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Media sentiment on monetary policy: determinants and relevance for inflation expectations

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Abstract

We construct a new indicator to capture media sentiment about the European Central Bank monetary policy and its relevant environment by analyzing 2,5,000 articles from five major international newspapers. Using named entity recognition and part-of-speech tagging, we propose a methodology to dissociate the dissemination of the central bank's official communications from the media comments. The resulting -daily- index correlates with some -monthly- standard measures of economic sentiment but reveals idiosyncratic information on monetary policy. Analyzing the determinants of our index, we find that both press conference and inter-meeting communications of the President significantly affect media sentiment. We then show that, controlling for a large range of factors, daily changes in media sentiment have predictive power on financial markets' inflation expectations.

Keywords : central bank communication, European Central Bank, textual analysis, inflation expectations, media sentiment.

JEL Classification : E43, E52, G12

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1 Introduction

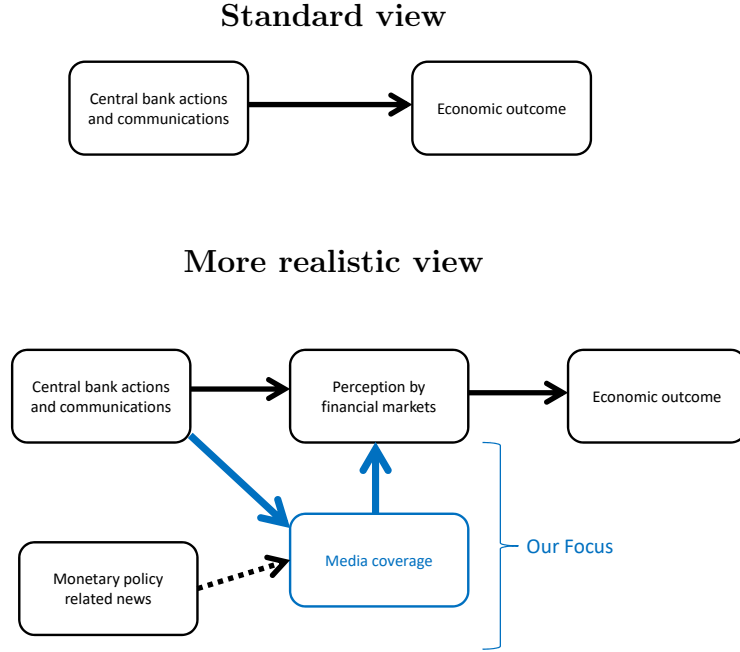
The media coverage of central bank actions is of central importance for monetary policy effectiveness (Berger et al., 2011). As financial market participants rely heavily on media reports to get information on central banks (Hayo and Neuenkirch, 2015), media coverage can facilitate the transmission of the central bank policy while simultaneously enhancing the perception of its actions. However, media are not just a mere relay of the information released by central banks. Through their analysis of the central bank actions and communications, the media could also influence the perception of the central bank policies and their relevant economic environment by market participants and, consequently, have an impact on the economic outcome. While such a media channel is acknowledged in research, such as Hayo and Neuenkirch (2015) or Blinder et al. (2008), its existence has not been, to our knowledge, empirically documented.

In this paper, we address the question of whether central banks do affect media sentiment through their actions and regular communications and whether media sentiment does in turn matter for financial markets' inflation expectations. We thus adopt a framework consistent with the *"more realistic view"* of the effect of central bank communication of Hayo and Neuenkirch (2015), where it is noted that media coverage is a potential key channel between central bank communication and financial market participants' perception (see Figure 1). Doing so, we depart from a large strand of research focusing solely on the direct link between central banks' communications and financial variables.¹

Media sentiment refers to the net degree of positivity (optimism) or negativity (pessimism) of the media content, in line with the connected literature (Kearney and Liu, 2014, Tetlock, 2007). We quantify it using advanced text-mining methods on a corpus of about 25,000 newspapers articles related to the European Central Bank (ECB henceforth), published between 2006 and 2017. When doing so, we do not consider each sentence of the media content. We use an innovative approach to disentangle the media dissemination of the central bank's communications from the media comments on the monetary policy and its environment. In fact, newspaper articles following a central bank communication (press conference, interviews, speeches, etc.) often contain several direct quotes of the official communication. If those quotes are considered to capture the sentiment of a given article, media sentiment will not only relate to the opinions of the journalists and experts but will also reflect the tone of the official communications. To avoid this, we use text-mining

