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ECB communication sentiments: how do they relate to the economic environment and financial markets?[1]

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ABSTRACT

In this paper we examine multiple dimensions of ECB monetary policy communication by identifying its sentiment and relation with the economic environment and financial markets. We quantify communication sentiment using transcripts from official ECB communication events – press conferences, accounts and Executive Board speeches – as well as media reactions that highlight the key messages of those events. Importantly, we create unique lexicons for both of those communication types. We find that the overall trends in the sentiment indices for the analysed communication events closely resemble the movements of monetary policy stance as well as macroeconomic indicators in the euro area, both before and after the COVID-19 shock period. The communication tone generally shifts in advance of actual monetary policy actions. Using regression analysis, we find some expected, statistically significant effects of press conference sentiment on bank stock prices (information-type shock) and identify the impact of Executive Board speeches on euro area fiscal borrowing costs (short-term OIS rates). Fragmentation issues among euro area member states do not seem to be negatively affected by the sentiments of the ECB's communication. Still, policy makers should be aware that the tone of their communication events is likely to affect particular financial markets.

Keywords: ECB, monetary policy, communication, sentiment analysis, euro area, financial markets.

JEL codes: C80, E43, E44, E58, G14.

1. INTRODUCTION

ECB communication helps to form expectations and plays a crucial role in monetary policy conduct. This is a two-way relationship with financial markets: the central bank influences the pricing in financial markets, while at the same time takes note of market signals in its decision-making process (de Guindos, 2019). This is especially relevant in recent years given that forward guidance has been developed as a monetary policy instrument amidst a low interest rate environment. As interest rates approached the effective lower bound (ELB), the ECB began to provide guidance that they would be kept low for some time (ECB, 2013). In addition, after the onset of asset purchase programmes, the ECB started to provide guidance about the possible duration of asset purchases as well as on the interlinkages between asset purchases and interest rates.

Communication during press conferences, while being arguably the most significant form, is not the only way to reach the public. ECB officials also provide speeches, interviews with media, and – since 2015 – monetary policy accounts. These events complement press conferences and provide further details and guidance on monetary policy outlook. This can be seen from the resulting media attention and the associated effects on financial markets (Gertler & Horvath, 2018). Quick and often unexpected changes in the economic and monetary policy environment (particularly over the 2020–2022 period) further exacerbate the need for unambiguous and clear communication.

Although news from different types of communication events can influence expectations about future monetary policy decisions, the clear understanding of the quantitative dimensions of these events has always been a challenge. Some of these events are of irregular frequency (e.g., *ad hoc* Executive Board speeches), can have different aims, and use different communication language. Through its communication, the ECB can provide views on the economic environment, monetary policy outlook and the reaction function, leading to multifaceted signals that are immediately reflected in the media and incorporated in financial markets. Picault & Renault (2017) showed that communication analysis has to take into account field-specific language of the ECB and different types of signals.

This paper contributes to the literature on monetary policy communication sentiment and its interaction with financial markets. We find somewhat scarce literature on the effects of monetary policy sentiment on financial markets – even though both of these areas are quite extensively analysed separately. Compared to other papers that have this particular focus, we find that there are still some research angles that are less developed, and we see the potential to provide additional insights. To be more precise, we measure the sentiment of both actual communication and media reaction to that communication, and we look at a wider scope of communication events (in particular – *ad hoc* speeches). Finally, we compare communication sentiment tendencies with macroeconomic indicators and measure the impact of communication sentiment (cleaned from trend dynamics and inflation expectations) on different financial market indicators with intraday data. The period of our analysis include the start of asset purchases in 2015 as well as the COVID-19 period and its aftermath.

We construct unique lexicons for ECB communication based on words frequently used in communication events and construct sentiment indices using combinations of words. We follow the methodology of Parle (2022) and Tadle (2022) and modify it with adapted lexicons, reflecting the *ad hoc* communication of the ECB. We also perform a robustness check for speeches using topic analysis and filtering out topics related to inflation and monetary policy; however, the results remain broadly unchanged after this check.

Regression analysis is used to determine the effect of the sentiment of original ECB communication and media reactions on financial market variables. We use euro area interest rates (fiscal borrowing costs), stock prices and exchange rates as dependent variables. Our main explanatory variable is the residual of sentiment cleaned from the effects of sentiment trend and inflation expectations. As a robustness check, we also use regression with the control variable of financial market moves in the US to account for important external events.

We find that trends in communication sentiment tend to be rather similar – both between different communication events as well as between original events and market reactions to these events. Additionally, we find sentiment dynamics to be correlated with ECB monetary policy stance (measured with the shadow rate) and macroeconomic environment both before and after the COVID-19 shock. We notice shifts in the communication sentiments of different events predating actual decisions, with the most noticeable effect coming from Executive Board speeches. Using regressions with intraday financial market data and filtering out trend dynamics and inflationary pressures, we find some evidence that *hawkish*[3] press conference communication is related to higher bank stock prices, while such speeches are associated with higher short-term risk-free rates (and thus fiscal costs).

These findings provide some policy implications. We show that the sentiment of media coverage reflects the sentiment of actual communication quite well, implying that a shift in the communication tone of policy makers would be smoothly transmitted and understood by the media. This is true in both calm and crisis periods such as COVID-19 shock. Sentiments predating policy decisions indicate that policy makers can steer expectations in the intended direction before undertaking actual decisions. Finally, policy makers should be aware that their communication tone – even in *ad hoc* events – may affect financial markets.

We also note some limitations in this study. For individual communication events, caveats in sentiment analysis include a lack of sufficient communication data and the presence of complex communication language. In some cases, we also find unexpected market reactions related to external events. There is also evidence that communication events can provide multidimensional signals, being perceived as both information and monetary policy shocks. Issues with sentiment analysis tend to be mitigated when taking multiple events and trends, while some other issues we aim to resolve with regression analysis and the separation of the cyclical component from trend and inflation expectations.

The paper is structured as follows. After this introductory section, the second section covers the literature review on monetary policy communication research, with a particular focus on policy sentiment and its effects on financial markets. The third section explains the data and methodology used in this study. The fourth section presents the results, including sentiment indices, event-by-event analysis of communication, and the results of regression analysis. Finally, the fifth section concludes the paper.

2. LITERATURE REVIEW

For a comprehensive analysis of earlier related literature, we refer to Blinder et al. (2008). They argued that communication can work as a policy tool affecting financial markets and improving the predictability of monetary

[3] The separation between *hawkish* and *dovish* communication is a common distinction in the monetary policy environment. *Hawkish* communication indicates intentions toward tighter monetary policy (higher interest rates), while *dovish* communication indicates a looser policy (lower rates).

policy decisions. Research on monetary policy communication has since advanced further, particularly as communication has increasingly become a policy tool in the form of forward guidance. As the methods and focus areas of such research differ substantially, we attempt to disentangle them into several strands, although admittedly there is some overlap.

A significant portion of the literature aims to examine monetary policy through central bank press conferences, i.e., the main communication event when decisions are being made. The assessment of changes in financial market indicators over the period of such events usually shows that not only monetary policy decisions but also subsequent communication affects financial markets. Gürkaynak et al. (2005) applied a factor analysis for Federal Open Market Committee (FOMC) policy decisions to find that not only can the interest rate target be extracted, but also the path factor, indicating that FOMC statements can shift expectations. Altavilla et al. (2019) showed that the reaction to ECB press conferences can be disentangled into four different factors according to the term structure of the yield curve. Jouvanceau & Mikaliūnaitė (2020) added the perception factor, which takes into account differences of yields across countries. Leombroni et al. (2021) identified the credit risk channel of monetary policy communication.

The focus on the effects of press conferences, however, is not limited to the term structure of interest rates. Many studies also focus on the interaction between yield curve and equity prices or inflation expectations. An effect in the opposite direction (e.g., an increase in yields and a decrease in stock prices) is generally referred to as monetary policy shock, and an effect in same direction is referred to as information shock. Disentangling these shocks allows us to assess whether the communication of the central bank is more related to the actual monetary policy reaction function or to economic outlook. Although it may seem that monetary policy shock should dominate in central bank policy decisions, multiple studies also found persistent evidence of information shock (Jarocinski & Karadi, 2018; Hansen et al., 2019; Nakamura & Steinsson, 2018). However, such a view is not unanimous as, for instance, Bauer & Swanson (2020) showed that monetary policy shocks dominate and the information effect, if it exists at all, is often small.

A large strand of the remaining related literature puts more emphasis on the extension of central bank communication data from various perspectives to measure its interaction with financial markets. One possible direction is to focus on additional types of communication. Several earlier papers have shown that while major communication events of the Federal Reserve (Kohn & Sack, 2004) and the Bank of England (Reeves & Sawicki, 2007) affect the financial markets, there is little evidence on the effect of policymakers' speeches. However, more recent evidence shows that a variety of communication events indeed affect the financial markets. Various types of communication events are employed in estimating the effects of monetary policy measures, e.g., ECB quantitative easing and unconventional policies (Altavilla et al., 2021; Bulligan & Monache, 2018). Multiple studies focus on the reaction of the market to the release of minutes/accounts of policy meetings, the speeches of central bank officials, and other *ad hoc* communication events, finding a statistically significant effect on financial market indicators – albeit this effect may not be as large as in the case of press conferences (Kansoy, 2020; Kliesen et al., 2019; Jurkšas et al., 2022; Tadle, 2022).

Various research has been performed by employing techniques to assess the content of communication. Among these, the most common is sentiment (or tone) analysis of communication that is conducted either manually or using automated approaches. Among manual approaches, Musard-Geis (2006) codified ECB monetary policy statements in a range from −2 (very *dovish*) to 2 (very *hawkish*). Similarly, Gerlach (2007) estimated policy sentiment in ECB monthly bulletins by separating communication into the inflation, real sector and money

growth areas. Gertler & Horvath (2018) used media articles covering ECB communication events and manually classified them by their tone on economic outlook and prospects for monetary policy. Heinemann & Kemper (2021) assessed the *hawkishness* of ECB Governing Council members from different countries based on their views on pandemic asset purchases.

Several studies focus on more automated approaches in order to avoid a human judgement bias by employing lexicons of pre-defined words and/or n-grams to estimate communication sentiment. Some researchers detected tone using general-purpose lexicons – e.g., the Loughran-McDonald (2011) dictionary in Iglesias et al. (2017). However, it is important to note that the language used in monetary policy communication events is quite specific, and general-purpose lexicons may not always be appropriate. As noted by Picault & Renault (2017), the non-consideration of field-specific features can lead to the misclassification of some terms. To account for this issue, Picault & Renault (2017) created their own lexicon from ECB introductory statements and showed that indicators created using this approach significantly outperform those based on general purpose lexicons (albeit, it should be noted that this leaves some subjectivity as the lexicon is created by manually classifying statements). Similarly, sentiment is created using monetary policy-related phrase lists from ECB introductory statements in Apergis & Pragidis (2019), and from Swedish Riksbank minutes in Apel & Grimaldi (2012). Parle (2022) used an automated approach to analyse ECB press conferences based on the monetary policy dictionary outlined in Tadle (2022). Anand et al. (2022) used tone measurement based on polar words and valence shifters in ECB and major euro area national central bank speeches and found that they affect stock market returns. Tobback et al. (2017) also applied automated techniques to estimate ECB sentiment, but semantic orientation and text classification were used on media articles instead of primary sources of communication. The text classification method was found to provide more accurate results. Similarly, media sentiment was measured in Picault et al. (2022), but the authors also removed the communication of ECB officials from media articles to filter only comments made by the media.

There are several important studies that assess the content of monetary policy communication from other perspectives than sentiment analysis. For instance, Ehrmann & Fratzscher (2009) employed topic analysis and showed that markets react more to ECB communication on inflation and policy rate. Topic analysis has also been widely applied for different communication events and central banks: for ECB speeches (Hartmann & Smets, 2018; Cross & Greene, 2019; Jurkšas & Klincevičius, 2020), Monetary Dialogues between the Members of the European Parliament and the President of the ECB (Ferrara et al., 2022), FOMC meeting transcripts (Edison & Carcel, 2019), FOMC minutes (Jegadeesh & Wu, 2015), and the statements and minutes of the Central Bank of Turkey (Iglesias et al., 2017). Coenen et al. (2017) estimated the complexity of ECB communication and found that it is positively related with volatility in the stock market. Gardt et al. (2022) compared the dynamics of ECB communication complexity in the ECB economic bulletin with those of the FED and the Bank of England. Byrne et al. (2023) addressed the time dimension in ECB communication and showed that information about the future affects financial markets. Gertler et al. (2020) showed that unscheduled ECB communication increases co-movements in financial markets. Ehrmann & Talmi (2020) analysed how Bank of Canada statements change over time, and found that more similar statements are associated with lower market volatility. Gati & Hanland (2022) showed that the FED's communication rule changes over time, and its perception of real variables differs from the perception of the market.

