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Keywords

ECB, communication, financial stability, FinBERT, monetary policy, sentiment analysis

JEL Classification

E50, E58

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1. Introduction

Since the introduction of the Euro, communication by the European Central Bank (ECB) has become a critical ingredient in its policy strategy. One part of the ECB's strategy that attracts considerable attention from the public and markets is the ECB president's introductory statement. The onset of the Effective Lower Bound (ELB), combined with a series of crises, intensified the efforts of market participants to analyze all qualitative information of the kind conveyed by the press conferences. These events likely influence sentiment and offer insights into the mindset of European central bankers. Indeed, a growing body of evidence links sentiment and economic activity (e.g., Beaudry and Portier (2014)). As Kashyap and Stein (2023) point out, if monetary policy "...achieves much of its effectiveness through its impact on financial market sentiment..." (Kashyap and Stein, 2023, p. 55) a loose monetary policy can sow the seeds of a subsequent recession or a financial crisis. Hence, an open question in the literature remains how concerns over price stability and financial stability issues influence the behavior and communication of euro area monetary policy. Does the ECB governing council take the risk of financial stability into account when deciding the stance of monetary policy? Our study considers whether financial stability concerns affect the main communication channel of euro area monetary policy.

Addressing this research question dovetails with another research strand focused on leveraging inter-meeting communication to aid in our understanding of how monetary policy decisions are made (Benanni et al. (2020); Istrefi et al. (2023)). Typically, this form of communication is categorized and employed to explain or forecast interest rate policies or unconventional monetary policy instruments. However, the extent to which it elucidates the sentiment embedded in press conference communication remains a gap in the literature. The significance of extracting information during inter-meeting periods is especially pertinent for the ECB, given that the Eurosystem does not publish detailed voting records or

comprehensive transcripts of its meetings, as noted by Benanni et al. (2020). Hence, our research also considers the role of inter-meeting communication to better understand shifts in the sentiment of press conference communication.

We analyze the introductory statements of the ECB president and derive new sentiment indicators for the euro area based on a novel approach. We identify which topics of relevance for the ECB governing council drives sentiment in the introductory statement. We rely on inter-meeting speeches of the ECB Executive Board and classify all speeches following the approach implemented by Bohl et al. (2023) and focus on the inter-meeting speeches with a thematic focus on monetary policy (MP) and financial stability (FS). These two broad areas are at the core of ECB communication (Feldkircher et al., 2022) and are the responsibility of the Eurosystem (European Central Bank, 2021b). Our approach allows us to address a growing interest in the literature in understanding how monetary policy is linked with concerns over financial stability (Boyarchenko et al., 2022). The results show that one can explain sentiment, and the framing of the introductory statement, by utilizing monetary policy-related speeches. In contrast, financial stability-related speeches do not provide significant explanatory power.

To evaluate sentiment contained in various central bank documents, we do not follow the established approach of relying on dictionary methods. Instead, we utilize a Large Language Model (LLM) called FinBERT, which classifies the verbal sentiment of economics and finance-related textual data (Huang et al., 2022). Existing research uses different versions of BERT to analyze central bank communication of the Fed (Curti and Kazinnik (2023); Gorodnichenko et al. (2023)) and the ECB (Kanelis and Siklos, 2022). FinBERT offers several advantages that go beyond the dictionary method measurement technique. Until recently, a common practice is to use different lexicons for different content. However, due to the significant differences when deriving and implementing the dictionaries the compara-

bility of sentiment indicators across different economics topics may be biased. In contrast, the sentiment indicators derived using models like FinBERT offer higher comparability due to reliance on a single unifying framework.

The remainder of this study is structured as follows: section 2 provides a literature review and an introduction and explanation of FinBERT as methodological advancements. Section 3 explains the derivation and visualization of the novel ECB sentiment indicator, and provides comparisons with established approaches to measure sentiment. Section 4 describes our regression framework and how we derive our independent variables, while section 5 presents the results. The final section concludes.

2. Literature Review and Methodology

2.1. Central Bank Communication

This study follows the literature on central bank communication (Blinder et al., 2008), particularly focusing on communication about financial stability (Born et al. (2014); Correa et al. (2021)). Another emphasis is on the current issue of how the anticipation of monetary policy-induced financial instabilities influences the actions of a central bank in advance, a topic addressed by Kashyap and Stein (2023). Central bank communication thus provides crucial insights into the development and learning process of central bankers. For example, Ferrara (2020) analysis how the ECB Executive Board progressively altered its interpretation of the underlying causes of the European Sovereign Debt Crisis (ESDC) as the crisis unfolded. Bohl et al. (2023) argue that the mandate of a central bank significantly influences how specific topics are addressed in speeches and which economic factors are particularly relevant.

A substantial part of the literature on financial stability communication follows a similar methodology, that is, capturing content or sentiment in financial stability-related documents

through algorithmic or dictionary-based[1] methods. These text analyses determine the informational content for immediate monetary policy decisions, often modeled using a Taylor rule. Oet and Lyytinen (2017) conduct such an analysis for the Federal Open Market Committee (FOMC) minutes and classify paragraphs according to their thematic focus. They argue that a larger share of discussion indicates higher relevance for the FOMC, thus suggesting that interest rate rules that include financial stability discussions better describe the behavior of the Fed than conventional interest rate rules. Wischnewsky et al. (2020) examine the communication during the Humphrey-Hawkins hearings and extend Taylor rules with sentiment indicators derived from financial stability discussions, enhancing the explanatory power of the interest rate rules. Istrefi et al. (2023) use Latent Dirichlet Allocation (LDA) to identify FOMC speeches focusing on financial stability and assess the negativity of the documents using the lexicon of Correa et al. (2021). The authors integrate the topic proportions and sentiment variables into a Taylor rule, concluding that a stronger focus on financial stability or more negative language tends to coincide with a more accommodative monetary policy than can be explained by the state of the economy alone. These results, however, are primarily driven by the period before the Great Financial Crisis (GFC) and by speeches of regional reserve bank presidents. Dybowski and Kempa (2020) identify statements in introductory statements of the ECB president focusing on price and financial stability. Interestingly, they find no evidence that financial stability considerations influence interest rate decisions. Anastasiou and Katsafados (2022) measure uncertainty and weak modal words in speeches of the ECB president to analyze if this communication channel explains deposit outflows from individual commercial banks. They conclude that linguistic cues with a higher fraction of uncertainty lead to more significant deposit outflows with implications for both economic and financial uncertainty.

[1]The words *dictionary* and *lexicon* are used interchangeably.

Our study shifts from traditional dictionary-based methods and relies instead on the advanced capabilities of LLMs. This approach allows for a more nuanced analysis of central bank communication by considering the context of words and phrases, a clear advantage over the traditional bag-of-words approach.[2] Specifically FinBERT eliminates the need to create our own potentially subjective dictionary. It allows for a more effective comparison of documents with different contents, such as those related to price versus financial stability.

2.2. Understanding FinBERT

FinBERT, a specialized variant of the BERT model (Bidirectional Encoder Representations from Transformers), was developed by Huang et al. (2022) for applications in economic and financial contexts. This specific focus makes FinBERT well-suited for processing and analyzing economic language and communication.[3] It builds upon the original BERT architecture (Devlin et al., 2019), grounded in the transformer architecture and the attention mechanism introduced by Vaswani et al. (2017).[4]

FinBERT's training comprises two stages. Initially, it undergoes unsupervised training, where it is optimized for two tasks: masked language modeling (MLM) and next sentence prediction (NSP). In MLM, some words within a sentence are masked randomly, and the model predicts these words by considering the context of the surrounding words.[5] NSP involves determining whether a randomly selected sentence logically follows a given sentence.

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[2]Hayo and Zahner (2023) demonstrate that sentiment indicators of ECB documents based on the dictionary of Loughran and McDonald (2011) are susceptible to noise. However, the extent to which this concerns field-specific lexicons for the ECB remains unclear.

[3]Researchers have successfully utilized financial adaptations of BERT to analyze corporate disclosures and documents, like SEC filings, to measure sentiment or content (Kim et al., 2022).