¹Important contributions include, among others, Jansen and De Haan (2005), Ehrmann and Fratzscher (2007a), Ehrmann and Fratzscher (2007b), Jansen and de Haan (2007), Rosa and Verga (2008), Schmeling and Wagner (2015), Gertler and Horvath (2018), Hubert and Labondance (2020), Beaupain and Girard (2020), and Tillmann (2020). See Blinder et al. (2008) for an influential survey on the topic.

Figure 1: "Standard view" versus "more realistic view" of the transmission of the central bank actions and communications, adapted from Hayo and Neuenkirch (2015)



Note: This Figure presents the "standard view" in which central bank actions and communications are assumed to directly affect the economic outcome, and the "more realistic view" (adapted from Hayo and Neuenkirch (2015)) in which the perception by financial markets is presented as a potential key element between the central bank action / communication and the economic outcome.

methods to remove all sentences and quotes where the subject of the sentence is one of the ECB Governing Council members or the ECB.

Once non-relevant sentences are filtered out, we use standard lexicon approaches (Loughran and McDonald, 2011) to capture the sentiment of each article related to the ECB and construct a daily media sentiment indicator. The resulting index intends to capture media sentiment on the ECB monetary policy and its relevant environment. Empirical investigations suggest that it does so relatively well. The monthly average of our index indeed correlates with some monthly standard measures of economic sentiment, but it also reveals idiosyncratic information on monetary policy. When, in a second stage, we investigate the determinants of our index, we find that monetary policy decisions, press conferences, and inter-meeting communications of the Presidents all significantly affect our media sentiment index, even when controlling for other factors. Consistent with some central bankers' comments, we find a straightforward linear effect: hawkish communications on monetary policy decrease media sentiment, while dovish communications increase media sentiment.

Communications related to the economic outlook are also found to matter in some cases, but to a lower extent than communications related to monetary policy inclination. The same applies for communications of other Governing Council members related to monetary policy inclination. In a last stage, we analyze the relevance of our index for the inflation expectations of financial markets. We focus on the 10-years and the 5-years-to-5-years inflation swap, of well known relevance for policy makers (Draghi, 2014).² We find that our media sentiment index has predictive power for the next-day change in the 5-year 5-year and 10-year inflation swap, with more positive sentiment increasing inflation expectations. This holds true even after controlling for a large set of macroeconomic surprises, central bank decisions, the textual content of press conferences, as well as central bank inter-meeting communications, where the latter are taken from a rich external hand-coded dataset. The effect we find is of low magnitude, suggesting a negligible economic relevance.

The paper first contributes to the literature on monetary policy and the media by providing new evidence showing the impact of various types of communication from central bankers on media sentiment. In particular we complement the findings of Berger et al. (2011) and Böhm et al. (2012), who analyzed the determinants of media favorableness toward, respectively, the monetary policy decisions of the ECB and the Czech Central Bank. Although our focus is on media *sentiment* rather than *favorableness*, we find, as in Berger et al. (2011), that only the surprising component of an interest rate decision matters for media. Tobback et al. (2017) build an index of perceived hawkisness / dovishness in the media for the days following the ECB press conference and find that the tone of the ECB communication (hawkish versus dovish) is reflected in the media perception of the ECB actions. We differ from Tobback et al. (2017) and from the two previously mentioned works insofar as we do not focus solely on what media say a few days after the conference: our index is a continuous measure. Consequently, we also contribute to the literature by showing that inter-meeting communications, especially those related to monetary policy inclination, do affect media.³

We also contribute to the literature on the impact of media sentiment on financial variables. Tetlock (2007) and Garcia (2013), among others, apply textual analysis methods to newspaper content and show that the resulting sentiment index helps forecast stock returns. Fraiberger et al. (2021) use articles from Reuters to show that general news sentiment predicts daily returns in both advanced and emerging markets and drives worldwide capital flows. Instead, the novelty of

²"The 5year/5year swap rate (...) is the metric that we usually use for defining medium term inflation"

³Another strand of the literature has focused on uncertainty in media. Husted et al. (2019) build an index of monetary policy uncertainty from three US newspapers and show that shocks to monetary policy uncertainty raise credit spreads and reduce output. Bennani (2018) measures media uncertainty related to the ECB's monetary policy decisions and finds it to be related to future monetary policy decisions.

this paper is that we focus on financial markets' inflation expectations. This variable is of special interest for central bankers and policymakers, as it shows whether markets are convinced that a central bank will keep the inflation rate within its set target. We find that sentiment also plays a role in that context though of limited economic relevance.