Multiple studies have found that sentiment indicators have statistically significant effects on financial markets, with the most prominent effects on stock markets. Schmeling & Wagner (2019) showed that a more positive

tone increases stock prices and decreases volatility via the risk premia channel. Apergis & Pragidis (2019) found that such a relationship has additional empirical support during crisis periods. Gertler & Horvath (2018) arrived at a similar conclusion in their analysis of *ad hoc* ECB communication events. In particular, indications of policy easing and a worse economic outlook lead to negative effects on the stock market and interest rates. Parle (2022) showed that *hawkishness* in ECB press conferences leads to higher stock prices, indicating that information about a more positive economic outlook outweighs monetary policy shock, while Picault & Renault (2017) additionally found that this decreases volatility. Picault et al. (2022) showed that positive media coverage of ECB communication tends to be associated with higher inflation expectations. Anand et al. (2022) found that the sentiments of speeches from six euro area national central bank officials also affected stock indices in their respective countries.

Several studies also identified the effects of communication on sovereign yields and future policy decisions. Hayo et al. (2014) showed that *hawkish* FED communication raises bond yields, and vice versa. Hubert & Labondance (2021) found that positive FOMC communication increases interest rates at 1-year maturity. Both studies found stronger effects during periods of financial distress. Multiple studies found that central bank communication helps to predict future monetary policy decisions (Bennani et al., 2019; Tobback et al., 2017, Baranowski et al., 2021; Hubert & Labondance, 2021).

Overall, we find related literature to have a relatively narrow focus on communication events, mostly analysing press conferences. We find a lack of analysis on the interrelation of sentiment between different communication events, as well as between the original communication of central bank officials and the reaction of the media to these events. We also find some scope to improve sentiment measuring techniques. Additionally, the relationship between *ad hoc* ECB communication sentiment, macroeconomic indicators, and a large variety of financial market variables remains scarce. This is particularly true for the post-COVID shock period. In our study, we attempt to fill these gaps.

3. DATA AND METHODOLOGY

3.1 Data

Communication data

We analyse three types of ECB monetary policy communication events: press conferences, monetary policy accounts, and the speeches of ECB Executive Board members. A press conference is an event that follows monetary policy decisions where the President of the ECB provides a brief summary of the economic and monetary policy outlook, which is then followed by a Q&A session. Monetary policy accounts indicate what was discussed during the latest monetary policy meeting and are released approximately 1 month after the Governing Council meeting. The speeches of ECB Executive Board members cover a variety of topics and are conducted on an *ad hoc* basis. For all three types of events, we retrieve transcripts of their content from the ECB website as well as an interpretation of these events from Refinitiv Eikon. News Monitor App provides us with a rich database of media articles and an advanced events search tool provides information on the exact time of many central bank communication events. We apply filtering procedures as in Jurkšas et al. (2022).[4]

[4] We apply the following filtering technique to find respective speeches on the News monitor app:

The length of the time series, number of communication events, and sentiment indices are presented in Table 1. The timespan of the data is substantially shorter for media events due to data availability issues in Refinitiv Eikon. Regarding monetary policy accounts, data are limited because ECB accounts have only been published since 2015. For all communication events we use the end of March 2022 as a cut-off point for data. Still, we are encompassing the COVID-19 period. The number of events with calculated sentiment is somewhat lower than the number of actual events due to the lack of data[5] that would allow us to identify sentiment. The number of speech sentiments is substantially lower when we additionally filter out particular topics (the rationale and methodology of topic analysis is explained in sub-section 3.2).

Table 1. Data sample of monetary policy communication events

Source	Communication event	Filtering of particular topics[6]	Timespan	Number of events	Number of collected sentiments
ECB	Press conference	No	1999–2022	253	251
ECB	Speech	No	1997–2022	2,288	2,184
ECB	Speech	Yes	1997–2022	2,288	1,467
ECB	Accounts	No	2015–2022	60	59
Media	Press conference	No	2014–2022	68	68
Media	Speech	No	2014–2022	511	371
Media	Speech	Yes	2014–2022	511	211
Media	Accounts	No	2014–2022	57	53

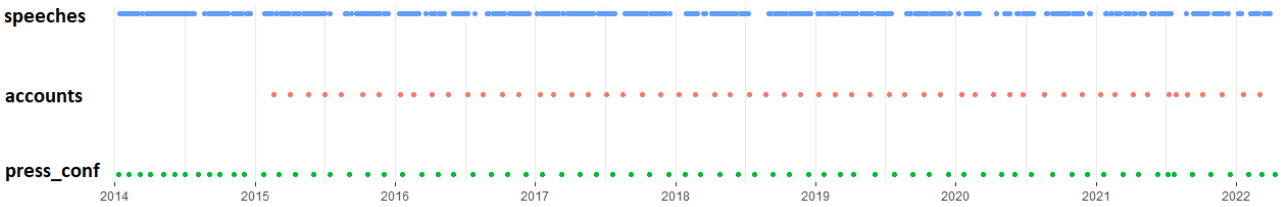
It is also important to note that the frequency is very different for the three types of ECB communication event, and consequentially for collected communication sentiments (Figure 1). Press conferences and accounts have been released every 6 weeks since 2015 (before then, press conferences were monthly). Meanwhile, speeches are delivered by Executive Board members on an irregular basis, but generally take place much more often than press conferences. Importantly, speeches are delivered on different dates than press conferences due to the silent period before ECB decisions.

i) selecting "European Central Bank" (for speeches, we add "<last name of Executive Board member>"); ii) excluding breaking news alerts; iii) filtering only English language. We avoid media articles that directly refer to financial market movements as we are interested in the media's interpretation of ECB communication. We apply the following filtering technique to find the respective speeches via an advanced events search: i) filtering by keyword – ECB; ii) filtering by event type – Economic, Central Bank Event.

[5] Cases where we did not find suitable combinations of words (as explained in section 3.2) that would allow us to identify sentiment. This was particularly relevant for some short media messages.

[6] The column showing the distinction of particular topics notes whether only speeches with paragraphs related to monetary policy were analysed. We find this distinction relevant as speeches may cover a wide variety of topics and some sentiment identifications may not be informative (please find a more detailed explanation in section 3.2).

Figure 1. Frequency of calculated sentiments for different monetary policy communication events



Financial market data

Data on the financial markets was retrieved from the Thomson Reuters Tick History (TRTH) database. The data was collected with a 1-minute frequency in order to capture the actual reaction of the market in the short period around the concrete time of the monetary policy communication event, and thus limit the possibility that unrelated factors affected the markets during this short period. However, not all of the financial market data were available since 1999, i.e., when the euro area was created. To be precise, we collected data for: the 2-year Overnight index swap (OIS) rate (from 1999) and the 10-year OIS rate (from 2011) for the euro area; the Italian-German (IT-DE) 10-year sovereign bond spread (from 2001); the Eurostoxx50 and bank stock indices (from 1999); and the EUR/USD exchange rate (from 1999). Importantly, regression analysis was also constrained by the length of control variables (when they are used): the US 10-year OIS rate (since 2009) and the S&P 500 futures index (since 2008). The last data point for all financial market indicators was 31 March 2022.

Other data

In order to compare sentiment indices with monetary policy cycles, we also show the dynamics of the shadow rate – i.e., the estimated rate that tries to reveal the actual monetary policy stance. As the ECB's main policy rates became constrained by the effective lower bound and the ECB had to employ non-standard monetary policy measures, policy rates were no longer a suitable proxy for actual monetary policy stance. For this reason, the shadow rates constructed by Krippner (2015) and Kortela (2016) that represent the actual monetary policy stance (and not just changes in the policy rate) are used in graphical analysis alongside the sentiment indices.

In order to compare sentiment indices with the macroeconomic environment, we use inflation and industrial production data for the euro area. We also employ 2-year/2-year inflation expectations for filtering the sentiment indices from the proxy of medium-term inflationary pressures in the euro area.

We cross-check our results with sentiment indices provided by the KOF institute and Parle (2022). KOF has produced ECB communication sentiment since 1999. This is calculated by aggregating statements on price stability from ECB press conferences. The DTM (Dynamic topic modelling) Hawk-Dove sentiment index produced by Parle (2022) is constructed by applying topic modelling and modifying the sentiment calculation approach depending on the topic.

3.2 Methodology

Data pre-processing

We pre-process the raw data in order to apply text analysis. First, we remove journalists' questions from the Q&A session of the press conference so that we can focus solely on the messages provided by ECB officials. Second, we apply some standard text cleaning procedures. We switch all capital letters to lower case and delete all special characters and punctuation – e.g., commas, exclamation points, excess spaces, quotation marks and numbers. Third, we omit all stop words, which are functional words in every article that do not represent content (e.g., a, the, of, to, was). Fourth, following Parle (2022), we combine some words into *ngrams*, as they usually go together. For instance, the words "Governing" and "Council" would be captured as one ngram: "Governing_Council".

For topic analysis using Latent Dirichlet Allocations (LDAs), we perform additional steps. We unify words by essentially truncating the word ending, leaving only its stem – for example, "inflation" becomes "inflat". Hyperparameters in LDA analysis are selected with an alpha of 0.5, and $K = 16$ – i.e., we distinguish 16 topics. We then separate topics that are likely to be the most important for financial markets. As was noted by Jurkšas et al. (2022), speeches on unconventional measures, price stability mandate and interest rates tend to be associated with stronger market movements. Based on LDA, in this study we find topics that reflect these abovementioned areas. We then calculate the probabilities of paragraphs belonging to each of these topics (topics with less than the threshold value of 20% probability are treated as 0). We then retain only those speeches that have paragraphs with at least a 50% probability of being in the four selected topics (and use only those paragraphs in the calculation of a particular sentiment).

Sentiment methodology

We create sentiments using different lexicons produced manually from the most frequently used words in different communication events. In particular, we construct separate lexicons for original communication events (Annex 1) and media messages (Annex 2), as their writing styles tend to differ significantly from that of the ECB. For instance, ECB officials use more technical terms (e.g., macroeconomic projections, asset purchase programme), while media outlets tend to choose shorter synonyms (e.g., forecasts, QE). We then calculate sentiments using the Dictionary-Based Hawk-Dove Index methodology from Parle (2022), which in turn uses the dictionary from Tadle (2022). The proposed method separates the dictionary into four categories, distinguishing categorical words into (i) *hawkish* and (ii) *dovish*, as well as splitting polarised terms into (iii) positive and (iv) negative. We divide the pool of the most frequently used words in all communication events into these four categories. We also include some common variations of these words (e.g., improve, improved, improves, improving).

Next, we apply the following procedures for both original communication events and media messages. We look for words matching lexicon categories at the sentence level. We classify a sentence as *hawkish* overall if: i) it has more *hawkish* words than *dovish* words and more positive words than negative words; or ii) it has more *dovish* words than *hawkish* words and more negative words than positive words. Similarly, a sentence is classified as *dovish* if these conditions are reversed. *Hawkish* sentences are assigned a value of 1 and *dovish* sentences with minus 1. Sentences that have an equal amount of *hawkish* and *dovish* words, as well as sentences with an equal amount of positive and negative words, are given a value of 0.

In short:

Hawkish sentence = *hawkish* + positive *OR dovish* + negative;

Dovish sentence = *dovish* + positive *OR hawkish* + negative.

The final sentiment of a particular communication event is calculated as an average of sentiment scores across all sentences multiplied by 100.

This methodology takes into account combinations of words, and as a result is likely to have an advantage over more basic approaches distinguishing words into only two categories (e.g., positive and negative). Below, we provide a few examples of how this model works in practice:

1. The following is a clear example of a *dovish* sentence, as categorical words indicating higher economic activity (prices, growth, employment) go together with negative polarising words (fall, lower): "But if prices *fall* or stagnate for the wrong reasons, as is the case today, then they are typically the harbinger of *lower* future growth and employment." 24 November 2020, I. Schnabel.

2. The following sentence is also *dovish* due to the categorical word that indicates worse economic performance (unemployment) going together with positive polarising words (rose, high): "At the same time, the unemployment rate *rose* to very *high* levels in all these countries, with the rate of youth unemployment being more than double the overall one." 31 January 2014, B. Coeure.

3. We can apply the same principle for sentences in media articles (although lexicons are different). For instance, this sentence is categorised as *hawkish* due to the combination of "inflation" with a positive polarising word – "up": "Headline inflation has moved *up* quite sharply," Praet said. 23 February 2017, Reuters.