[4]The attention mechanism, introduced by Vaswani et al. (2017), represents a significant advancement in natural language processing. This mechanism allows the algorithm to selectively weigh key words within a text, thereby granting them relatively more "attention". Hence, the importance of individual words and their relationships within larger text segments can be captured more effectively. This innovation has led to models with significantly greater accuracy compared to the recurrent neural network models (RNNs) that were commonly used before (Bishop and Bishop, 2024, pp. 380-382).

[5]Devlin et al. (2019) typically mask 15% of the words.

The model minimizes loss functions for each task simultaneously.[6] Huang et al. (2022) employed this training strategy relying on an extensive corpus of economic and financial texts, tailoring FinBERT to this specific domain.[7] The resulting model framework is adept at handling the sophisticated interrelationships between words. Hence, language is not merely evaluated at face value but within a broader context.

The pre-trained FinBERT model undergoes fine-tuning for selected natural language processing (NLP) downstream tasks in the second phase. We utilize the sentiment analysis version of FinBERT from Huang et al. (2022), which they fine-tuned using a labeled dataset of 10,000 sentences from analyst reports categorized as positive, negative, or neutral. Fine-tuning involves retraining specific model parameters to enhance accuracy for the targeted task, enabling FinBERT to classify sentences based on their sentiment effectively.[8]

Compared to methods like Term Frequency (TF) and Term Frequency - Inverse Document Frequency (TF-IDF), upon which researchers base unigram-based dictionaries, LLMs like BERT offer the advantage of considering the context. Rather than focusing solely on isolated word frequencies, BERT analyzes sentences in their entirety, capturing the intricate meanings and relationships of words. Furthermore, its transformer-based architecture enables more efficient handling of long-range dependencies in texts, a challenge often encountered with TF and TF-IDF approaches.[9] For the analysis of central bank communication, using

[6]For each task, a cross-entropy loss function is minimized, which is a standard approach in classification tasks for measuring the difference between the predicted and actual probability distributions.

[7]In their appendix, Huang et al. (2022) provide detailed insights into the selection and processing of the data, as well as the hardware used for the training process. For a comprehensive description of the BERT architecture, we refer to Devlin et al. (2019).

[8]An alternative approach would be fine-tuning FinBERT to classify sentences into hawkish and dovish. However, we have deliberately decided against this approach, as hawkish and dovish classifications represent different text metrics that are not directly equivalent to positive or negative sentiments. Moreover, our analysis focuses not solely on inflation but also includes financial stability communication. For this broader analytical focus, looking at positivity and negativity is more appropriate (see Correa et al. (2021)).

[9]As a lexicographic alternative, n-grams can be employed for context capture (see, for example, Neuhierl

LLMs represents a logical step towards more effectively capturing the significance of context in analysis and enables comparison of different sub-topics.[10]

3. Deriving a New Sentiment Indicator from Press Conferences

We implement FinBERT on the sentence level of the press conference statements of the ECB president. FinBERT classifies every sentence i as either positive, negative, or neutral. This allows us to estimate a new sentiment indicator[11] of the whole statement in t using the following standard formula (Apel et al., 2022):

$$Sentiment_t^{IS} = \frac{Positive_{i,t} - Negative_{i,t}}{Positive_{i,t} + Negative_{i,t}} \tag{1}$$

Figure (1) visualizes the derived sentiment indicator based on the introductory statements:

- Figure (1) around here -

Figure (1) illustrates that the sentiment conveyed by central bank communication follows clear patterns and does not just fluctuate around some mean. Thus, we notice a continuous positive sentiment in the statements during the years before the GFC and a quick turn into negative territory right after the beginning of the financial crisis induced recession.

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and Weber (2019)). These must be constructed in advance and share some of the limitations of unigram-based lexicographic methods but offer more intuitive insights for sentiment measurement. They capture sequences of words, which can lead to a more precise analysis than single words. However, they do not achieve the comprehensive contextualization of advanced models such as BERT.

[10]While earlier studies like Dybowski and Kempa (2020) utilize specific dictionaries, such as those by Benanni and Neuenkirch (2017) and Apel et al. (2022) for monetary policy, or Correa et al. (2021) for financial stability content, these approaches often face challenges in comparability due to variations in dictionary construction (e.g., differences in the n in n-grams). LLMs like FinBERT, by contrast, enable a more uniform analysis of sentiment across diverse economic topics, mitigating biases inherent in traditional dictionary-based comparisons.

[11]We use the terms *tone* and *sentiment* interchangeably.

We can also detect a similar development before and during the ESDC when the sentiment indicator reaches an all-time low. Following an increase from the beginning of 2015 until around mid-2018, we observe a steady decline during rising economic challenges including conflicts in international trade, a slowdown in economic growth (Draghi, 2018), and a significant fall at the beginning of the COVID-19 recession. Following more positive communication by the president in 2021, the beginning of the Russia-Ukraine war led again to a return into negative sentiment territory.

Next, we compare this new sentiment indicator with price and financial stability-related text-based sentiment indicators. The KOF is a well-known sentiment indicator that „*aggregates forward-looking statements concerning price stability*“ and quantifies them.[12] Figure (2) visualizes the parallel development of both indicators.

- Figure (2) around here -

The two indicators are significantly correlated, with a contemporaneous correlation coefficient of 53%.[13] However, as we show below, our proposed indicator encompasses the KOF indicator.

Next, we consider the financial stability perspective and generate a separate sentiment indicator by applying the financial stability-based dictionary of Correa et al. (2021) to the introductory statement. In doing so, we consider only the sentences containing the keywords of Correa et al. (2021) to explicitly measure the financial stability-related content. We use equation (1) to calculate the net sentiment, except that we use the number of positive and negative uni-grams instead of sentences. Figure (3) visualizes the parallel development

[12]https://kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-monetary-policy-communicator.html (Last access: 19 May 2023)

[13]We also calculate cross-correlations for both indicators to check whether one indicator leads or lags. The correlation between both indicators is highest at the zero lag.

of both indicators.

- Figure (3) around here -

The two indicators have a statistically significant correlation coefficient of 26% and one should note the similar developments during recessions.

To evaluate how our new sentiment indicator compares with these more topic-specific indicators, we implement the Chong and Hendry (1986) forecast-encompassing test. We regress all three sentiment indicators as covariates against different dependent variables to test if specific indicators are encompassed by others. As dependent variables, we consider the long-short yield spreads (10Y - 3M) of AAA bonds in the euro area on the same day (y_t^1) of the ECB press conference and the next day (y_t^2).[14] The yield curve's slope is a valuable indicator for predicting recessions or financial instability. Furthermore, we use the absolute value of the average inflation gap, that is, inflation deviations from the 2% objective, in the six months following the press conference (y_t^3) in recognition that the principal task of the ECB is to deliver price stability:

$$y_t^3 = |\frac{1}{6}\sum_{m=1}^{6}\pi_{t+m} - 2| \tag{2}$$

π_{t+m} is the monthly HICP inflation rate m months following the press conference at t. Table (1) presents the results of the Chong and Hendry (1986) test.

- Table (1) around here -

We estimate a statistically significant correlation regarding the yield difference for all three

[14]We obtain the yield data from the ECB Data Warehouse. The yield data go back to 2004.

sentiment indicators. Hence, no single sentiment indicator encompasses all the others. A more positive sentiment correlates with a declining yield difference, that is, higher short-term or lower long-term risk-free interest rates on the same day (y_t^1) and the next day (y_t^2) following the press conference. Also noteworthy are the results for the average inflation gap six months following the press conference (y_t^3). Including our new sentiment indicator renders the inflation communication-specific KOF indicator statistically insignificant. The financial stability-related sentiment indicator may reflect the positive connection between improved FS sentiment and a rise in economic activity reflected in higher inflation. That said, one should remember that we derive the FS index without incorporating considering inflation-related communication. Hence, some measurement error remain. We conclude that the sentiment indicator, derived using FinBERT, simultaneously interprets price and financial stability-related communication.[15]

4. Interpreting Press Conference's Sentiment via Inter-Meeting Speeches

Although the focal point of public attention about the conduct of monetary policy is contained in the outcome of policy meetings, inter-meeting speeches likely also communicate information about current economic conditions and the outlook.