We add to the literature on inflation expectations, a key component of the response of long-term nominal rates to news (Bauer, 2015), by providing evidence that media sentiment has an impact them. Several studies noted that financial markets' long-term⁴ inflation expectations were not responsive to monetary policy or macroeconomic news surprises when the central bank was perceived as credible in achieving an explicit inflation target (see Garcia and Werner (2018) for a comprehensive review). For example, Beechey et al. (2011) find that long-term inflation expectations were unresponsive to monetary policy or macroeconomic surprises in the Euro area before the global financial crisis, while they were in the US. In contrast, Garcia and Werner (2018) find that long-term financial markets' expectations have become more responsive to macroeconomic news surprises after 2013 in the Euro area, while Ambler and Rumler (2019) find that some recent unconventional monetary policy announcements moved financial markets' inflation expectations.⁵

Lastly, we contribute to the overall literature on monetary policy transmission by providing a new index related to media sentiment on monetary policy, which can be used for further research. Our Media Sentiment Indicator is freely available online.⁶

The rest of the paper is organized as follows. Section 2 details the construction of our index and discusses its interpretation. Section 3 describes the methodology and the empirical results on the determinants of media sentiment. Section 4 presents the methodology and the empirical results on the relevance of media sentiment for inflation expectations. Section 5 concludes the paper.

⁴By "long-term" we refer in this paper to inflation expectations where the relevant horizon is 10 years. Some papers we survey later also refer to such horizons as the "medium term".

⁵Other important contributions on the anchoring of financial markets' expectations in the Euro area include, among others, Bundick and Smith (2018) and Galati et al. (2011).

⁶<http://www.cbcomindex.com/data.php> or <https://sites.google.com/site/julienpinter/data-1>

2 Measuring media sentiment on monetary policy

2.1 Construction

We first extract from the Factiva database all articles containing the keywords “ECB” or “European Central Bank” published by five major international newspapers (The Financial Times, The Wall Street Journal, The New-York Times, Barron’s, and The Times) from January 2006 to December 2016. These newspapers are selected because they have a large audience of professional investors and they are known to include journalists’ views and analysis on the information compared to other outlets, like newswire services.⁷

Within these, we consider only articles of which the main topic is the ECB by imposing a minimum of three⁸ mentions of either "European Central Bank" or the name of a member of the Governing Council.⁹ Our final database contains 24,931 articles.

To dissociate the mere dissemination of central bank official communication by the media from the sentiment of the media, we remove from each article all quotes where the subject of the sentence is a member of the ECB or the ECB itself. To do so, we use the *spaCy* package in Python to analyze the semantic structure of each sentence. We use part-of-speech (POS) tagging to classify each word based on its context within a sentence. POS allows us to "tag" each word, that is, to classify it as a noun, verb, determinant, or any other grammatical category and identify its syntactic dependency in a given sentence.¹⁰

Table 1 shows an example of sentences that our methodology allows us to detect (and remove) in an article extract from The Wall Street Journal (available entirely in Appendix A.1).

Following previous research on the quantification of textual content, we use the Loughran and McDonald (2011) dictionary to compute a sentiment score for each article.¹¹ We adapt it to

⁷Doing so, our indicator may not capture the overall sentiment of the market and may be relatively biased. In particular, the sentiment from the English-speaking newspapers we collected may differ from the views conveyed in French or German newspapers for example.

⁸We read and manually classified 600 articles to select the threshold value to obtain an adequate balance between type 1 errors (selecting an irrelevant article) and type 2 errors (not selecting a relevant article).