The separation of sentiment indices to the cyclical and trend components

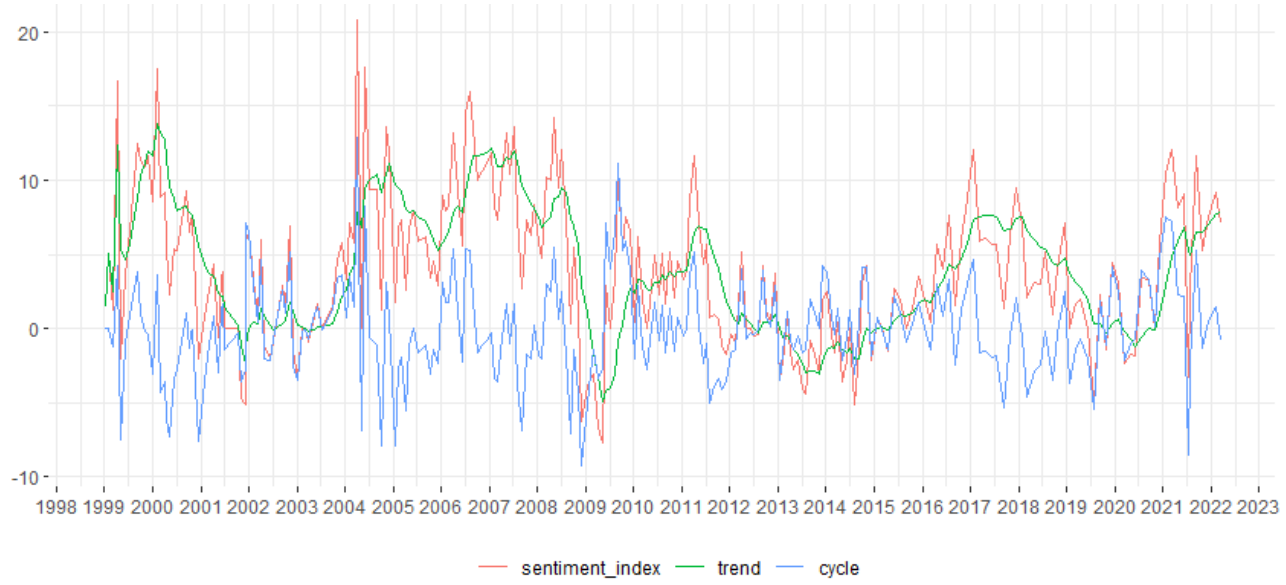
While constructed sentiment indices depict the overall stance of monetary policymaker(s), financial markets should actually be more affected by the changing nature of these sentiments over longer horizons. Therefore, it is essential to separate the long-term component (trend), which changes infrequently, from the shorter-term component (cyclical).

To separate these two components, we first extract the trend component with a one-sided Hodrick–Prescott (HP) filter.[7] As the more frequently used filter in similar types of research – the two-sided HP filter – uses forward information not available by markets participants at a given date, our analysis instead employs the one-sided version of the HP filter. The latter filter determines the trend component with all available information up to each time-series point (i.e., particular communication event). As a result, it is more volatile than the estimates from the two-sided filter – particularly at the start of the sample period.

An example of the separation of the press conference index into trend and cyclical components is shown in Figure 2. The original sentiment index is highly volatile, while the trend component changes the direction of *hawkishness*/*dovishness* less frequently – around every 2–3 years. Naturally, the cyclical component fluctuates from one press conference to another much more often than the trend component.

[7] The results do not change materially if another method is used to separate trend and cyclical components, such as the two-sided HP filter and the moving average approximation of the sentiment index.

Figure 2. The sentiment index of press conferences separated into cyclical and trend components



However, in order to find a sentiment index that would capture the sentiment surprise, which should have a more direct impact on markets, we also have to account for the future outlook of price stability. As the ECB's main goal is the inflation in the euro area in the medium-term, we also decided to filter the sentiment index for changing inflation expectations. To proxy the ECB's medium-term orientation, we additionally employ the indicator of 2-year/2-year inflation expectations.[8] This indicator serves as a forward-looking measure that is directly available to market participants at the time of the communication event.

Regression methodology

Therefore, we run the following regression to remove the trend and inflationary pressure components out of the original sentiment index:

$$MP\_Sentiment_t = \beta_0 + \beta_1 Sentiment\_Trend_t + \beta_2 Inflation\_2y2y_t + \varepsilon_t \text{ , where:} \quad (1)$$

- $MP\_Sentiment$ – the original sentiment index for a particular monetary policy communication event;
- $Sentiment\_Trend$ – the trend component extracted with a one-sided HP filter;
- $Inflation\_2y2y$ – the market-based 2-year/2-year inflation expectations in the euro area indicator;
- t – the time of a particular monetary policy communication event;
- ε_t – the residual that we use as a cyclical component in the following regressions.

The residual of this regression acts as a cyclical sentiment component that measures the surprise of a particular communication event and does not capture the evolution of inflationary pressures.

Then, we run a regression to estimate the relationship between sentiments and financial markets. Our baseline regression (the results of which are presented in section 4.3) with the cyclical component (i.e., residual from regression (1)) as the main explanatory variable has the following form when the control variable is also used:

[8] This indicator denotes market participants' expectations regarding potential 2-year average inflation that should persist after 2 years – i.e., average inflation in year 3 and 4 after that particular moment. For the robustness check, we also used the 5-year/5-year indicator, but the results did not change.

$$R_t = \beta_0 + \beta_1 Sentiment\_Cyclical_t + \beta_2 R\_control_t + \varepsilon_t \text{ , where:} \quad (2)$$

- R – the change of a particular financial market instrument: 2-year OIS rate, 10-year OIS rate, IT-DE 10-year sovereign bond spread, Eurostoxx50, bank stock index, EUR/USD exchange rate;
- t – the time interval around a particular monetary policy communication event;
- $Sentiment\_Cyclical$ – the cyclical component of the sentiment index for a particular monetary policy communication event (a residual from regression (1));
- $R\_control$ – the change of the control variable during period t for a particular euro area instrument: US 10-year OIS rate change for euro area yields, S&P 500 futures index change for euro area stock prices and EUR/USD exchange rate.

This type of regression is run separately: i) with or without the control variable; ii) for 6 different euro area financial market instruments; iii) for 3 different communication events – press conferences, accounts and Executive Board member speeches; and iv) for original communication events or media messages on those events. It is important to note that we use the cyclical component of a particular sentiment index rather than the actual index as in most cases the latter should not surprise the markets – only the changing nature of monetary policy stance (e.g., a sentiment that is different to the previous trend and inflationary pressures) should bear any meaningful effect.

In order to limit other market-moving factors (not related to ECB communication), we take a 10-minute period after the end or the release of a particular ECB monetary policy communication. For a press conference, we calculate the change in financial market indicators on the day of the press conference from 14:29 (i.e., 1 minute before the press conference) to 15:40 (i.e., 10 minutes after the press conference) Frankfurt time. For accounts, we calculate the change during the day of the release of the accounts from 13:29 (i.e., 1 minute before the release) until 13:40 (i.e., 10 minutes after the release). For non-periodical Executive Board member speeches, we calculate the change on the day of the speech from the time of the release of the media message until 10 minutes afterwards. For the robustness check, we tried other different periods too, including the periods used by Altavilla et al. (2019).

4. RESULTS

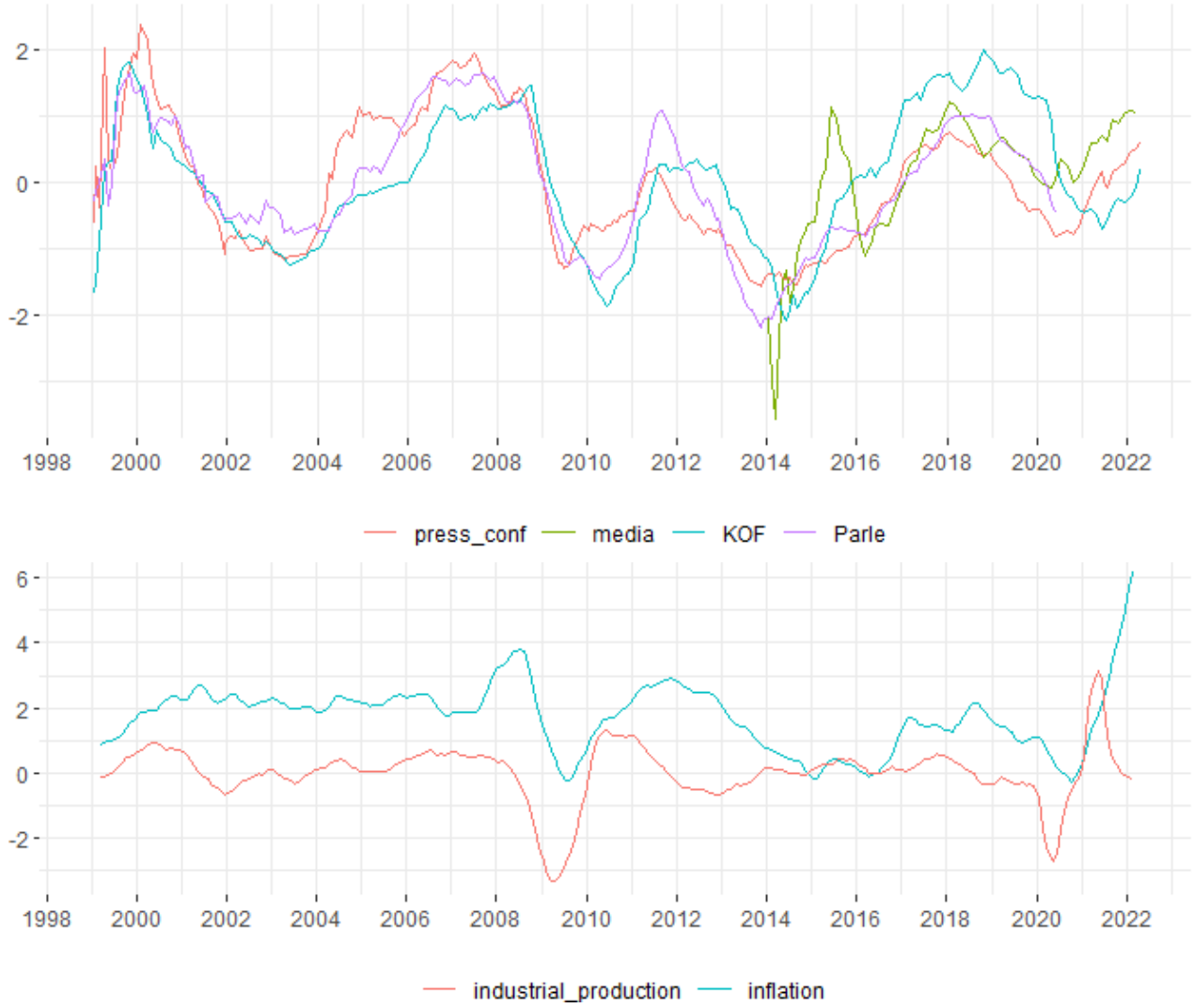
We provide the results of the paper from several perspectives. First, we present the results of sentiment analysis showing the trend dynamics of communication sentiments and compare them with the trends in monetary policy stance and macroeconomic environment. Such analysis does not aim to identify causal relationships, but rather shows whether communication sentiment goes in line with macroeconomic conditions. In the second part of this section, we look at the broader context behind some communication events and explain possible issues that should be addressed in regression analysis. The third part measures the effect of the cyclical component of sentiment on financial market indicators using regression analysis. The fourth part provides policy implications.

4.1 Sentiment indices

Press conferences

The trend dynamics of all four (two constructed by the authors of this paper and two by external researchers) standardised sentiment indices for press conferences are rather similar (Figure 3, upper chart). The correlation between the monthly averages of four trend sentiment indices varies between 0.7 and 0.8. The *hawkishness* of press conferences peaked four times during the review period: in 2000, 2007, 2011 and 2018 – i.e., at the end of periods of relatively strong economic growth and higher inflationary pressures. For instance, industrial production peaked in very similar periods, while inflation – as a lagging indicator – would often peak in a somewhat later period (Figure 3, lower chart). The correlation of press conference trend sentiments with the monthly inflation indicator and industrial production is around 0.4. Meanwhile, the largest *dovishness* of press conferences can also be observed in 4 periods: 2002–2003, 2009, 2013 and 2020, i.e., during economic downturns in the euro area (when industrial production growth become negative) followed by lower inflationary pressures. For instance, the start of the COVID-19 economic shock was marked by *dovish* sentiments when ECB monetary policy became extremely accommodative (including forward guidance), while the inflationary period after COVID-19 shock is characterised by increasingly *hawkish* rhetoric. Although all four indices move rather closely, the KOF index seems to be somewhat detached from other indices in some time-periods when the tightening rhetoric of press conferences was on the rise – e.g., in 2005–2007 and 2015–2019. The original sentiment indices for press conferences are much more volatile (see Annex 3), and thus it is harder to understand underlying dynamics than with trend indices. The correlation between original sentiment indices is naturally somewhat smaller.