To identify which topics have the most relevance in explaining the variation in the tone of the introductory statement, we utilize the inter-meeting speeches of the ECB Executive Board. Speeches allow executive board members to convey the governing council's messages and delve more deeply into specific topics than is possible through the introductory statement.

[15]We also considered the „*overall backward-looking indicator for corporations*" from the ECB's Bank Lending Survey (BLS). A higher score translates into more restrictive credit standards for corporate loans offered by commercial banks. Since the BLS data are collected quarterly, we correlate the results with the sentiment indicator from the first press conference following the BLS release since ECB governing council members will be aware of the latest results. We find a negative relationship between the two indicators, that is, significantly more restrictive credit standards go hand-in-hand with a more negative tone in the statement.

We use the dataset on ECB speeches constructed by Bohl et al. (2023) and extend the data until 2022.[16] Studying communication via speeches provides insights into the intellectual development and the learning processes of senior central bank officials (Ferrara, 2020).

One challenge is that central bankers discuss a wide range of issues, including topics of general interest that are not necessarily within the ECB's area of responsibility. In other words, using all speeches without a proper differentiation of the underlying topics discussed can bias the analysis due to a consideration of information with no direct relationship to the core responsibilities of the central bank of interest. Therefore, we follow the approach implemented by Bohl et al. (2023) and classify all speeches regarding the underlying topics by using Structural Topic modeling (STM) (Roberts et al., 2016).[17] Put differently, we identify latent variables that approximate different lines of thought behind speeches with a similar thematic focus.

In the next step, we aggregate all speeches about monetary policy and financial stability into two independent speech corpora.[18] Next, we estimate the tonality of every speech by using FinBERT. One of the advantages of using this LLM model is that we classify several documents with different economics-related topics using a unifying framework, making comparability more natural. We use the following formula:

$$Sentiment_i = \frac{Positive_i - Negative_i}{Number\ of\ Sentences_i} \tag{3}$$

The sentiment is calculated as the difference between the number of positive and negative

[16]We obtain the unprocessed speech data from European Central Bank (2019).

[17]One challenge when using topic modeling is the ex-ante decision of the appropriate number of topics for the STM to identify. We follow the strategy of Ferrara et al. (2022) and Bohl et al. (2023) and calculate an interval of plausible topics that provide reasonable interpretations. For the main analysis, we choose 10 topics to identify. The results remain robust when using the other topic numbers within the interval (see Appendix B.1). In Appendix A, we present how we derive the interval of suitable topics.

[18]The aggregation of the documents across similar topics is inspired by Moschella and Pinto (2019).

classified sentences divided by the absolute number of sentences.[19] Next, we calculate the average sentiment for the monetary policy and the financial stability speech corpus for the periods between the press conferences:[20]

$$\overline{Sentiment_t}^J = \frac{1}{N}\sum_{i=1}^{N} Sentiment_{i,t}^J \ , \ \ where\ J \in \{MP,\ FS\} \tag{4}$$

Here, $\overline{Sentiment_t}^J$ denotes the average tone of all speeches with either a focus on monetary policy or financial stability between the press conference in t and $t-1$.[21] We use the two sentiment indicators to approximate the ECB Executive Board's assessment of the euro area's current economic and financial situation. Therefore, a positive tone implies a positive description and evaluation of the state of the macroeconomy or the financial system.

Utilizing our new inter-meeting speech sentiment indicators as independent variables, we estimate the following regression model:

$$\begin{aligned} Sentiment_t^{IS} = \beta_0 + \beta_1 * (E_t\pi_t^{12M} - 2) + \beta_2 * E_t y_t^{12M} + \beta_3 * \overline{Sentiment_t}^{MP} \\ +\beta_4 * \overline{Sentiment_t}^{FS} + \beta_5 * Duisenberg_t + \beta_6 * Draghi_t + \beta_7 * Lagarde_t \\ +\beta_8 * Sentiment_{t-1}^{IS} + \epsilon_t \end{aligned} \tag{5}$$

Here, $Sentiment_t^{IS}$ denotes the sentiment of the introductory statement from the press conference in t (which we derived using equation (1)), $E_t\pi_t^{12M}$ and $E_t y_t^{12M}$ are the one-year ahead expectations for inflation and real economic growth,[22] and $\overline{Sentiment_t}^{MP}$ and

[19] Due to the variation in the length of speeches, in contrast to the introductory statement, speech sentiment indicators need to take this into account.

[20] On average, Executive Board members hold between two and three speeches about monetary policy and between two and three speeches about financial stability per inter-meeting period.

[21] In Appendix A, we plot sentiment time series for the monetary policy and financial stability corpora.

[22] We use the ECB/Eurosystem staff projections and extend them with the forecasts from Consensus

$\overline{Sentiment_t}^{FS}$ are our inter-meeting speech sentiment indicators. Therefore, the parameters β_3 and β_4 are the focus of our interest. Furthermore, we add dummies for each ECB president (Jean-Claude Trichet is the constant) and a lagged dependent variable to control for persistence.[23] We emphasize the forward-looking information content that the speeches may provide concerning the subsequent press conference since we focus on the speeches between two press conferences.

Using our regression model, we test the following two hypotheses:

- *Hypothesis 1: A positive sentiment in monetary policy-related inter-meeting speeches signals a more positive sentiment in the subsequent press conference statement.*
- *Hypothesis 2: A positive sentiment in financial stability-related inter-meeting speeches signals a more positive sentiment in the subsequent press conference statement.*

The first hypothesis implies that European central bankers' views about the economy's current situation conveys useful new information about how the stance of monetary policy is determined. The second hypothesis implies that European central bankers' views about the financial system's stability, expressed in their speeches, explains sentiment when policy decisions are taken. Both hypotheses are not mutually exclusive and we expect positive signs for β_3 and β_4, the regression coefficients of interest.

Economics (CE), which we collect from the monthly and later quarterly reports of the ECB. We take the SPF forecasts for few press conferences for which CE forecasts are not provided. We generate a weighted average of the forecast for the current and next calendar year by taking the remaining months as the weights (see Benanni and Neuenkirch (2017), Dybowski and Kempa (2020)).

[23] In Appendix B.2, we show that the results remain robust when using two and three lagged dependent variables instead of one.

5. Results

5.1. Inter-Meeting Communication and Press Conferences

We estimate equation (5) using OLS. Our analysis centers on the time frame spanning beginning of 2002 until the end of 2021. This decision ensures we draw from a dataset comprising complete years, thereby reducing the potential for biases stemming from incomplete temporal data. On the one hand, we aim to circumvent the implications of potential structural breaks post-2021. On the other hand, before 2002, communications regarding financial stability from ECB Executive Board members were infrequent. This led to several inter-meeting periods without any discourse on financial stability.[24] By commencing our dataset in 2002, we are equipped with two decades of consistent communication for our examination. Results are shown in table (2) for the total sample and when splitting the data into a pre- and post-GFC sample.

- Table (2) around here -

We begin by analyzing the full sample results, with a primary focus on understanding the informativeness of the inter-meeting speech sentiment indicators. We use these indicators to gauge the sentiment of the introductory statement presented during the first press conference following the inter-meeting period.

Our findings indicate a significant positive relationship between the average sentiment of inter-meeting monetary policy-related speeches ($\overline{Sentiment}_t^{MPSpeeches}$) and the sentiment expressed in the introductory statement ($Sentiment_t^{IS}$). This suggests we cannot reject our first hypothesis: speeches offer insights into the mind set of senior ECB officials about monetary policy and the broader economic outlook, extending beyond what can be inferred

[24]This can be interpreted as evidence that ECB officials placed little focus on financial stability in the initial years following the introduction of the euro.

from forecasts alone. To quantify, a 1% rise in the average positivity of inter-meeting monetary policy speeches is associated with a 0.44% increase in the positivity of the introductory statement.[25] This implies that shifts in communication prior to the press conferences can already account for changes observed in the introductory statements. We note that the results capture correlations. Hence, causation is not implied. However, it is plausible that the ECB Executive Board members' expectations and interpretations of economic developments — as communicated in their monetary policy-related speeches — also influence the sentiment of the introductory statement.