⁹The list thus includes "ECB", "European Central Bank", and the main members of the Governing Council: Draghi, Coeure, Mersch, Asmussen, Constancio, Gonzales, Lautenschlager, Praet, Bini-Smaghi, Stark, Issing, Papademos, Gonzalez Paramo, Trichet, Tumpel-Gugerell, Noyer, Orphanides, Smets, Visco, Weidmann, Wellink, Knot, Linde, Reinesch, Lane, Villeroy de Galhau, Honohan, Weber, Ordóñez, Quaden, Coene, Nowotny, Provopoulos, and Stournaras.

¹⁰We remove not only the sentences in which the subject is explicitly the ECB or a member of the Governing Council but also sentences where the subject is a pronoun indirectly referring to the member of the ECB or the ECB itself (as identified by the subject of the previous sentence(s) in that case).

¹¹This approach is probably the most widely used in the connected literature, and it has been shown to capture relevant information in a central banking context (e.g., Schmeling and Wagner, 2015 or Hubert and Labondance,

Table 1: Media sentiment computation: example based on an article (extract)

Text format	Meaning
in blue	Positive words from LM dictionary
in red	negative words from LM dictionary
crossed-out	Exact re-transcriptions of ECB members' words removed with part-of-speech tagging

The Wall Street Journal, September 9, 2011 :

The ECB's sudden shift opens it to renewed **criticism** that -as in July 2008 when it increased rates just weeks before the **collapse** of Lehman Brothers- officials didn't recognize early **warning** signs on the economy and **overestimated** inflation risks, **exacerbating** the slowdown. ~~The ECB made the right call, Mr. Trichet said Thursday. "We think what we did was appropriate" he said, referring to this year's rate hikes. (...) "I would very much like to hear the congratulations for an institution that has delivered price **stability** in Germany...which is **better** than has ever been **achieved** in this country," he said, responding to a question about Mr. Gabriel's criticism.~~

Full article in Appendix A.1

our monetary policy context: to avoid a straightforward bias in the sentiment measure, we discard expressions that undoubtedly refer directly to ECB monetary policy measures while containing the following words from the Loughran and McDonald (2011) dictionary: "negative rate", "negative interest/deposit rate", and "quantitative easing".¹² Then, we define $Sentiment_i$ as the difference between the number of positive and negative words in the article i divided by the total number of words in the article:

$$Sentiment_i = \frac{\sum(Positive\ words_i) - \sum(Negative\ Words_i)}{Number\ of\ Words_i} \quad (1)$$

By construction, each article has a sentiment score between -1 and +1. Examples of very negative and very positive articles are given in Appendix A.1. In the article extract of Table 1, we also show the words captured by the Loughran and McDonald (2011) dictionary (the methodology is illustrated in Appendix A.1 on the full article). The 20 positive and negative words with the highest number of occurrences are detailed in Appendix A.2. Finally, at a daily frequency, we compute an aggregate media sentiment indicator equal to the average sentiment of all articles published during the period, $Sentiment_t$, so that:

$$Sentiment_t = 100 \times \frac{\sum_{i=1}^{n_t} Sentiment_i}{n_t} \quad (2)$$

2020). However, it has the well-known drawback of ignoring qualitative differences between words.

¹²This happens to be particularly important for "negative". By applying our filter, we remove about one-third of its mentions.

where n_t is the number of all our relevant articles published during day t in all of our five major newspapers.

Built as such, our index intends to capture the media sentiment regarding the ECB monetary policy and its relevant economic environment. A more negative media sentiment indicates that the ECB monetary policy and its underlying environment are viewed with more pessimism, while a more positive media sentiment indicates more optimism. Figure 2 shows the Media Sentiment Index (MSI) as well as the evolution of the number of articles during our sample period, with a weekly frequency.¹³