Figure 3. The trend dynamics of four standardised sentiment indices for press conferences (upper chart) and y-o-y changes of industrial production and prices in the euro area (lower chart)

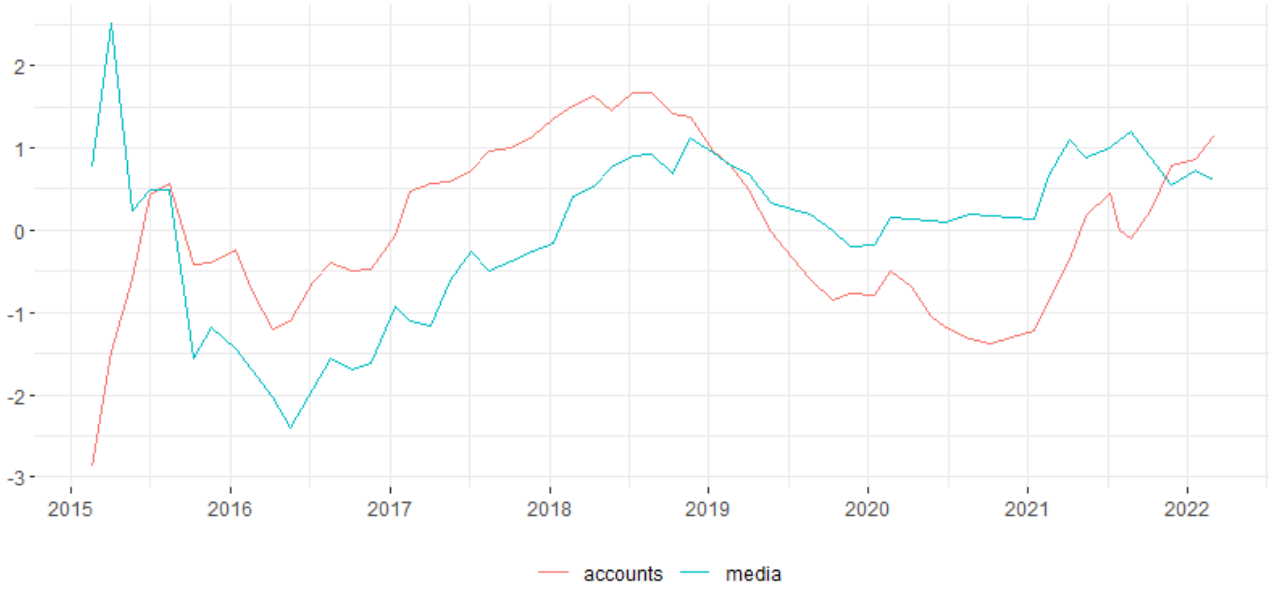


Notes: Each trend sentiment index is scaled and centred for the purposes of comparison. The Parle (2022) index ends in mid-2020, while the media index starts in 2014. A moving average is used for the inflation and industrial production series.

Accounts

The trend dynamics of two constructed sentiment indices for accounts also exhibit similar dynamics and high correlation, although there are some important differences (Figure 4). The peak (in 2018) and trough (in 2020) are the same for both constructed accounts' indices, and are the same as with press conferences. For instance, the COVID-19 shock led to relatively *dovish* accounts. However, the media index exhibits more local minimum (in 2016) and maximum (in 2021) values. These troughs and peaks highly resemble the minimum/maximum values of industrial production, and somewhat lead the inflation momentum. The original sentiment indices for accounts reveal more volatile dynamics, and thus the correlation is somewhat smaller (see Annex 4).

Figure 4. The trend dynamics of two standardised sentiment indices for accounts

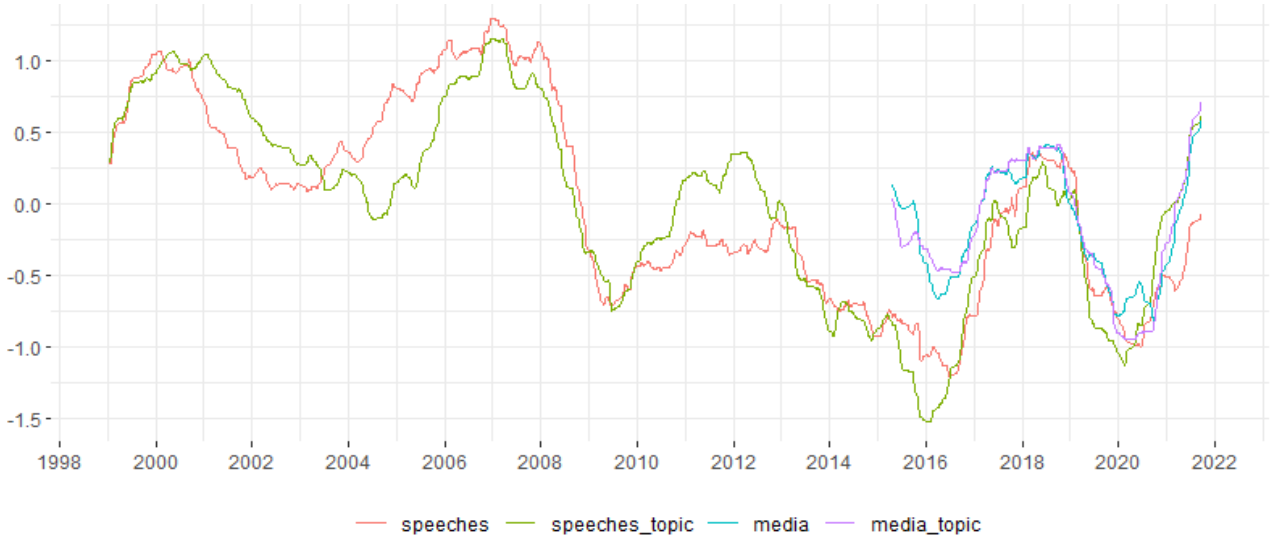


Notes: Each sentiment index is scaled and centred for comparison purposes.

Speeches

The sentiment trend dynamics are more volatile and diverging for different speeches' indices (Figure 5). The highest peak (tightening rhetoric) periods were in 2000, 2007, 2011, 2018 and 2021–2022, while the lowest (easing rhetoric) were in 2003, 2009, 2016 and 2020. Importantly, these periods also closely relate to the changes in euro area economic activity. Although the overall tone of ECB communication was *dovish* at the end of 2014 and the start of 2015, the media also picked up on some *hawkish* signals. For instance, on 26 September 2014 it was printed that Executive Board member B. Coeure had remarked that "banks are in a stronger position to lend after ECB health checks", and on 9 October 2014 President M. Draghi was quoted as saying that lending will pick up in 2015. The COVID-19 shock led to the very *dovish* rhetoric of Executive Board members, but soon this changed with increasing inflationary pressures. The dynamics of original sentiment indices are again even more volatile than the trend component (see Annex 5).

Figure 5. The trend dynamics of four standardised sentiment indices for speeches

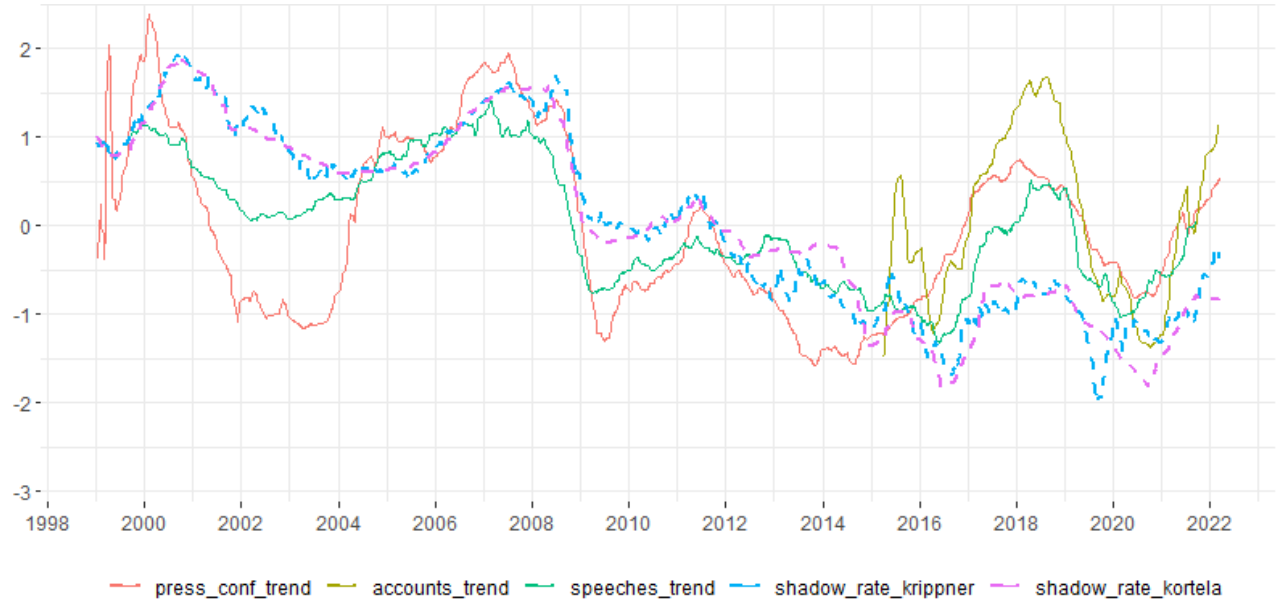


Notes: Each sentiment index is scaled and centred for comparison purposes, and a moving average is applied.

Shadow rates and three different types of ECB communication event

The trend dynamics of sentiment indices for all three communication events are rather similar and closely resemble the movements of shadow rates, although the latter are overall trending downwards (Figure 6). Shadow rates (both those constructed by Krippner (2015) and Kortela (2016)) particularly resemble the sentiment index of the most frequent ECB monetary policy event – i.e., speeches. The correlation between monthly values of shadow rate and average speech sentiment is over 0.6, but is somewhat smaller with other communication events (around 0.5). Interestingly, communication indices often seem to change direction earlier than shadow rates – i.e., actual monetary policy actions. For instance, the peak of press conference and speech sentiment was observed in 2007, while shadow rates peaked in the first half of 2008. This is also confirmed by the correlation between the monthly averages of shadow rates and the lagged values of communication sentiments: the correlation somewhat increases up until the 5th–7th monthly lag of press conferences and speeches (that have longer time-series values).

Figure 6. The trend dynamics of standardised sentiment indices for three different monetary policy events and shadow rates



Notes: each index is scaled and centred for comparison purposes, and a moving average is applied for speeches. The shadow rate was constructed by Krippner (2015) and Kortela (2016).

There are some episodes of divergence between communication sentiment and shadow rates (2001–2002, 2004 and 2017–2018) that require additional explanation:

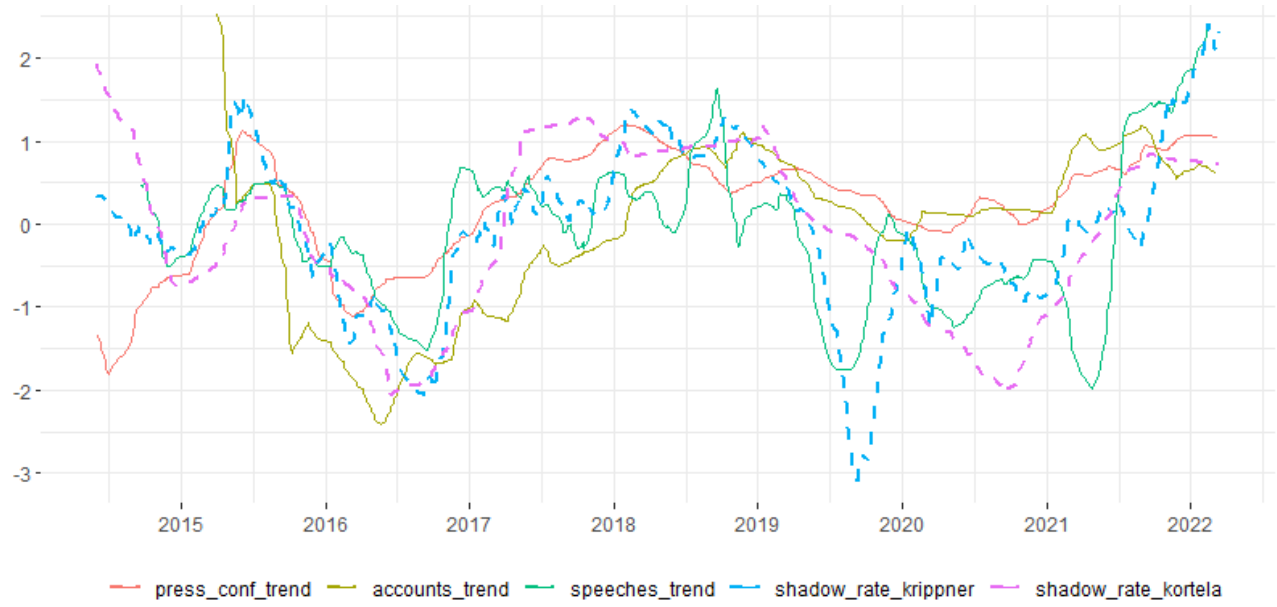
- The negative sentiment with relatively high shadow rates in 2001–2002 can be explained by sluggish economic activity following negative supply shocks (as is visible in the industrial production data in the lower chart of Figure 4). In this environment, monetary policy has a reduced ability to act, as was clearly explained by former President of the ECB Wim Duisenberg in a June 2002 press conference: *"I am referring to two oil price hikes, which we can explain but which we cannot take away and about which we can do*

nothing using monetary policy. So in a certain sense we have been disarmed of the weapons we use to fight inflation."