When looking at financial stability-related communication ($\overline{Sentiment}_t^{FSSpeeches}$), we find no discernible relationship between the average sentiment of financial stability-related inter-meeting speeches and $Sentiment_t^{IS}$. As a result, the second hypothesis is rejected, which suggests that fluctuations in the ECB's tone when assessing the stability of the European financial system are uninformative. Consequently, financial stability assessments play a secondary role when drafting the communication for the press conference. Instead, the sentiment conveyed predominantly reflects the stance of monetary policy.[26]

The results echo the findings of Dybowski and Kempa (2020), who analyzed various paragraphs of the introductory statement to enrich Taylor rules and did not identify any significant influence of financial stability considerations on monetary policy decisions. Furthermore, Benanni et al. (2020) emphasize the predictive power of European central bankers' communication during inter-meeting periods regarding future monetary policy decisions. Consistent with their approach, we further contend, depending on the content, that such inter-meeting communication is a significant predictor of shifts in the introductory state-

[25]The interpretation is unchanged in case of negative sentiment values.

[26]This aligns with the viewpoint that monetary policy tools are not optimal for addressing adverse shifts in specific financial market segments due to the associated high costs. Macroprudential measures are recommended for effectively responding to financial imbalances (Svensson, 2017).

ment's communication which is a crucial element for the success of monetary policy.

The coefficients for the inflation and real economic growth expectations are consistent prior expectations. A positive expected inflation gap, that is, expected inflation higher than the ECB's inflation target of about 2%, generates more negative communication.[27] In contrast, higher real economic growth expectations lead to more positive sentiment. The conclusion that expectations about inflation and real economic growth affect the tone of the introductory statement is consistent with the views expressed by most central bankers that their „*loss*" function is not restricted only to inflation.

Next, we further investigate the connection between inter-meeting speech communication and the introductory statement by segmenting our analysis based on periods of economic activity. Specifically, we divide our sample into two timeframes: before and after the GFC. We consider 2008 and 2009 as crisis years and exclude them from this segment of our analysis. By excluding the GFC, we ensure that the estimations are robust and not driven by this extraordinary crisis.[28]

Our findings highlight that the post-GFC era primarily underpins the association between inter-meeting monetary policy communication and the sentiment articulated in the introductory statement. In the phase leading up to the GFC, the estimates do not discern a statistically or economically significant link between inter-meeting speeches and press conference communications. This observation aligns with the literature. Before the GFC, communication of ECB Executive Board members chiefly aimed to convey information about the new currency's introduction to the European public and to underscore the significance

[27]The ECB's inflation target was "below, but close to 2%" for a long time. Since the strategy review 2021, the official inflation target has been exactly 2% (European Central Bank, 2021a).

[28]Hartmann and Smets (2018) pinpoints August 2007 as the starting date of the GFC in the euro area. Since the crisis was less intense during its initial months, we include all of 2007 in the pre-GFC sample. Nevertheless, in Appendix B.3, we demonstrate that the results remain robust when we use the date proposed by Hartmann and Smets (2018).

of central bank independence (Bohl et al., 2023). It is worth noting that post-GFC, the sentiment of speeches is affected by real-time macroeconomic data (Benanni and Neuenkirch (2017); Bohl et al. (2023)).

The findings from our post-GFC analysis underscore a pivotal aspect of our study: the crucial importance of the ECB's monetary policy communication and insights into economic developments. This is evidenced by the fact that analyzing monetary policy speeches can help in preemptively deciphering shifts in the tone of introductory statements.[29] This paradigm shift following the financial crisis denotes an enhanced role of communication, complementing monetary policy, particularly evident since the ELB (Blinder et al. (2008); Blinder et al. (2023)).

5.2. Dynamic Responses

Up to this point, our analysis has primarily relied on a static examination of the significance of expectations and inter-meeting communication on the content and sentiment of subsequent press conference statements. Next, we consider the potential of a dynamic relationship between sentiment in the introductory statements and inter-meeting communication on MP and FS. Therefore, we employ local projections (Jordá, 2005)[30] and modify equation (5) as follows:

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[29]Our post-GFC sample covers the period from early 2010 to the end of 2021. In Appendix B.3, we demonstrate the robustness of our conclusions, even when we exclude the entire COVID-19 phase, limiting the post-GFC period to the end of 2019. Moreover, we also exclude the ESDC as a whole based on the dates suggested by Hartmann and Smets (2018). Our findings remain consistent, indicating they are not influenced solely by acute crisis periods.

[30]A reviewer has recommended estimating a time-varying parameter (TVP-) VAR to enhance our analysis. It is not immediately apparent that adopting a TVP-VAR approach would significantly alter our conclusions regarding the impact of MP and FS sentiment on introductory statement sentiment. Specifically, the demanding data requirements and potential instability of estimates derived from TVP-VARs raise concerns about the reliability of such an approach at this stage. However, as more data becomes available, the TVP-VAR approach is a promising avenue for further exploration.

$$\begin{aligned}\text{Sentiment}_{t,t+h}^{IS} = \beta_0^h + \beta_1^h * (E_t\pi_t^{12M} - 2) + \beta_2^h * E_t y_t^{12M} + \beta_3^h * \overline{Sentiment_t}^{MP} \\ +\beta_4^h * \overline{Sentiment_t}^{FS} + \beta_5^h * Duisenberg_t + \beta_6^h * Draghi_t + \beta_7^h * Lagarde_t \\ +\beta_8^h * Sentiment_{t-1}^{IS} + \epsilon_t^h\end{aligned} \tag{6}$$

$\text{Sentiment}_{t,t+h}^{IS}$ represents the sentiment of the introductory statement, as depicted in figure (1), communicated during the press conference at $t+h$. Meanwhile, $\overline{Sentiment_t}^{MP}$ and $\overline{Sentiment_t}^{FS}$ denote the average sentiment of speeches concerning monetary policy and financial stability, respectively, given during the inter-meeting period immediately preceding the press conference at t. Figure (4) illustrates the impulse-response-functions for the whole sample following shocks in either the inflation gap (Panel a) or RGDP (Panel b) expectations or the sentiment of monetary policy-related (Panel c) or financial stability-related (Panel d) inter-meeting speeches.

- Figure (4) around here -

Changes in the inflation gap and RGDP expectations lead to persistent shifts in introductory statement sentiment in directions consistent with the results and interpretations of the static analysis from the previous section. Positive inflation deviations persistently negatively influence the introductory statement, while heightened growth expectations positively affect the communication sentiment. It should be noted that an increase in growth expectations leads to a smaller percentage change in sentiment in absolute value than a comparable change in the inflation gap. This may reflect the relatively greater importance of inflation in influencing sentiment emanating from the ECB.

Looking at inter-meeting speech communication, we find that shifts in the sentiment of monetary policy speeches explain the changes in sentiments of the introductory statement over several conferences but become statistically insignificant at the fourth press conference fol-

lowing the subsequent press conference at $t = 0$. This persistence suggests that when ECB Executive Board members alter their communication strategy, it has lasting effects. Nevertheless, consistent with our earlier findings, no significant effects are found from speeches dealing with financial stability on the sentiment of the introductory statement. Our dynamic analysis underscores that monetary policy communication is influenced mainly by macroeconomic indicators and expectations and how ECB senior officials interpret them, as expressed in their speeches.

6. Conclusions

We have developed new sentiment indicators to better understand the ECB's communication during regular press conferences. Leveraging recent advancements in neural network models, which surpass traditional lexicographic methods, we offer a novel approach to analyzing central bank communication.

Our findings reveal that the ECB's views on the euro area's economic outlook and macroeconomy, expressed in speeches, play a significant role in shaping the content of subsequent press conferences following a governing council decision. However, sentiments about financial stability do not significantly influence the introductory statement's content. This indicates that the governing council seems to apply a separation principle between financial stability and monetary policy via the introductory statement that follows a monetary policy decision. It will be interesting to see how these communication patterns evolve, especially after introducing the "Monetary and Financial Analysis" in the ECB's 2021 strategic review.