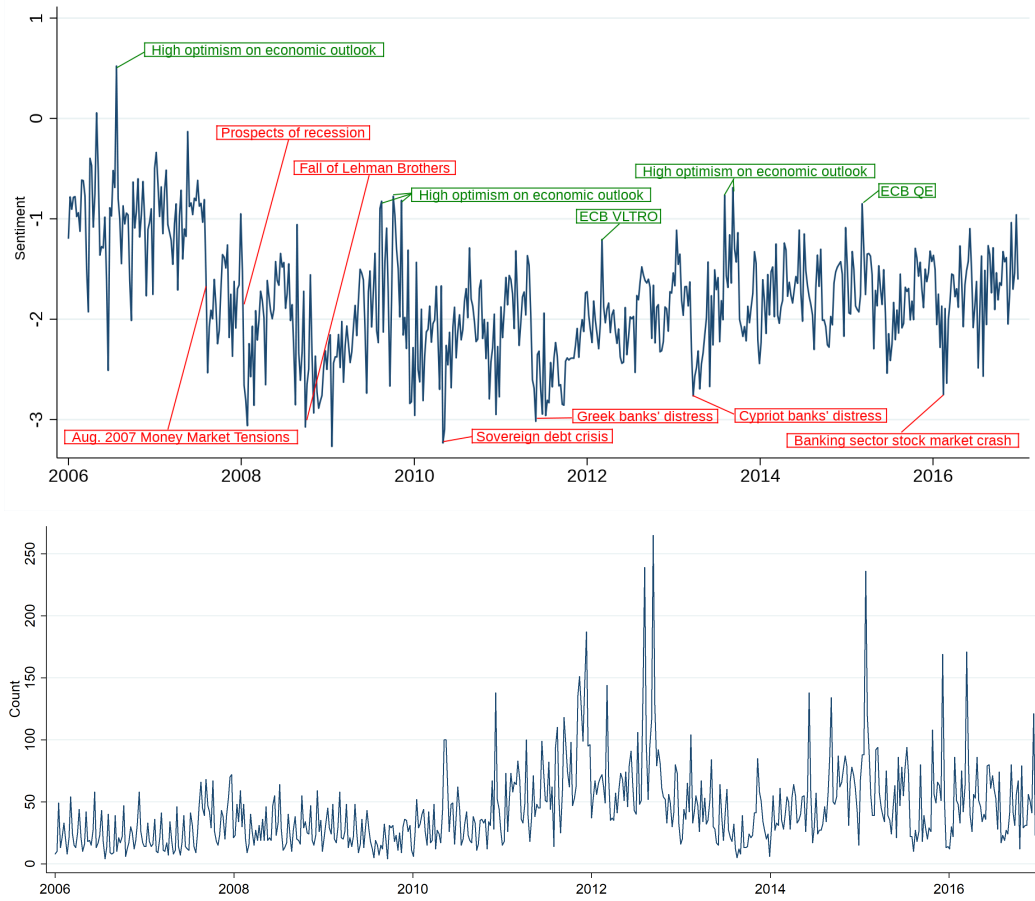
2.2 Discussion and comparison with other indexes

As Figure 2 highlights, many highs and lows of the MSI are related to important monetary policy events. For example, the second allotment of the ECB Targeted Longer-Term Refinancing Operations (TLTROs) in February 2012 and the beginning of the ECB Quantitative Easing (QE) in January 2015 are both associated with an unusually sharp increase in media optimism. No other policy after 2013 appears to be associated with a higher media sentiment than the one associated with the launch of QE. The index also soars when the media convey high optimism on the economic outlook, indicating that our index captures well information on economic developments which are relevant to the ECB. Conversely, the media sentiment decreased sharply during the Great Recession and during the Eurozone crisis. It is interesting to observe that not all unconventional monetary policies are associated with a sharp increase in media sentiment. For example, the first TLTRO allotment, at the end of 2011, is not associated with an increase in media sentiment while the second one is. One potential explanation is that the allotment figures were better than expected for the second TLTRO, while they were more in line with expectations for the first TLTRO, according to some newspaper articles. We also do not observe any sharp increase in media sentiment the week of the implementation of the Security Market Program (second week of May 2010).

The MSI significantly differs from other well-known measures related to monetary policy perception, such as the newspaper-based Monetary Policy Uncertainty (MPU) index of Husted et al. (2019). The MSI has a correlation of only -0.05 with the MPU index for the ECB, considering monthly aggregate data (given that the MPU index is only available at a monthly frequency).

¹³In addition, we also corrected for any potential newspaper-specific political bias by subtracting the mean sentiment for each newspaper (over the whole time period) from each sentiment score of the articles of the corresponding newspaper. The resulting index maintained a correlation of 99.5% with the original one. We still used this version in our empirical analyses, although the transformation does not affect the results. Note also that the values of the MSI are mostly negative because the Loughran and McDonald (2011) dictionary, as the English dictionary, contains more negative words than positive words (2,355 negative words for 354 positive ones).