- Sentiment increased in 2004 as headline inflation remained above 2% in the euro area for a couple of years from April. Higher inflation was addressed in monetary policy communication events – even though, initially, interest rates did not increase.
- The strong increase in sentiment in 2017–2018 relates to robust economic growth (real annual GDP growth above 2% from 2016Q4 to 2018Q2) and increasing confidence that inflation would converge with the ECB's inflation target. This period involved some phasing out of unconventional monetary policies (lower net asset purchases), which is depicted by the slowly increasing shadow rate.

The dynamics of different sentiment indices are also rather similar for media reactions since 2015, although volatility is quite different (Figure 7). The monthly values of media sentiment for ECB press conferences and accounts are more similar, with a correlation above 0.6. Trends in the sentiment of media messages from press conferences and accounts are also rather slow-moving. Meanwhile, ECB speeches' media trend is much more volatile and tracks the shadow rates rather closely – their correlation is close to 0.7. Importantly, the sentiments of media messages after Executive Board speeches seem to change somewhat earlier (up to the 3rd lag of monthly values) than the actual monetary policy stance characterised by shadow rates.

Figure 7. The shadow rate and the trend dynamics of standardised sentiment indices for three different monetary policy media events



Notes: each index is scaled and centred for comparison purposes and a moving average is applied for speeches. The shadow rate was constructed by Krippner (2015) and Kortela (2016).

4.2 Event-by-event analysis of ECB communication events

In this section, we apply a case-by-case analysis of ECB communication events, aiming to better understand the drivers of sentiment indices as well as the resulting market reactions. By looking deeper into ECB communication events that are followed by large repricing events in financial markets, we aim to explore causal relationships that we further investigate in the next section using regression analysis.

First, it is important to note that in order to correctly determine the effect of the sentiment index on repricing in financial markets, both of the following conditions have to be satisfied: i) the sentiment index has to appropriately represent the tone of the communication event; and ii) the financial market reaction has to be induced by the communication event in a logical manner. We manually analyse some ECB communication events in order to assess whether both of these conditions hold. Overall, although many cases are followed by expected market reactions, we also detect some possible issues with the automated creation of sentiment indices in other cases.

The rationale behind market reactions

We expect the sentiment that we estimate to affect market expectations regarding future policy rate and unconventional monetary policy measure outlook. These changes are expected to be reflected in OIS rates. However, several studies show that communication sentiment may also affect stock prices (e.g., Schmeling & Wagner, 2019; Parle, 2022). The explanation for this could be twofold. First, monetary policy intentions can be perceived as news about the economy instead of policy reaction function, indicating information shock. Second, lexicons that are used to calculate policy sentiment have words related to the macroeconomic environment; therefore, they can directly address economic outlook and consequentially affect stock prices.

Although in this section we will focus more on the effects of sentiment on OIS rates, effects on stock prices cannot be ruled out and are mentioned in particular instances. As an example, we can use the press conference on 25 July 2019 where M. Draghi provided strong negative indications about the economic outlook, but at the same time offered a *hawkish* message that the rate cut had not been discussed. OIS rates increased following the meeting, while stock prices declined, indicating that the markets incorporated both messages. Our sentiment indicators are strongly *dovish* for this meeting, leaning more towards the messages offering a negative economic outlook.

Cases where the sentiment index fails to represent the tone of a communication event

As was shown in section 4.1, the trends of our communication sentiment indices closely follow economic-monetary cycles and are comparable with sentiment indices from other sources. Correlation with the shadow rate also shows that our sentiment indices on average reflect the ECB's monetary policy stance. However, this does not necessarily hold for every communication event. By performing meeting-by-meeting case analysis, we suggest several reasons as to why this may be the case.

First, the scarcity of data and the complex language used sometimes leads to the misinterpretation of some events (e.g., P. Praet's speech on 11 March 2015[9]). Such situations are especially impactful for events with less textual information (e.g., media reaction to speeches), while for actual transcripts from the ECB's website (which are usually much longer) such misinterpretations are less likely to have a material effect. Second, the sentiment of the ECB communication event may be determined by very specific policy hints, while the majority of the content is often expected and does not provide additional information about policy stance. We find that such a situation occurred in the press conferences held on 16 December 2021 and on 4 September 2014. Third, misinterpretation of sentiment is more likely when the undertaken policy measures are less significant than expected, or when some expected elements are missing. We find that such cases occurred in the press conferences held on 3 December 2015 and on 6 February 2014.

[9] We substantiate our arguments in this section regarding specific communication events in Annex 6.

Cases when there is an unexpected market reaction to communication events

We also find occasions when market indicators moved due to external factors, or did not move in line with sentiments. Although we take relatively short timespans around particular communication events for financial market data changes, there is still the possibility that some global events may occur contemporaneously. A notable example is US initial jobless claims data, which, within the analysed period, was released at the time of an ECB press conference. A number of studies using high-frequency data aim to control for this data release.

Unfortunately, this may not be the only unexpected circumstance. For instance, US President Donald Trump's announcement of a travel ban at the beginning of the COVID-19 pandemic (12 March 2020) may have been a major contributor to the decline of European stocks and OIS rates during the ECB press conference on that day. For other communication events, we can observe that on 8 May 2015 news about ECB Vice-President V. Constancio's speech was overshadowed by a weak US jobs report. By observing US 10y OIS moves that are similar to or even larger than euro area 10y OIS moves, we can be quite confident that these market repricing events are the result of events not related to the euro area.

Therefore, it is essential to include proper control variable(s) in the regression analysis.

Cases with expected sentiment indexes and market reactions

In spite of the abovementioned issues, we can also identify clear examples where sentiment indices catch the tone of a communication event and induce the expected effect on financial markets. Such cases are observable across monetary policy communication events, types of messages and financial market indicators.

We find cases where the market reaction seems in line with the sentiment of the monetary policy message. OIS rates declined on 8 May 2014 and 21 January 2016 as the ECB expressed a willingness to ease monetary policy in the next meeting. Similarly, rates fell on 22 January 2015 after the announcement of higher-than-expected volumes of bond purchases. The opposite reaction was observed on 9 March 2017 after the ECB removed the reference to urgent (accommodative) action and the need to use all instruments. A *hawkish* reaction was also observable after accounts were released on 11 January 2018, indicating that *dovish* forward guidance may be adjusted.

On multiple occasions financial markets appeared to react to updated ECB views on macroeconomy. For instance, on 25 January 2018, 10y OIS rates climbed significantly as President M. Draghi expressed confidence that inflation would increase towards the 2% level. After a 7 March 2019 ECB press conference, 10y OIS rates and stock prices fell following the announcement of lower GDP and inflation forecasts. On 24 September 2018, 10y OIS rates increased after positive elements of a speech given by M. Draghi on wage growth and vigorous inflation.

4.3 Regression analysis

Press conferences

The regression analysis revealed that there are several euro area financial instruments that seem to have been impacted by the sentiments of ECB press conferences on an intraday basis since 2014 (Table 2). Although the majority of regression specifications do not exhibit statistically significant effects, there are some notable cases for the impact of the sentiment index. In particular, the cyclical component of the sentiment index for press conferences has a significant direct effect on euro area bank stock prices (and in one case, on the overall stock

index). This is confirmed both by our own original press conference sentiment indices as well as by the Parle (2022) index with and without control variables. These results are also consistent with Schmeling & Wagner (2019) as well as Apergis & Pragidis (2019).

Euro area risk-free rates (and thus fiscal costs) seem not to have been affected by the constructed sentiment indicators of the press conference. This might be related to the fact that market rates are usually impacted immediately when monetary policy decisions are announced[10] – i.e., before the press conference (Jurkšas et al., 2022). This might also imply an information-type shock in the market's reaction when, for instance, the positive sentiment of policymakers is regarded as implying a more positive outlook for economic and/or financial developments.

Table 2. The results of regression models for the cyclical component of the press conference sentiment index on different euro area markets since 2014

instrument	variable	press_conf	press_conf control	media	media_ control	KOF	KOF_ control	Parle	Parle_ control
OIS2Y	estimate	−0.002	−0.0118	−0.002	0.0039	−1.216	−1.037	−0.0035	−4e-04
	p-value	(0.977)	(0.84)	(0.925)	(0.815)	(0.228)	(0.237)	(0.78)	(0.974)
	R^2	0	0.2576	2e-04	0.2554	0.0233	0.2753	0.0016	0.2743
	DoF	63	62	59	58	62	61	48	47
OIS10Y	estimate	−0.0276	−0.0517	0.0066	0.0205	−1.759	−1.318	−0.0029	0.0059
	p-value	(0.794)	(0.428)	(0.826)	(0.265)	(0.269)	(0.18)	(0.898)	(0.652)
	R^2	0.0011	0.6278	8e-04	0.6306	0.0197	0.6351	3e-04	0.6671
	DoF	63	62	59	58	62	61	48	47
IT-DE spread	estimate	−0.2935	−0.292	−0.046	−0.047	5.308	5.2845	−0.0678	−0.0695
	p-value	(0.189)	(0.195)	(0.465)	(0.457)	(0.115)	(0.12)	(0.166)	(0.161)
	R^2	0.0273	0.0278	0.0091	0.0104	0.0396	0.04	0.0395	0.0443
	DoF	63	62	59	58	62	61	48	47
Stocks	estimate	0.039	0.0206	0.0022	0.0075	0.2443	0.1176	**0.0115**	0.0065
	p-value	(0.123)	(0.278)	(0.754)	(0.148)	(0.527)	(0.681)	**(0.027)****	(0.103)
	R^2	0.0373	0.4726	0.0017	0.4867	0.0065	0.4637	0.0973	0.4928
	DoF	63	62	59	58	62	61	48	47
Bank_ stocks	estimate	**0.1061**	**0.0743**	−0.006	0.003	0.6977	0.4739	**0.0315**	**0.0233**
	p-value	**(0.026)****	**(0.05)****	(0.651)	(0.777)	(0.342)	(0.41)	**(0.001)*****	**(0.002)*****
	R^2	0.0758	0.4342	0.0035	0.3966	0.0146	0.4062	0.2151	0.5303
	DoF	63	62	59	58	62	61	48	47
EUR/ USD	estimate	−0.0212	−0.0181	−0.002	−0.003	−0.286	−0.264	−0.0024	−8e-04
	p-value	(0.257)	(0.334)	(0.742)	(0.606)	(0.311)	(0.348)	(0.545)	(0.837)
	R^2	0.0203	0.042	0.0018	0.0323	0.0165	0.0419	0.0077	0.0805
	DoF	63	62	59	58	62	61	48	47

[10] It is important to note that these results are likely to depend on the construction of the sentiment index. Using the same lexicon as in Parle (2022), we find a statistically significant effect on OIS rates, but a weaker relation with stock prices.

Notes: The control variables (in the regressions specified in the top row) are the US 10-year yields (for EA yields) and US S&P 500 futures (for EA stocks and EUR/USD). The estimate of the intercept and control variables (when used) are not shown due to brevity. Asterisks indicate statistical significance at the 10% (*), 5% (**) and 1% (***) levels. DoF denote degrees of freedom.

The majority of observed significant links are also confirmed for the longer sample period, with different intervals around each press conference[11] as well as when the two-sided HP filter is used. Importantly, there are somewhat more statistically significant links in the longer period than since 2014, potentially meaning that with the introduction of explicit forward guidance ECB communication has become less surprising to the markets (Parle, 2022). Other studies analysing earlier periods also found statistically significant effects of ECB communication events on interest rates (Musard-Geis, 2006; Gertler & Horvath, 2018). We have also tried to use longer time intervals before and after each press conference, as in Altavilla et al. (2019), but even so the results would still reveal the same statistically significant variables (with one additional weakly significant variable of the 10-year OIS rate for the KOF sentiment index). The robustness check with the two-sided HP filter (instead of the one-sided filter and correction for inflation expectations) exhibits similar results – i.e., a strong effect on bank stock prices, although overall euro area stock prices are more often statistically significant (see Annex 7).