Other extensions to our research are also contemplated. For example, we have not exhausted the documents that the ECB publishes, which could provide additional insights about sentiment. The Economic Bulletin and the Macroprudential Bulletin could be mined for further sentiment-related data. No doubt, additional improvements in LLMs ability to extract sen-

timent and tone will enable further and more detailed analysis of the overall consistency and intention of ECB communication. Furthermore, as more data becomes available, other econometric techniques can also be applied to obtain further insights into the impact of MP and FS sentiment. Another avenue for research would be to estimate how the consistency of ECB communication or the sentiment of individual communication instruments across different thematic focuses affects news sentiment (Shapiro et al., 2022) and directly, or indirectly, consumer confidence. Ultimately, our study highlights an important consideration: insights can be derived from examining the ECB's communication strategies regarding monetary policy and financial stability. Although distinguishing these two areas might be challenging, future research has the potential to leverage advancements in NLP methodologies. This could enhance our understanding of how central bankers craft narratives and articulate the need for different types of policies across various central banks.

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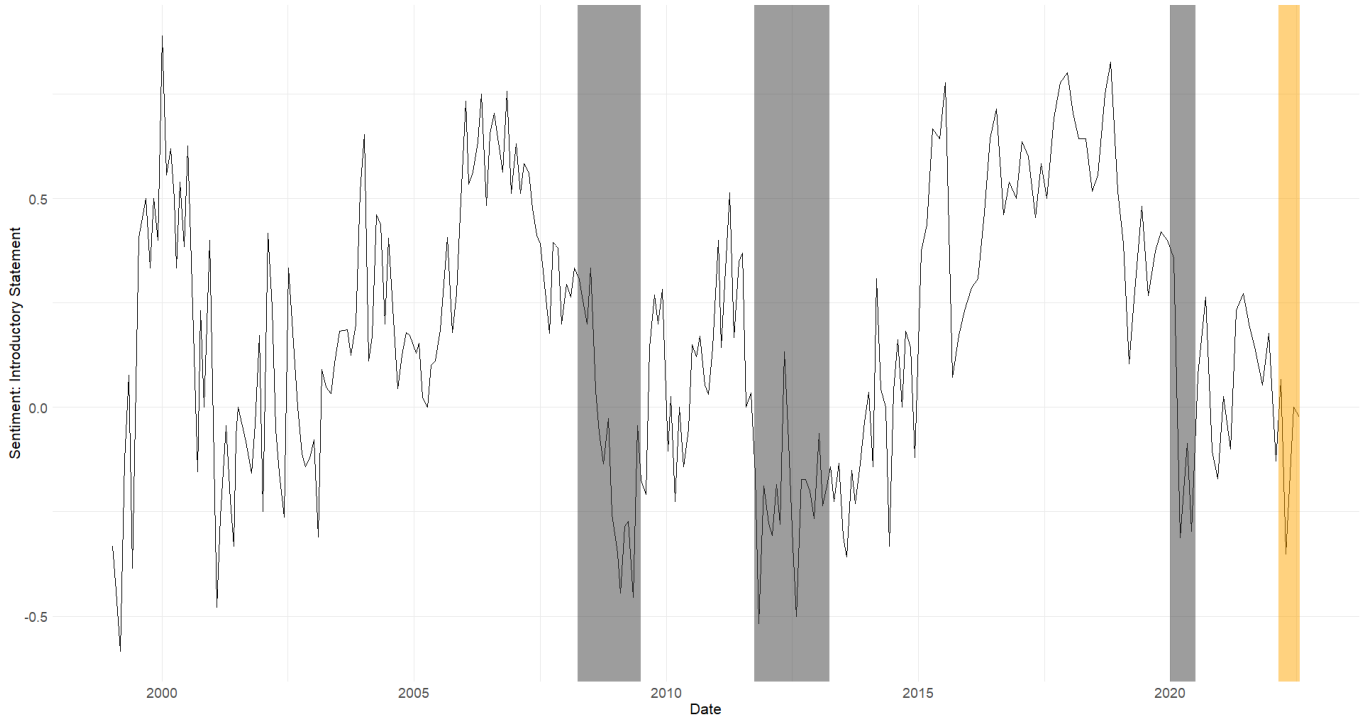
Figure 1: **ECB Introductory Statement Sentiment Indicator**



Note: This figure visualizes the sentiment of the ECB president's introductory statements during the press conferences for 1999 - 2022. We use FinBERT on the sentence level to derive the sentiment and then aggregate the tonality from the individual sentences (see section 3). We denote recessions with shaded areas using the dates of the recessions of the CEPR. The orange area marks Russia - Ukraine War.

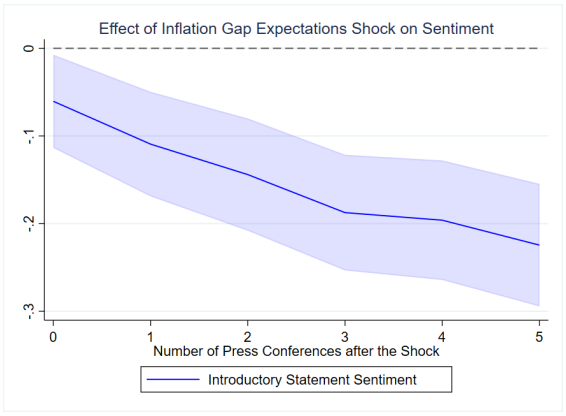
Figure 2: **Comparison of Sentiment and KOF Index**

Note: This figure visualizes our sentiment indicator for the ECB president's introductory statements and the KOF Index in comparison. We denote recessions with shaded areas using the dates of the recessions of the CEPR. The orange area marks Russia - Ukraine War.

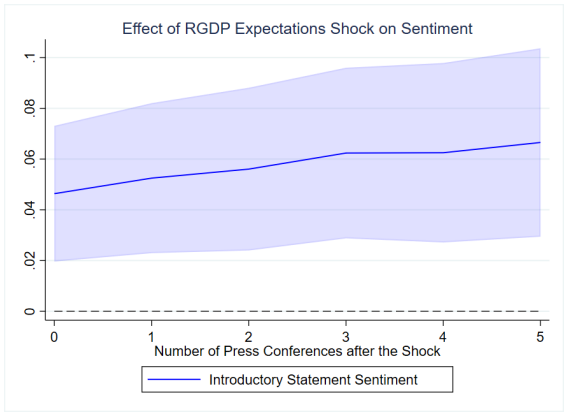
Figure 3: **Comparison of Sentiment and FS Index**

Note: This figure visualizes our sentiment indicator for the ECB president's introductory statements and a financial stability-related sentiment index using the dictionary of Correa et al. (2021). We denote recessions with shaded areas using the dates of the recessions of the CEPR. The orange area marks Russia - Ukraine War.

