changes from 185 ECB press conferences between January 7, 1999 and October 2, 2014, we compute the time series of tone changes, and measure tone shocks as the residuals from an AR(1)-regression. Using these tone shocks, we evaluated the affect on yields with maturities ranging from one to 20 years (x-axis) on PC-days and over PC-cycles. Panel (a) presents average PC-day yield changes conditional on ECB tone shocks being positive (green) or negative (red). Panel (b) plots slope coefficients of regressing PC-day yield changes on tone shocks along with 90% confidence bands (based on Newey and West (1987) standard errors). Panels (c) and (d) present analogue results for yield changes over PC-cycles.

Figure IA.5: ECB Tone and Changes in Equity Market Volatility



This figure presents results on the link between ECB tone and market expectations of future equity volatility as measured by the VSTOXX volatility index, which is constructed from options on the EuroStoxx50. In our analysis of how ECB tone changes and tone shocks affect market volatility on ECB press conference (PC) days and over PC cycles, we use the VSTOXX sub-indices for maturities of one, two, three, six, nine, twelve, 18, and 24 months. Panel (a) plots slope coefficients of regressing PC-day changes in volatility on tone changes along with 90% confidence bands (based on Newey and West (1987) standard errors) and Panel (b) presents the results of repeating the analysis with tone shocks (estimated as the residuals of an AR(1)-regression for tone changes). Panels (c) and (d) present analogue results for changes in implied equity volatility over PC-cycles. Our sample of covers 185 ECB press conferences between January 7, 1999 and October 2, 2014.