Accounts

There is only one statistically significant effect of monetary policy account sentiment on financial markets (Table 3). Media messages seem to directly affect IT-DE bond spread. This means that the more *hawkish* the media message, the more the IT-DE spread increases. However, this effect is rather weak and is observable only for the media reaction when the control variable is included in the regression. The accounts of ECB meetings are rather long, are often hard to understand, and are published after a rather long time period, so it is not surprising that the sentiments of original accounts have no statistically significant effect. This result is also confirmed when the trend and cyclical component is extracted with a two-sided HP filter (see Annex 8). Surprisingly, there is some evidence that FOMC minutes' sentiments have a statistically significant association with the fed funds futures and USD exchange rate (Tadle, 2022).

[11] The results can be provided upon request.

Table 3. The results of regression models for the cyclical component of the account sentiment index on different euro area markets since 2015

instrument	variable	accounts	accounts_ control	media	media_ control
OIS2Y	estimate	−0.0059	−0.0069	0.0021	0.001
	p-value	(0.548)	(0.481)	(0.391)	(0.682)
	R^2	0.0065	0.038	0.0145	0.0615
	DoF	56	55	51	50
OIS10Y	estimate	0.0094	0.004	0.0027	−0.0027
	p-value	(0.495)	(0.691)	(0.491)	(0.351)
	R^2	0.0083	0.4696	0.0093	0.4847
	DoF	56	55	51	50
IT-DE spread	estimate	0.0023	0.0052	0.0072	**0.0108**
	p-value	(0.908)	(0.792)	(0.205)	**(0.059)***
	R^2	2e-04	0.0631	0.0313	0.1279
	DoF	56	55	51	50
Stocks	estimate	0.0016	−0.0013	−4e-04	−8e-04
	p-value	(0.527)	(0.501)	(0.605)	(0.116)
	R^2	0.0072	0.4636	0.0053	0.4911
	DoF	56	55	51	50
Bank_stocks	estimate	0.0054	0.002	7e-04	1e-04
	p-value	(0.229)	(0.627)	(0.601)	(0.913)
	R^2	0.0257	0.2238	0.0054	0.2192
	DoF	56	55	51	50
EUR/USD	estimate	0.0019	0.0028	1e-04	3e-04
	p-value	(0.356)	(0.187)	(0.801)	(0.658)
	R^2	0.0152	0.073	0.0013	0.0436
	DoF	56	55	51	50

Notes: The control variable (in the regressions specified in the top row) are the US 10-year yields (for EA yields) and US S&P 500 futures (for EA stocks and EUR/USD). The estimate of the intercept and control variables (when used) are not shown due to brevity. Asterisks indicate statistical significance at the 10% (*), 5% (**) and 1% (***) levels. DoF denote degrees of freedom.

Speeches

On average, the sentiments of the speeches made by ECB Executive Board members rarely have a statistically significant effect (Table 4). The clear exception is the OIS rate, which bears a statistically significant effect from media reaction and/or the original speeches of ECB Executive Board members. This effect is more evident for short-term OIS rates and thus is consistent with the findings of Gertler & Horvath (2018), who also show a positive reaction to *hawkish* messages. This implies that the speeches of ECB Executive Board members might carry hints regarding monetary policy stance that are important for market participants. However, the estimates are on average rather small, so the effect is related only to some particular speeches (as was shown in section 4.2). The negative effect on IT-DE spread is rather surprising, and may be explained with positive aspects on

economic outlook, increasing confidence in the sustainability of the euro area as a whole. However, this effect is only visible for less than half of the different types of speech sentiments. The sentiments of media topics related to monetary policy also have a direct effect on the change of EUR/USD exchange rate. This is not surprising, as more *hawkish* messages should naturally lead to a stronger domestic currency.

Byrne et al. (2023) showed the importance of information deficit for financial markets alongside a higher similarity score between speeches and press conference answers over the period analysed in this study. This may imply that speeches partially repeat the information provided in press conferences, and this could be one of the ways to explain the lack of statistically significant results.

Table 4. The results of regression models for the cyclical component of the Executive Board member speech sentiment index on different euro area markets since August 2014

variable		speeches	speeches _control	speeches _topic	speeches_ topic_contr	media	media_ control	media_ topic	media_topi _control
OIS2Y	estim.	**0.0179**	**0.0172**	**0.0066**	**0.0065**	9e-04	0.001	0.0019	**0.0021**
	p-value	**(0.002)*** **	**(0.003)*** **	**(0.053)***	**(0.058)***	(0.395)	(0.346)	(0.135)	**(0.096)***
	R^2	0.0298	0.0345	0.0159	0.0216	0.0021	0.0105	0.0119	0.0321
	DoF	321	315	235	232	341	335	188	186
OIS10Y	estim.	**0.0078**	0.0055	0.0019	0.0011	2e-04	5e-04	−3e-04	5e-04
	p-value	**(0.1)***	(0.144)	(0.502)	(0.611)	(0.843)	(0.48)	(0.748)	(0.526)
	R^2	0.0084	0.3988	0.0019	0.4236	1e-04	0.346	6e-04	0.424
	DoF	321	315	235	232	341	335	188	186
IT-DE spread	estim.	**−0.015**	**−0.0134**	**−0.0081**	−0.0076	0.0015	0.0012	0.0015	7e-04
	p-value	**(0.068)***	**(0.098)***	**(0.098)***	(0.103)	(0.307)	(0.393)	(0.502)	(0.741)
	R^2	0.0104	0.0818	0.0117	0.1041	0.0031	0.058	0.0024	0.091
	DoF	319	313	233	230	339	333	187	185
Stocks	estim.	−5e-04	−6e-04	4e-04	7e-04	2e-04	1e-04	−1e-04	2e-04
	p-value	(0.727)	(0.575)	(0.595)	(0.286)	(0.417)	(0.67)	(0.789)	(0.457)
	R^2	5e-04	0.4049	0.0016	0.3492	0.0025	0.4002	5e-04	0.4032
	DoF	254	253	181	180	269	268	146	145
Bank_ stocks	estim.	−0.0019	−0.002	0.0016	0.0019	1e-04	0	0	3e-04
	p-value	(0.49)	(0.42)	(0.293)	(0.176)	(0.769)	(0.987)	(0.994)	(0.596)
	R^2	0.0019	0.1449	0.0061	0.1285	3e-04	0.1428	0	0.1299
	DoF	253	252	180	179	268	267	145	144
EUR/ USD	estim.	7e-04	6e-04	4e-04	4e-04	0	0	**2e-04**	2e-04
	p-value	(0.29)	(0.299)	(0.266)	(0.264)	(0.913)	(0.95)	**(0.094)***	(0.103)
	R^2	0.0035	0.0046	0.0053	0.007	0	0.0013	0.0149	0.0174
	DoF	321	320	235	234	341	340	188	187

Notes: The control variable (in the regressions specified in the top row) are the US 10-year yields (for EA yields) and US S&P 500 futures (for EA stocks and EUR/USD). The estimate of the intercept and control variables (when used) are not shown due to brevity. Asterisks indicate statistical significance at the 10% (*), 5% (**) and 1% (***) levels. DoF denote degrees of freedom.

For the robustness check, we re-run the regressions on speeches with different time intervals around the media event, for different ECB Executive Board members, and for different filtering procedures of the cyclical component. The results reveal that when a shorter period after a particular speech (e.g., 2 minutes) is used, the effect on OIS rates is even more widespread, while the impact might diminish when periods longer than 10 minutes are used.[12] This might mean that the markets often overreact to a particular media message after an ECB speech, but self-correct in the longer-run, or might imply that the signal becomes blurred due to the new incoming information. Meanwhile, the analysis of different ECB Executive Board members showed that several members in particular – e.g., Mario Draghi and Vítor Constâncio – have a more pronounced effect on euro area market indicators. We have also checked for potential anticipation effects (by including the change during the same time interval of a particular market indicator before the ECB communication event), but the main results of the regression analysis did not change materially. The main findings also hold when we change the one-sided and inflation expectations' filtering procedures with a two-sided HP filter (see Annex 9).

4.4 Policy implications

There are several important policy implications that follow from this research.

Our results imply that the sentiment of media coverage reflects the sentiment of actual communication of policy makers quite well. The media trend closely follows the trend of original communication events, despite the fact that communication languages and lexicons differ significantly. The correlation coefficient between the sentiments of original communication events and that of the media is also high. This holds true for press conferences, speeches and accounts. If policy makers decide to shift the communication tone, it is likely to be accurately reflected in media coverage.

Shifts in communication can predate actual monetary policy actions. We show that communication tone generally shifts in advance of the monetary policy stance indicator. Communication sentiment also correlates with macroeconomic developments. This implies that, amidst a changing macroeconomic environment, shifts in policy communication followed by policy decisions can be expected – this is the reason why we include inflation expectations in the filtering procedure of the cyclical component. By adjusting their communication, central banks can steer expectations on upcoming policy decisions in their intended direction.

Policy makers should also be aware that their communication tone may affect the financial markets. We find some evidence of this in both regression analysis and event-by-event analysis. At the same time, markets sometimes look for very specific policy details, hints, or even missing information. Such details often outweigh the broader tone of communication.

5. CONCLUSIONS

Using minute-by-minute financial market data from the Thomson Reuters Tick History database, media messages from Refinitiv Eikon, and transcripts from the ECB website, we shed some new light on the sentiment of the ECB's communication and its effect on financial markets. We calculated sentiments by adapting the lexicon used for US FED communication. Importantly, to make our study more suitable for the euro area, we

[12] The results can also be provided upon request.

deviated from this lexicon by including words that we found to be most frequently used in different ECB communication events. We also created separate lexicons for original communication transcripts and media messages interpreting these communication events. We studied the relationship between sentiment and financial markets using regression analysis, and by performing an event-by-event analysis of key communication events.

We found that the dynamics of the constructed sentiment indices for analysed communication events were rather similar and resembled the movements of monetary policy stance. This finding holds both for different types of events (press conferences, accounts and speeches), different text sources (original transcripts and media messages) and different periods (start of asset purchases, before and after COVID-19 shock). Trends in media sentiments actually tended to reveal the overall sentiments of the original texts of ECB communication, and the correlation coefficient with the original sources was rather high. Communication sentiment trends were also highly correlated with actual levels of industrial production, inflation, and shadow rates. This indicates that the constructed sentiment indices reflect macroeconomic dynamics and monetary policy stance.

After a closer look at the construction of sentiments on a case-by-case basis, we found some technical issues that have to be taken into account. First, policy signals can be multidimensional, indicating monetary policy or information surprises and invoking different market reactions. Second, the scarcity of data and complex language of communication may lead to the misinterpretation of some communication events. Additionally, there are factors blurring the effects of communication sentiment on financial markets. For instance, even when a short time window is used, there are cases of external events affecting financial markets contemporaneously. We aimed to resolve some of these difficulties using regression analysis. In particular, we accounted for trend and inflationary pressures to address the issue of expected sentiment, and also included US control variables to address the effects of external events.

Although the sentiments of the majority of communication events do not seem to have impacted financial markets, we found several important effects. The sentiment of press conferences was positively related to changes in bank stock prices. This is consistent with the findings of several other studies (e.g., Schmeling & Wagner, 2019; Apergis & Pragidis, 2019) and implies a potential information shock reaction – e.g., when a *hawkish* signal may be understood as providing positive news on the economy. We also found a somewhat positive relation between the sentiment of Executive Board members' speeches and short-term OIS rates (as in Hayo et al., 2014; Hubert & Labondance, 2020). This means that more *hawkish* messages could lead to higher fiscal costs among euro area member states, although fragmentation issues do not seem to be negatively affected. We did not consistently find effects on monetary policy accounts. Various robustness checks confirm these findings, with some small exceptions.

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Annex 1.

Lexicons from the original texts of ECB officials.

Hawkish:

activity	financing_conditions	loans
annual_growth	firms	macroeconomic_projections
business	gdp	markets
confidence	growth	outlook
credit	headline_inflation	output
demand	hicp	price
economy	income	prices
economic_growth	inflation	private_sector
economies	inflation_expectations	projection
employment	inflation_rates	projections
expansion	interest_rate	rate
expectations	interest_rates	rates
financial_conditions	investment	real_economy
financial_market	job_creation	recovery
financial_markets	labour	situation
financial_system	labour_market	stability
financial_stability	liquidity	wage

Dovish:

asset_purchases	issue	risks
challenge	issues	stress
challenge	loss	turbulence
challenges	losses	uncertainty
challenges	problem	uncertainties
concerns	problems	unemployment
crises	programme	volatility
crisis	recession	
fragmentation	risk	

Positive:

better	good	growing
favourable	grew	grows
favourably	grow	high

higher	large	strong
improve	larger	stronger
improved	positive	strongly
improves	rise	sustainable
improving	rises	up
increase	rising	upside
increased	rose	upswing
increases	stable	uptick
increasing	strengthen	
increasingly	strengthens	

Negative:

adverse	falling	reduce
decline	fell	reduced
declined	lack	reduces
declining	less	reducing
decrease	limited	slide
difficult	low	small
end	lower	smaller
fall	negative	vulnerable

Annex 2.