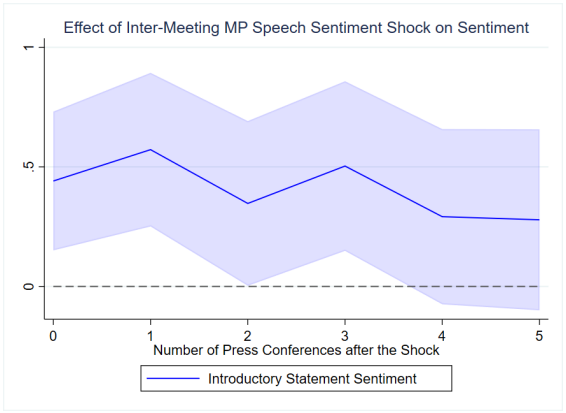
Figure 4: Impulse Response Sentiment Analysis



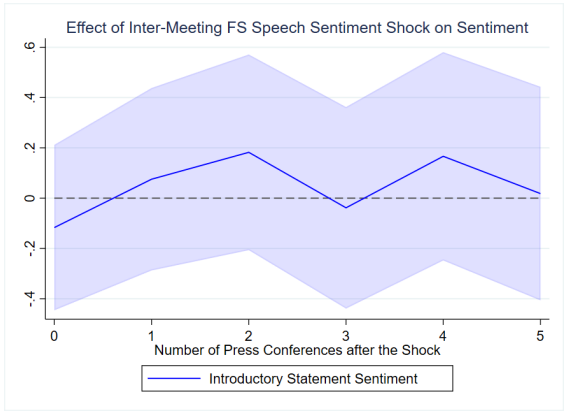
(a) Inflation Gap Expectations



(b) Real Economic Growth Expectations



(c) Monetary Policy Speech Sentiment



(d) Financial Stability Speech Sentiment

Note: This figure illustrates the impulse-response functions based on Equation (6) via local projections for the entire period from 2002 to 2021. The top panels (Panel (a) and (b)) depict the effects of a shock in the expectations for the inflation gap and real economic growth. In contrast, the bottom panels (Panel (c) and (d)) show the effects of a shock in the sentiment of inter-meeting speeches related to monetary policy and financial stability. The time axis indicates the number of introductory statements that have been already communicated since the shock occurred. Accordingly, $t = 0$ means this is the first statement read after the inter-meeting period. We use a 95% confidence interval. We removed one observation due to being an outlier.

Table 1: **Chong and Hendry (1986) Forecast Encompassing Test Results**

	y_t^1	y_t^2	y_t^3
$Sentiment_t^{FinBERT}$	-0.65^{***}	-0.65^{***}	-0.49^{**}
	(0.23)	(0.23)	(0.24)
$Sentiment_t^{KOF}$	-0.84^{**}	-0.91^{***}	-0.30
	(0.33)	(0.33)	(0.25)
$Sentiment_t^{FS}$	-0.49^{**}	-0.48^{**}	0.42^{*}
	(0.19)	(0.20)	(0.23)
$Intercept$	1.69^{***}	1.69^{***}	0.93^{***}
	(0.09)	(0.09)	(0.07)
$H_0 : \beta_1 = \beta_2,\ p$	0.71	0.62	0.69
$H_0 : \beta_1 = \beta_3,\ p$	0.62	0.61	0.03^{**}
$H_0 : \gamma = 0,\ p$	0.00^{***}	0.00^{***}	0.18
R^2	0.25	0.26	0.08
Obs	176	175	176

Note: This table presents the results of the Chong and Hendry (1986) test, using the FinBERT-based and the Correa et al. (2021)-based sentiment indicators and the KOF indicator in a combined regression. We regress the sentiment indicators on the long-short yield difference of the same day as the ECB press conference (y_t^1), on the long-short yield difference of the next day following the ECB press conference (y_t^2), and the average inflation gap in the six months following the ECB press conference. We define $\gamma \equiv \beta_1 + \beta_2 + \beta_3$. Robust standard error in parenthesis $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.10$

Table 2: **Estimation Results**

	Full $Sentiment_t^{IS}$	Pre-GFC $Sentiment_t^{IS}$	Post-GFC $Sentiment_t^{IS}$
$E_t\pi^{12M}$	-0.06^{**}	0.12	-0.08^{**}
	(0.03)	(0.15)	(0.04)
$E_t y^{12M}$	0.05^{***}	-0.02	0.04^{***}
	(0.01)	(0.09)	(0.01)
$\overline{Sentiment}_t^{MPSpeeches}$	0.44^{***}	0.27	0.68^{***}
	(0.14)	(0.34)	(0.21)
$\overline{Sentiment}_t^{FSSpeeches}$	-0.12	-0.18	-0.15
	(0.15)	(0.19)	(0.24)
$Duisenberg_t$	-0.06	-0.18^{**}	
	(0.05)	(0.07)	
$Draghi_t$	-0.02		-0.01
	(0.03)		(0.04)
$Lagarde_t$	-0.11		-0.09
	(0.07)		(0.07)
$Sentiment_{t-1}$	0.64^{***}	0.47^{***}	0.66^{***}
	(0.06)	(0.13)	(0.07)
$Constant$	0.13^{**}	0.00	0.15^{**}
	(0.05)	(0.25)	(0.07)
R^2	0.65	0.56	0.70
obs	206	65	114

Note: This table presents the estimation results of our sentiment regression based on the tonality of the introductory statement. $E_t\pi^{12M}$ and $E_t y^{12M}$ are the one-year ahead expectations for inflation and real economic growth. $\overline{Sentiment}_t^{MPSpeeches}$ and $\overline{Sentiment}_t^{FSSpeeches}$ are the sentiment indicators for the inter-meeting speeches between the press conferences in t and $t-1$, which we derive in section 4. We include president dummies but do not include a dummy for Jean-Claude Trichet to avoid multicollinearity. The "Full" sample spans the years 2002-2021. The "Pre-GFC" subset covers the years 2002-2007, while the "Post-GFC" subset covers the period 2010-2021. We removed one observation due to being an outlier. Robust standard error in parenthesis $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.10$

Online Appendix to "The ECB Press Conference Statement Deriving a New Sentiment Indicator for the Euro Area"

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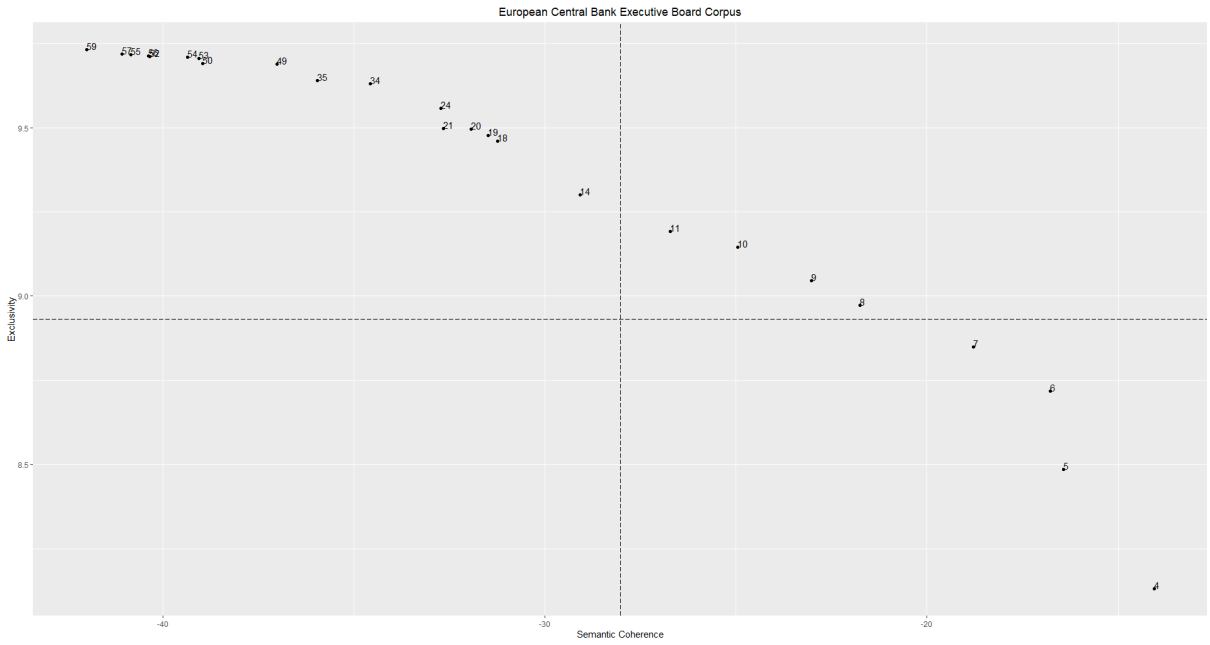
Appendix A. Deriving the Speech Topics and Sentiment Indicators

Before implementing the Structural Topic Model (STM), we first do certain preprocessing steps: remove the bibliography and references, convert all letters to lower case letters, exclude punctuation and stop words, and reduce the words to their word stem. Furthermore, we exclude every word in each speech with a term frequency lower than two. The STM also allows to use document metadata as covariates. We use a dummy variable that equals one if the speaker is the president of the ECB and a dummy variable for each committee speaker. We now estimate STM with ex-ante determined topic number of $K \in \{4, ..., 60\}$ and calculate topic exclusivity and semantic coherence for each STM. We focus on the topics number of the upper right corner and choose $K = 10$ for the main analysis.