Figure IA.6: Equity Excess Returns following ECB Press Conferences

(a) Equity excess returns following press conferences

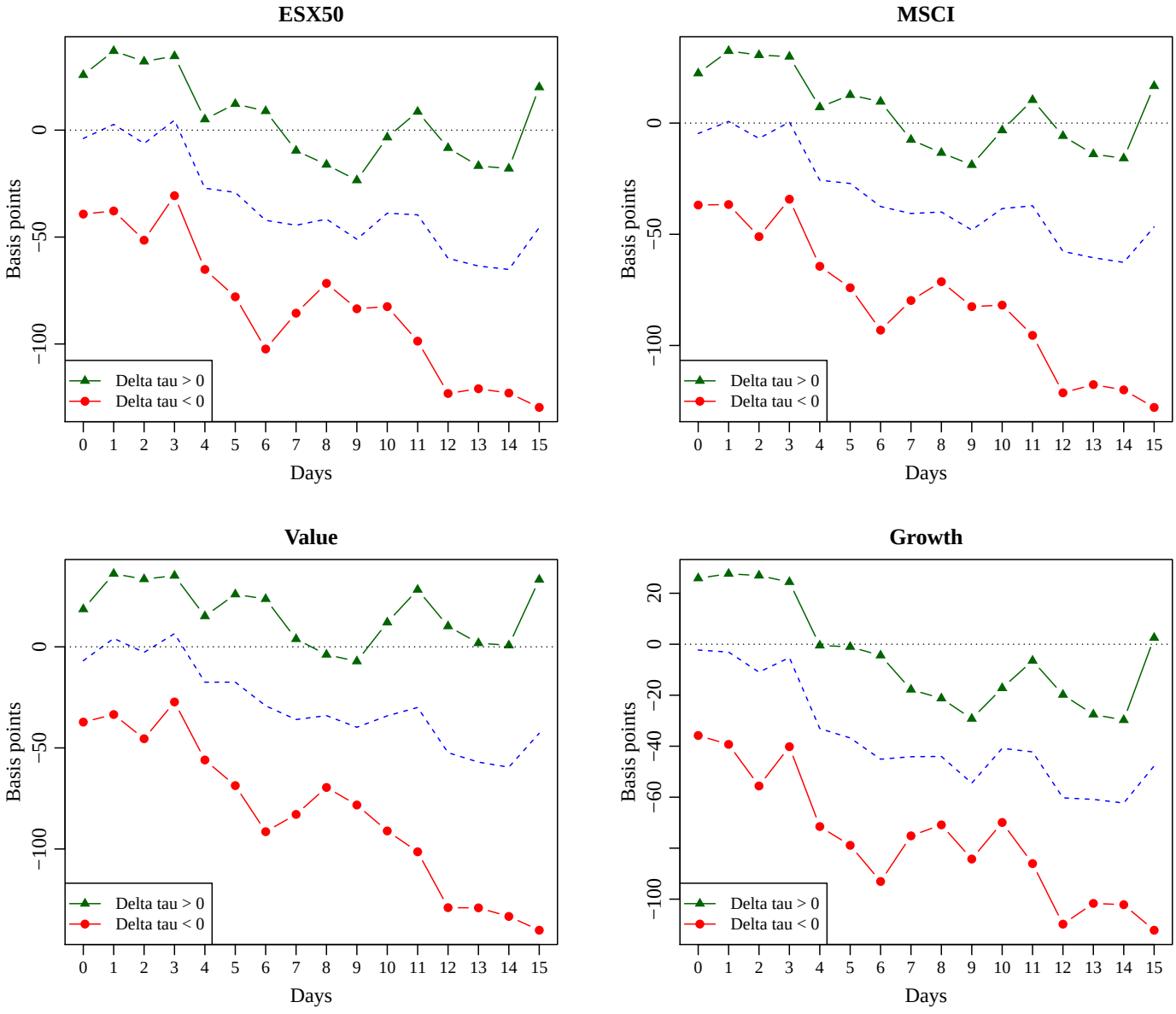


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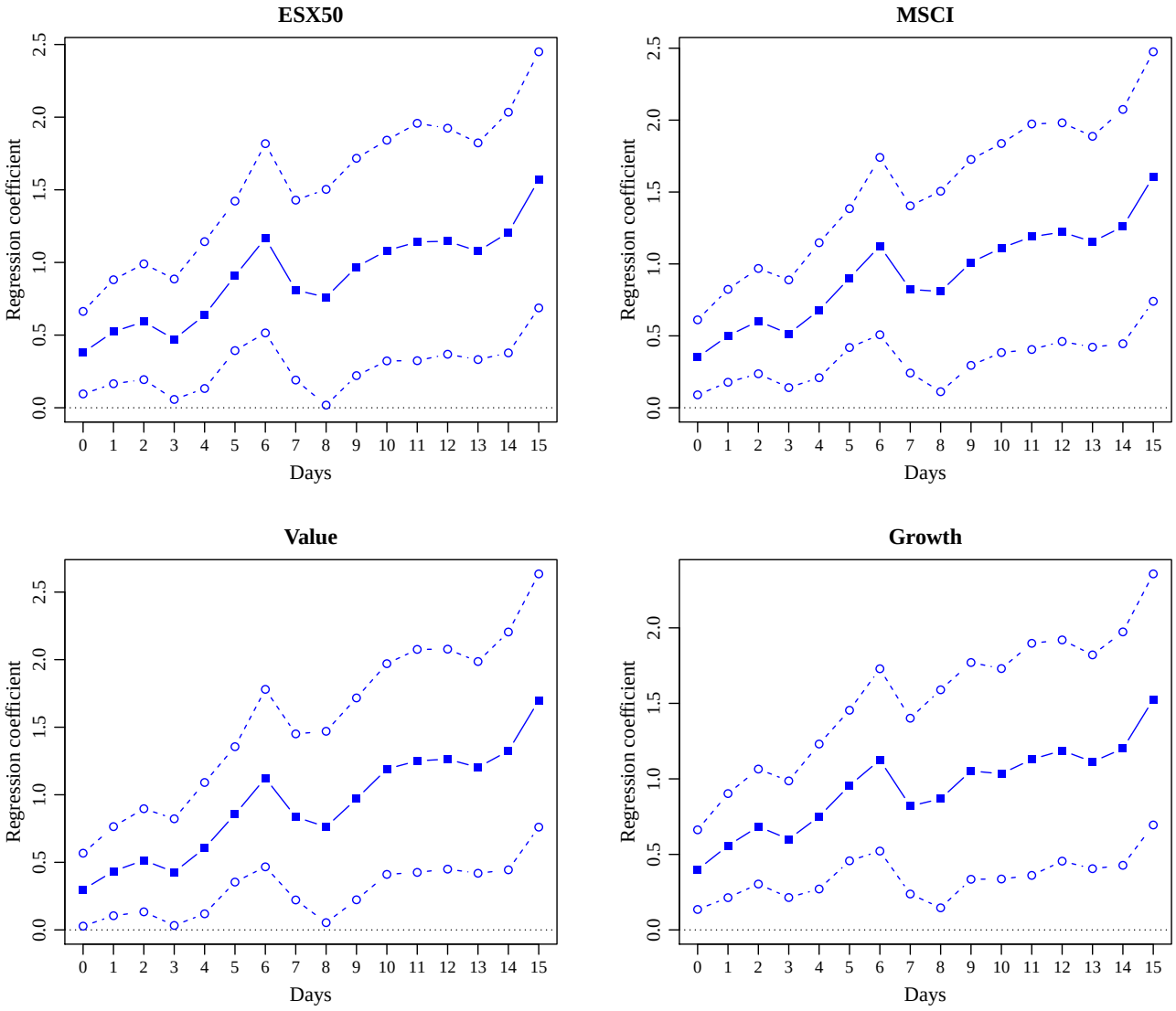
Figure IA.6 *(continued)*

(b) Coefficients of regressing equity excess returns on tone changes



This figure shows how changes in ECB tone revealed at the most recent ECB press conference (PC) affect equity excess returns. In Panel (a), we plot the average k-day cumulative equity excess returns from $k = 0$ (representing the PC-day return) up to $k = 15$. The green (red) lines plot the average cumulative excess returns on the k-th day after the PC, conditional on the tone being revealed at the press conference having been more positive (negative) compared to the previous one; values are reported in basis points. The dashed blue line represents the average excess return accumulating up to day k after the PC. Panel (b) plots the coefficients (and 90% confidence bands based on Newey and West (1987) standard errors) for regressing k-day cumulative returns on changes in tone revealed at the preceding press conference. The sample spans a total of 184 tone changes from 185 ECB press conferences between January 7, 1999 and October 2, 2014.