Lexicons for media messages

Hawkish:

activity	growth	prices
conditions	inflation	projection
confidence	lending	projections
demand	loans	rate
economy	outlook	rates
forecasts	output	recovery
gdp	price	

Dovish:

accommodation	purchase	shock
buying	purchases	stimulus
measures	qe	uncertainties
pepp	recession	volatility
programme	risk	war
programmes	risks	

Positive:

above	increase	rebound
boost	lift	rise
climb	more	rising
expand	over	strength
further	positive	strong
high	raise	stronger
higher	raised	up
hike	raising	

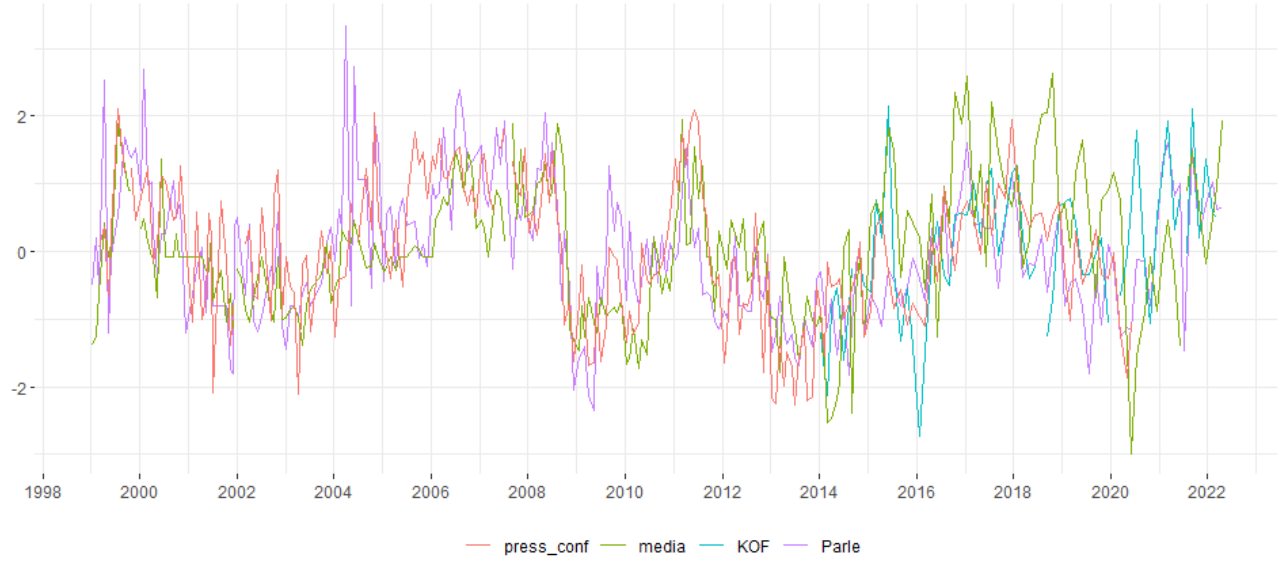
Negative:

accommodative	down	loose
against	downside	loosen
back	drop	low
below	fall	lowered
cut	falling	lows
decrease	less	minus

negative	slow	trim
no	slowdown	weak
not	slowly	worse
off	stop	worsening
reduce	subdued	
reducing	threat	

Annex 3.

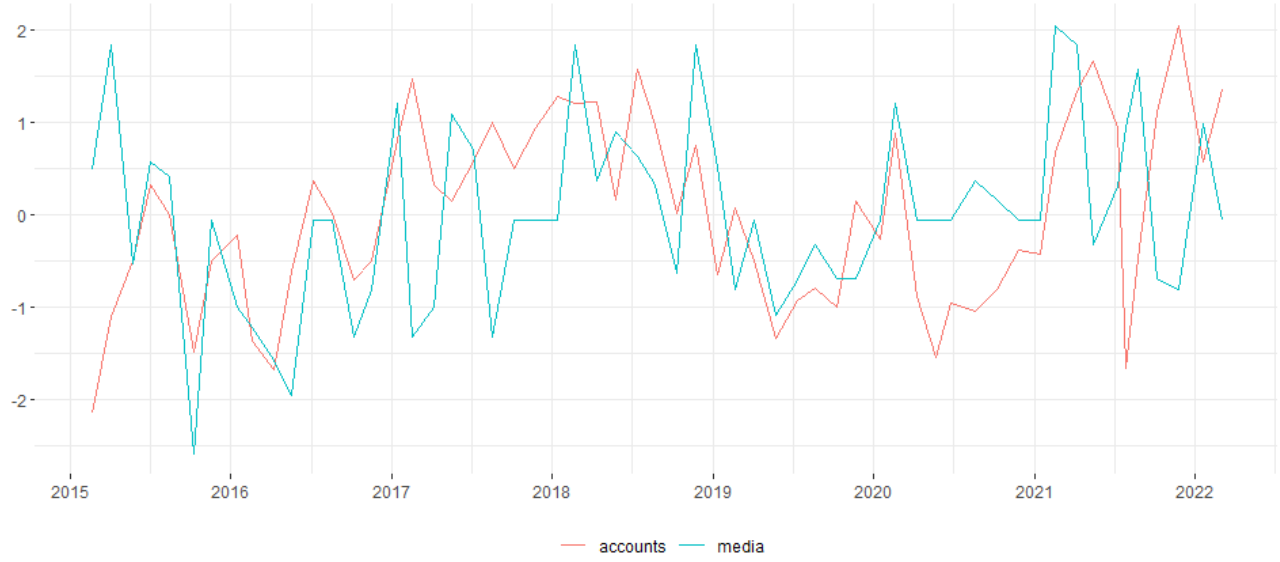
Dynamics of sentiment indices for press conferences



Notes: the indices are scaled and centered (separately) for easier comparison.

Annex 4.

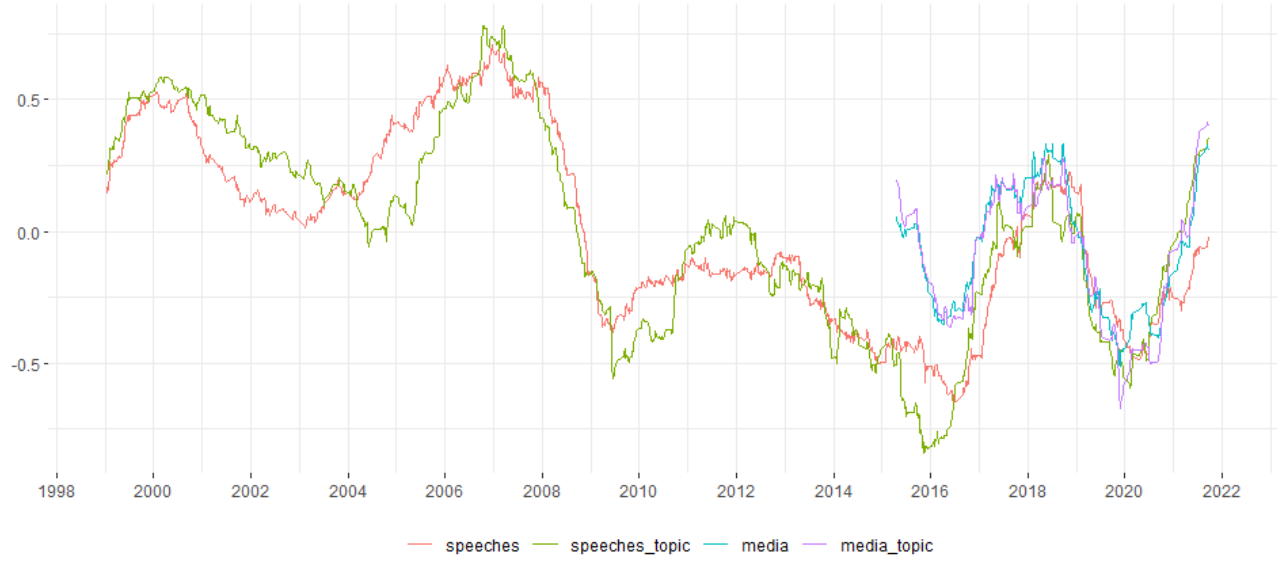
Dynamics of sentiment indices for accounts



Notes: the indices are scaled and centered (separately) for easier comparison.

Annex 5.

Dynamics of sentiment indices for speeches



Notes: Each sentiment index is scaled and centered for comparison purpose and moving average is applied.

Annex 6.

The substantiation of arguments on specific communication events in section 4.2

Note: we are not including the majority of media messages provided in this section, as they mostly refer to market developments and aim to explain them. Meanwhile, with our sentiment indicators we aim to capture only interpretations of ECB communication events. Messages with references to financial markets in this section serve the purpose of cross-checking.

P. Praet's speech on 11 March 2015 – the media message covers only a brief quotation: "There is no such thing, from the point of view of the ECB, as a risk-free asset". The lexicon notes the negative modifier "no" and *dovish* word – "risk" – concluding the statement to be *hawkish*, even though it is much more nuanced. Such a message can be understood from a more *hawkish* perspective: that the ECB may not be willing to take significant credit risk using asset purchases. In the actual speech, Praet acknowledged that the "ECB's monetary policy always involves credit risk: private or public. There is no distinction on that front". At the same time, Praet expressed confidence in ECB accommodative decisions: "The Governing Council decision has demonstrated that we are unconstrained in our ability to meet our mandate, and could make full use of all legal and effective monetary policy instruments". As a result, we cannot be sure that the *hawkish* market reaction which followed after a media article on that speech had any causal implication.

Press conference on 16 December 2021 – *hawkish* language explaining the reduction of pandemic stimulus was followed by a *dovish* market reaction. *Hawkish* sentiment indices from both factual transcripts and media reaction are unsurprising given that the meeting involved phasing out some accommodative policy measures and resulted in some *hawkish* indications: "We will discontinue net asset purchases under the PEPP at the end of March 2022"; "We judge that the progress on economic recovery and towards our medium-term inflation target permits a step-by-step reduction in the pace of our asset purchases over the coming quarters". However, this news was broadly expected and a *dovish* reaction could have been provoked by C. Lagarde sending a message that the ECB is "very unlikely to raise rates in 2022". In addition, just before the ECB meeting, the Bank of England unexpectedly raised rates, and bond yields went up just before our analysed period. The fall in US 10y OIS (−3.6 bps) over the analysed period – by an even higher amount than the 10y OIS (−2.6 bps) of the euro area – further supports the argument that external factors may have contributed to these rate dynamics.

Press conference on 4 September 2014 – sentiments indicate a *dovish* policy tone as the ECB reduced interest rates and expressed negative risks regarding the economic outlook: "loss in economic momentum may dampen private investment, and heightened geopolitical risks could have a further negative impact on business and consumer confidence". The initial market reaction seemed to be *dovish* "Euro plummets after ECB cuts rates, announces asset purchases" (Reuters). However, some further remarks of M. Draghi seem to have reversed the trend, for instance: "[decision] was not unanimous"; "we are at the lower bound, where technical adjustments are not going to be possible any longer". A media message followed: "German Bund futures erased gains on Thursday after European Central Bank President Mario Draghi said markets should not expect further interest rate cuts" (Reuters).

Press conference on 3 December 2015 – this meeting included some accommodative decisions to decrease interest rates and extend asset purchases followed by some *dovish* statements, for instance: "Our new measures will ensure accommodative financial conditions and further strengthen the substantial easing impact

of the measures taken since June 2014". However, easing was not as significant as expected, as is shown in the following media messages: "European shares fell on Thursday, and were set for their biggest drop in over two months, after the European Central Bank's policy update was not as *dovish* as had been expected. While the ECB decided to extend its asset purchase programme until March 2017, it did not increase its size, and a cut in deposit rate was in line with expectations, with hopes of further easing being dashed" (Reuters); "European stock markets sank while the euro surged after the package of stimulus measures announced by the European Central Bank President Mario Draghi failed to live up to the hype" (Reuters).