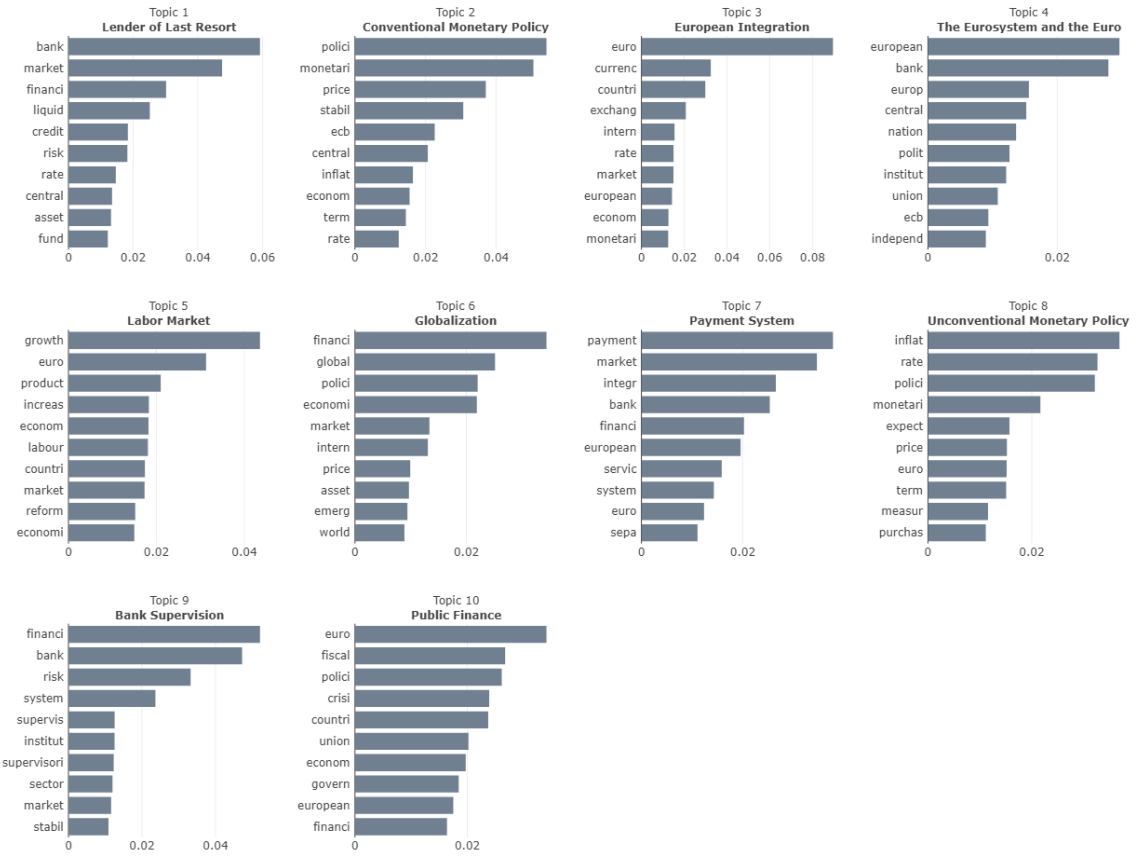
Figure A1: **Semantic Coherence and Exclusivity for the Executive Board Corpus**



Note: This figure illustrates the trade-off between exclusivity and semantic coherence for the ECB Executive Board corpus. We estimate STM for $K \in \{4, ..., 60\}$ and remove all models strictly dominated in metrics. We focus on the topic numbers in the upper right corner and choose $K \in \{8, 9, 10, 11\}$ as possible classifiers based on interpretability.

We provide the topics and the most influential words for each topic in a bar chart. The relevance of the words is based on their respective beta values. We derive the names of the topics looking at the words and reading the most representative speeches for each topic. We aggregate all speeches from topic two and eight to create a *Monetary Policy* corpus and all speeches from topic one and nine to create a *Financial Stability* corpus for further analysis.

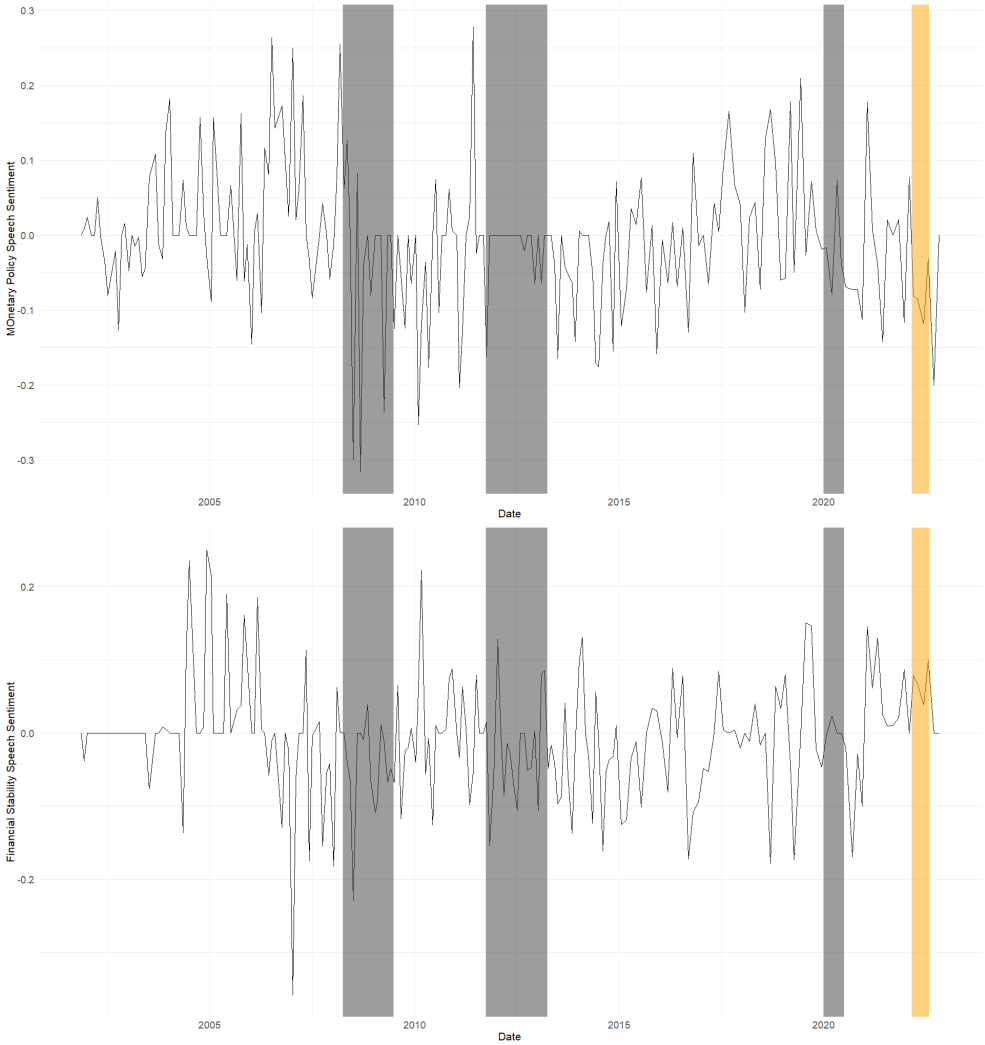
Figure A2: **Most Influential Words in the Topics of the Executive Board Corpus**



Note: We generate these bar charts for the ECB Executive Board corpus using the STM with a topic number of $K = 10$. We use 10 topics to provide the highest interpretability and clarity. For each topic, we show the most influential words based on their respective beta values. We derive the names after reading the most representative speeches of each topic.