Press conference on 6 February 2014 – the meeting predates ECB asset purchases, and markets were already looking for hints of new accommodative measures. M. Draghi provided multiple *dovish* remarks: "To sum up, the economic analysis confirms our expectation of a prolonged period of low inflation…"; "It is quite clear that, first, adjustment with low inflation is more difficult, and second, the very fact of having low inflation for a protracted period of time is a risk in itself. So, it warrants close attention by the ECB". However, concrete steps as to how additional monetary policy easing would be provided were lacking, and this likely was the catalyst of a *hawkish* market reaction as noted in the following media message: "German Bund yields and euro zone money market rates rose on Thursday after European Central Bank President Mario Draghi gave no hint of imminent monetary policy easing in initial remarks after holding rates steady".

Press conference on 12 March 2020 – the ECB announced policy stimulus measures, but at the same time significant media attention and market reaction was dedicated to the recently announced Trump travel ban on Europe: "Global stocks plunged into a bear market and oil slumped on Thursday after US President Donald Trump banned travel from Europe to stem the coronavirus, threatening more disruption to the world economy" (Reuters). Markets were also tense due to the emerging COVID-19 pandemic. The yields of the peripheral member states also increased at the meeting, reacting to C. Lagarde saying that "we are not here to close spreads".

V. Constancio's speech on 8 May 2015 – this speech was focused on financial stability and did not seem to have had strong monetary policy messages. Media reaction to the speech occurred at the moment when US labour market data was released, and this may have contributed to the market reaction: "U.S and European benchmark bond yields dropped sharply after a report showed US jobs gains were weaker than initially thought in March". The fact that US OIS rates (−1 bps) reacted in the same direction as European OIS (−1.8 bps) rates also supports this interpretation.

Press conference on 8 May 2014 – although interest rates were left unchanged, the media perceived the press conference as *dovish*. M. Draghi said that the Governing Council may provide further accommodation in the meeting: "At the end of this discussion I would say that the Governing Council is comfortable with acting next time but before we want to see the staff projections that will come out in early June". The 2y OIS fell by 6.6 bps following the press conference.

Press conference on 21 January 2016 – M. Draghi also indicated action in the next meeting, leading to a *dovish* market response. As stated in Refinitiv article: "The euro fell below $1.08 for the first time in two weeks on Thursday after European Central Bank president Mario Draghi said it would be necessary to review the Bank's monetary policy stance in March." Additionally, OIS rates fell by ~4 bps across the yield curve.

Press conference on 22 January 2015 – a *dovish* market reaction to the announcement of larger-than-expected asset purchases. M. Draghi also said that inflation could stay below 0 in the coming months. Long-term yields fell significantly, including the 10y OIS falling 10.5 bps.

Press conference on 9 March 2017 – a sentence regarding usage of all available instruments in order to increase growth was removed from the introductory statement. M. Draghi explained that "That sentence has been removed because the sense of urgency is not there." The market reaction was *hawkish*, with 10y OIS rates increasing by 3 bps. Stock prices increased as inflation and growth forecasts were raised.

Accounts released on 11 January 2018 – the previous meeting featured a decrease in monthly bond purchases from €60 bn to €30 bn per month through September 2018, but indicated that bond buying may continue afterwards. The accounts revealed the intention to adjust this guidance, invoking a *hawkish* market reaction with OIS increasing by 2.7 bps.

Press conference on 25 January 2018 – this press conference was interpreted as *hawkish* given the upbeat statement by M. Draghi. The rationale is explained in the following Refinitiv media message: "The euro climbed against its major counterparts in the European session on Thursday, as the European Central Bank President Mario Draghi said that acceleration in the region's economic momentum give confidence that inflation will head towards 2 percent goal." Besides the euro, 10y OIS rates also rose by 4.2 bps.

Press conference on 7 March 2019 – the market's reaction to a worse-than-expected ECB macroeconomic outlook was *dovish*, as indicated in the following Refinitiv media message: "The euro on Thursday fell to its lowest level since mid-November after the European Central Bank slashed its 2019 eurozone growth and inflation forecasts, citing 'uncertainties' around geopolitical risks and trade rows for the slowdown."

M. Draghi's speech on 24 September 2018 – a *hawkish* market reaction was invoked by M. Draghi's upbeat statements on wage growth and inflation, as indicated in the following media message: "Euro zone bond yields rose on Monday, with Germany's 10-year Bund yield hitting its highest since mid-June, with analysts citing European Central Bank President Mario Draghi's comments on wage growth and vigorous inflation."

Annex 7.

The results of regression models for cyclical component (two-sided HP filter) of press conference sentiment index on different euro area markets since 2014

instru-ment	variable	press_conf	press_conf control	media	media_ control	KOF	KOF_ control	Parle	Parle_ control
OIS2Y	estimate	-0.014	-0.0175	-0.0146	-0.0081	-0.8502	-0.9429	-0.0045	-0.006
	p-value	(0.86)	(0.803)	(0.47)	(0.65)	(0.398)	(0.285)	(0.773)	(0.661)
	R-squared	5e-04	0.2427	0.0081	0.2423	0.0105	0.2559	0.0016	0.2477
	DoF	69	68	65	64	68	67	54	53
OIS10Y	estimate	-0.0386	-0.0464	0.0136	0.0287	-0.829	-1.039	0.0093	0.0055
	p-value	(0.734)	(0.511)	(0.636)	(0.106)	(0.564)	(0.243)	(0.7)	(0.701)
	R-squared	0.0017	0.6208	0.0035	0.6323	0.0049	0.6262	0.0028	0.6579
	DoF	69	68	65	64	68	67	54	53
IT-DE spread	estimate	-0.295	-0.2946	-0.0617	-0.0629	**5.534**	**5.5473**	-0.0843	-0.0839
	p-value	(0.211)	(0.215)	(0.304)	(0.3)	**(0.062)***	**(0.063)***	(0.102)	(0.107)
	R-squared	0.0226	0.0229	0.0163	0.0171	0.0503	0.0509	0.0487	0.05
	DoF	69	68	65	64	68	67	54	53
Stocks	estimate	**0.0463**	0.0293	0.004	**0.0098**	0.1067	0.0332	**0.0148**	0.0063
	p-value	**(0.084)***	(0.148)	(0.55)	**(0.051)***	(0.756)	(0.897)	**(0.007)*****	(0.157)
	R-squared	0.0426	0.4657	0.0055	0.4848	0.0014	0.449	0.1268	0.47
	DoF	69	68	65	64	68	67	54	53
Bank_ stocks	estimate	**0.0992**	**0.069**	-0.0032	0.0068	0.2503	0.119	**0.0341**	**0.02**
	p-value	**(0.052)***	**(0.088)***	(0.807)	(0.508)	(0.702)	(0.817)	**(0.001)*****	**(0.017)****
	R-squared	0.0538	0.418	9e-04	0.3939	0.0022	0.3946	0.1969	0.476
	DoF	69	68	65	64	68	67	54	53
EUR/ USD	estimate	**-0.0341**	-0.0317	-0.0025	-0.0035	-0.2807	-0.269	-0.0037	-0.0014
	p-value	**(0.088)***	(0.115)	(0.629)	(0.5)	(0.271)	(0.29)	(0.38)	(0.752)
	R-squared	0.0415	0.0568	0.0036	0.0289	0.0178	0.0381	0.0143	0.0606
	DoF	69	68	65	64	68	67	54	53

Notes: The control variables (in the regressions specified in the top row) are the US 10-year yields (for EA yields) and US S&P 500 futures (for EA stocks and EUR/USD). The estimate of intercept and control variable (when used) are not shown due to brevity. Asterisks indicate statistical significance at the 10% (*), 5% (**) and 1% (***) levels. DoF denote degrees of freedom.

Annex 8.

The results of regression models for cyclical component (two-sided HP filter) of account sentiment index on different euro area markets since 2015

instrument	variable	accounts	accounts_ control	media	media_ control
OIS2Y	estimate	-8e-04	-0.0016	0.0011	2e-04
	p-value	(0.93)	(0.864)	(0.635)	(0.944)
	R-squared	1e-04	0.0298	0.0045	0.0584
	DoF	56	55	51	50
OIS10Y	estimate	0.0089	0.0047	0.0012	-0.0031
	p-value	(0.497)	(0.631)	(0.736)	(0.24)
	R-squared	0.0083	0.4703	0.0022	0.49
	DoF	56	55	51	50
IT-DE spread	estimate	-0.0108	-0.0086	0.0079	**0.0108**
	p-value	(0.576)	(0.652)	(0.133)	**(0.04)****
	R-squared	0.0056	0.0654	0.0437	0.1393
	DoF	56	55	51	50
Stocks	estimate	2e-04	-0.0026	-7e-04	**-0.001**
	p-value	(0.922)	(0.166)	(0.281)	**(0.033)****
	R-squared	2e-04	0.4779	0.0227	0.5121
	DoF	56	55	51	50
Bank_stocks	estimate	0.0042	0.001	-1e-04	-5e-04
	p-value	(0.33)	(0.807)	(0.918)	(0.635)
	R-squared	0.0169	0.2213	2e-04	0.2225
	DoF	56	55	51	50
EUR/ USD	estimate	7e-04	0.0014	0	1e-04
	p-value	(0.737)	(0.486)	(0.929)	(0.82)
	R-squared	0.002	0.0514	2e-04	0.0409
	DoF	56	55	51	50

Notes: The control variable (in the regressions specified in the top row) are the US 10-year yields (for EA yields) and US S&P 500 futures (for EA stocks and EUR/USD). The estimate of intercept and control variable (when used) are not shown due to brevity. Asterisks indicate statistical significance at the 10% (*), 5% (**) and 1% (***) levels. DoF denote degrees of freedom.

Annex 9.

The results of regression models for cyclical component (two-sided HP filter) of Executive Board member speech sentiment index on different euro area markets since August 2014

instru-ment	variable	speeches	speeches _control	speeches _topic	speeches _topic_c ontr	media	media_ control	me-dia_to pic	me-dia_topic_c ontrol
OIS2Y	estimate	**0.0127**	**0.0118**	0.0037	0.0036	0.0012	0.0011	**0.002**	**0.002**
	p-value	**(0.015)****	**(0.026)****	(0.21)	(0.22)	(0.199)	(0.224)	**(0.08)***	**(0.076)***
	R-squared	0.0183	0.0232	0.0067	0.0126	0.0048	0.0122	0.0163	0.034
	DoF	321	315	235	232	341	335	188	186
OIS10Y	estimate	**0.0087**	**0.0058**	0.0022	0.0018	0.001	7e-04	8e-04	9e-04
	p-value	**(0.042)****	**(0.087)***	(0.353)	(0.335)	(0.186)	(0.26)	(0.38)	(0.213)
	R-squared	0.0128	0.4003	0.0037	0.4253	0.0051	0.3475	0.0041	0.4276
	DoF	321	315	235	232	341	335	188	186
IT-DE spread	estimate	**-0.0189**	**-0.0168**	**-0.0096**	**-0.0093**	2e-04	4e-04	3e-04	2e-04
	p-value	**(0.011)****	**(0.021)****	**(0.02)****	**(0.02)****	(0.888)	(0.762)	(0.885)	(0.897)
	R-squared	0.0202	0.0893	0.023	0.1152	1e-04	0.0562	1e-04	0.0906
	DoF	319	313	233	230	339	333	187	185
Stocks	estimate	-0.0012	-0.0015	-2e-04	2e-04	1e-04	0	-1e-04	2e-04
	p-value	(0.382)	(0.152)	(0.788)	(0.689)	(0.772)	(0.899)	(0.617)	(0.459)
	R-squared	0.003	0.409	4e-04	0.3456	3e-04	0.3998	0.0017	0.4032
	DoF	254	253	181	180	269	268	146	145
Bank_ stocks	estimate	-0.0023	-0.0026	9e-04	0.0014	4e-04	4e-04	5e-04	**0.0004**
	p-value	(0.359)	(0.255)	(0.486)	(0.262)	(0.316)	(0.33)	(0.324)	**(0.081)***
	R-squared	0.0033	0.1471	0.0027	0.1257	0.0038	0.1459	0.0067	0.1465
	DoF	253	252	180	179	268	267	145	144
EUR/ USD	estimate	4e-04	4e-04	3e-04	3e-04	0	0	2e-04	2e-04
	p-value	(0.437)	(0.448)	(0.32)	(0.301)	(0.762)	(0.792)	(0.15)	(0.165)
	R-squared	0.0019	0.003	0.0042	0.0063	3e-04	0.0015	0.011	0.0135
	DoF	321	320	235	234	341	340	188	187

Notes: The control variable (in the regressions specified in the top row) are the US 10-year yields (for EA yields) and US S&P 500 futures (for EA stocks and EUR/USD). The estimate of intercept and control variable (when used) are not shown due to brevity. Asterisks indicate statistical significance at the 10% (*), 5% (**) and 1% (***) levels. DoF denote degrees of freedom.