Following the procedure described in section 4, we generate the following inter-meeting speech sentiment indicators for monetary policy-related speeches and financial stability-related speeches.

Figure A3: **Inter-Meeting Speech Sentiment Indicators**



Note: The upper (lower) figure visualizes the average sentiment of monetary policy-related (financial stability-related) inter-meeting speeches of the ECB Executive Board. We use FinBERT on the sentence level to derive the sentiment and then aggregate the tonality from the individual sentences (see section 4). We denote recessions with shaded areas using the dates of the recessions of the CEPR. The orange area marks Russia - Ukraine War.

Appendix B. Robustness Checks

Appendix B.1. Using alternative Number of Topics

To ensure that our results are robust to the choice of the prior of our STM model, we measure the speech sentiment indicators and re-estimate our regression model for the other potential topics $K \in \{8, 9, 11\}$. The results remain robust regardless of which topic number we choose.

Table B.1: **Estimation Results with Different Topic Numbers**

	(1) $K = 8$	(2) $K = 9$	(3) $K = 10$	(4) $K = 11$
$E_t\pi^{12M}$	-0.05^{*}	-0.06^{**}	-0.06^{**}	-0.05^{**}
	(0.03)	(0.03)	(0.03)	(0.03)
$E_t y^{12M}$	0.04^{***}	0.04^{***}	0.05^{***}	0.04^{***}
	(0.01)	(0.01)	(0.01)	(0.01)
$\overline{Sentiment}_t^{MPSpeeches}$	0.36^{**}	0.35^{**}	0.44^{***}	0.33^{**}
	(0.14)	(0.14)	(0.14)	(0.13)
$\overline{Sentiment}_t^{FSSpeeches}$	-0.11	-0.08	-0.12	-0.08
	(0.17)	(0.14)	(0.15)	(0.14)
$Duisenberg_t$	-0.06	-0.05	-0.05	-0.04
	(0.05)	(0.05)	(0.05)	(0.05)
$Draghi_t$	-0.02	-0.02	-0.02	-0.02
	(0.03)	(0.03)	(0.03)	(0.03)
$Lagarde_t$	-0.11^{*}	-0.10	-0.11	-0.10
	(0.07)	(0.07)	(0.07)	(0.07)
$Sentiment_{t-1}$	0.66^{***}	0.66^{***}	0.64^{***}	0.67^{***}
	(0.06)	(0.06)	(0.06)	(0.06)
$Constant$	0.12^{**}	0.12^{**}	0.13^{**}	0.11^{**}
	(0.05)	(0.05)	(0.05)	(0.05)
R^2	0.66	0.65	0.65	0.65
obs	204	204	204	204

Note: This table shows the estimation results for our sentiment regression on the introductory statement's tonality for every absolute topic number K within the interval of plausible and interpretable topic numbers. $E_t\pi^{12M}$ and $E_t y^{12M}$ are the one-year ahead expectations for inflation and real economic growth. $\overline{Sentiment}_t^{MPSpeeches}$ and $\overline{Sentiment}_t^{FSSpeeches}$ are the sentiment indicators for the inter-meeting speeches between the press conferences in t and $t-1$, which we derive in section 4. We include president dummies but do not include a dummy for Jean-Claude Trichet, to avoid multicollinearity. The sample spans the years 2002-2021. We remove one observation due to being an outlier. Robust standard error in parenthesis $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.10$

Appendix B.2. Using different Numbers of Lagged Dependent Variables

Table B.2: **Estimation Results with Different Lagged Dependent Variables**

	$Sentiment_t^{IS}$	$Sentiment_t^{IS}$	$Sentiment_t^{IS}$
$E_t\pi^{12M}$	-0.06^{**}	-0.06^{**}	-0.06^{**}
	(0.03)	(0.03)	(0.03)
$E_t y^{12M}$	0.05^{***}	0.04^{***}	0.04^{***}
	(0.01)	(0.01)	(0.01)
$\overline{Sentiment}_t^{MPSpeeches}$	0.44^{***}	0.36^{***}	0.36^{**}
	(0.14)	(0.14)	(0.14)
$\overline{Sentiment}_t^{FSSpeeches}$	-0.12	-0.10	-0.12
	(0.15)	(0.14)	(0.14)
$Duisenberg_t$	-0.06	-0.06	-0.06
	(0.05)	(0.05)	(0.05)
$Draghi_t$	-0.02	-0.02	-0.02
	(0.03)	(0.03)	(0.03)
$Lagarde_t$	-0.11	-0.10	-0.10
	(0.07)	(0.06)	(0.06)
$Sentiment_{t-1}$	0.64^{***}	0.54^{***}	0.50^{***}
	(0.06)	(0.07)	(0.07)
$Sentiment_{t-2}$		0.18^{***}	0.11
		(0.06)	(0.07)
$Sentiment_{t-3}$			0.13^{*}
			(0.07)
$Constant$	0.13^{**}	0.12^{**}	0.12^{**}
	(0.05)	(0.05)	(0.05)
R^2	0.65	0.69	0.69
obs	206	203	202

Note: This table presents the estimation results of our sentiment regression based on the tonality of the introductory statement. $E_t\pi^{12M}$ and $E_t y^{12M}$ are the one-year ahead expectations for inflation and real economic growth. $\overline{Sentiment}_t^{MPSpeeches}$ and $\overline{Sentiment}_t^{FSSpeeches}$ are the sentiment indicators for the inter-meeting speeches between the press conferences in t and $t-1$, which we derive in section 4. We include president dummies but do not include a dummy for Jean-Claude Trichet to avoid multicollinearity. The sample spans the years 2002-2021. We removed one observation due to being an outlier. Robust standard error in parenthesis $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.10$

Appendix B.3. Alternative Dates for Sample Split

Table B.3: **Estimation Results with Earlier GFC Start and without COVID-19 and ESDC**

	Pre-GFC $Sentiment_t^{IS}$	Post-GFC $Sentiment_t^{IS}$	Post-GFC $Sentiment_t^{IS}$
$E_t\pi^{12M}$	0.18	−0.02	−0.05
	(0.16)	(0.04)	(0.06)
$E_t y^{12M}$	−0.03	0.24***	0.29***
	(0.09)	(0.04)	(0.08)
$\overline{Sentiment}_t^{MPSpeeches}$	0.17	0.61***	0.73**
	(0.34)	(0.19)	(0.29)
$\overline{Sentiment}_t^{FSSpeeches}$	−0.22	−0.02	−0.26
	(0.20)	(0.23)	(0.26)
$Duisenberg_t$	−0.20***		
	(0.07)		
$Draghi_t$		0.11**	−0.12**
		(0.05)	(0.05)
$Lagarde_t$		0.22***	
		(0.07)	
$Sentiment_{t-1}$	0.47***	0.39***	0.39***
	(0.14)	(0.10)	(0.15)
$Constant$	−0.09	−0.21*	−0.04
	(0.26)	(0.12)	(0.09)
GFC	NO	NO	NO
$ESDC$	NO	YES	NO
$COVID-19$	NO	NO	NO
R^2	0.58	0.79	0.74
obs	61	98	56

Note: This table presents the estimation results of our sentiment regression based on the tonality of the introductory statement. $E_t\pi^{12M}$ and $E_t y^{12M}$ are the one-year ahead expectations for inflation and real economic growth. $\overline{Sentiment}_t^{MPSpeeches}$ and $\overline{Sentiment}_t^{FSSpeeches}$ are the sentiment indicators for the inter-meeting speeches between the press conferences in t and $t-1$, which we derive in section 4. We include president dummies but do not include a dummy for Jean-Claude Trichet to avoid multicollinearity. The "Pre-GFC" subset spans from 2002 to July 2007, based on the GFC starting date by Hartmann and Smets (2018), while the "Post-GFC" subset encompasses 2010-2019, excluding the COVID-19 pandemic period. We define the ESDC period as the time immediately after the GFC, lasting until June 2013, based on Hartmann and Smets (2018). We removed one observation due to being an outlier. Robust standard error in parenthesis $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.10$