Figure 2: Weekly aggregated sentiment and number of media articles



Notes: Figure A (top) presents the media sentiment indicator (weekly frequency for readability). Positive (negative) events are shown in green (red). Figure B (bottom) shows the number of articles per week.

This suggests that the two indexes capture very different aspects of monetary policy perception. The MSI has a higher correlation (0.49) with the widely used market-based measure of investors' sentiment of Baker and Wurgler (2006),¹⁴ a correlation of 0.51 with the Economic Sentiment Indicator (ESI) from Eurostat, and 0.61 with the investor economic confidence index for the Eurozone developed by Sentix, all available only at a monthly frequency. This suggests that the "relevant economic environment" information component of our index is relatively important at a monthly

¹⁴Investor sentiment, as the authors define it (belief about future cash flows and investment risks that is not justified by the facts at hand), is not conceptually equivalent to the sentiment we measure. Media sentiment, i.e., the positivity or negativity of newspapers' tone, can reflect both fundamentals and autonomous beliefs. When we take their measure not orthogonal to macroeconomic fundamentals measures, we get a correlation of -0.53. This may suggest that our index is correlated to investor sentiment as "autonomous beliefs on the future state of the economy", assuming that the comparison with US data is relevant.

frequency, while about half of the variations of our index still cannot be attributed to the variations in the sentiment on the economic environment relevant for monetary policy. To better understand the idiosyncratic information of our index relative to economic sentiment indexes, in Appendix B, we plotted the residual component of the MSI index after having regressed it (its monthly average) on the Sentix investor confidence index. We observed that the three highest points after 2010 corresponded in turn to the month when the "whatever it takes" speech was pronounced, the month when forward guidance was introduced, and the month when QE was introduced. Overall, this further confirms that our index captures relevant and idiosyncratic information on monetary policy perception.

We also compared our index with a commonly used index capturing the overall tone of the speech of the President during the ECB press conferences, measured also by the Loughran and McDonald (2011) dictionary (LM press conference tone henceforth). We mean-standardized the index, as well as our index, taking only its values on average over the day of the conference and two days after it to ensure a meaningful comparison. The correlation with the LM press conference and our index for these days is quite large, about 46%. It suggests that our index captures relevant information on monetary policy. Investigating which idiosyncratic information is present in our index for these particular days, we looked at the events with the largest differences between the value of our index and the value of the LM press conference tone. The largest difference arises in the meeting of February 2010 during which Jean-Claude Trichet *"hinted strongly"* that the ECB emergency measures to support financial markets would further unwind, according to The Financial Times, in a context of fears related to sovereign debts. That day, an analyst summarized in The Financial Times that *"Mr Trichet's firm attitude has fuelled fears of horror scenarios"*. The second largest difference arose during the meeting of January 2009. At that meeting, the ECB decreased its key interest rate, but several newspapers report a substantial *"disappointment"* among market actors, related to fears over growth prospects. Many other large differences arise in similar contexts, thereby tending to confirm that our index captures idiosyncratic information on the media perception on monetary policy that are not available in standard indexes based on the official ECB communications.

3 The determinants of the media sentiment

3.1 Methodology

In investigating the determinants of media sentiment, we are particularly interested in analyzing whether the central bank can affect it. We conjecture that the central bank can influence media sentiment through two channels. First, its monetary policy decisions *per se* may impact media sentiment. In this case, media sentiment might primarily reflect the favorableness/unfavorableness of central bank news coverage, as studied by Berger et al. (2011). Second, monetary policy communications of the President and other members of the Governing Council could, by themselves, influence media sentiment on a regular basis. Taking into account relevant control variables, the model we intend to estimate is as follows:

$$MSI_t = \sum_{i=1}^J \alpha_i MSI_{t-i} + \beta ECB_decisions_t + \phi ECB_comm_t + \tau Controls_t + \epsilon_t \quad (3)$$

where MSI_t corresponds to our Media Sentiment Index on the ECB monetary policy at day t , $ECB_decisions_t$ is a vector of variables related to ECB monetary policy decisions, ECB_comm_t is a vector of variables related to the communication of ECB Governing Council members, and $Controls_t$ is a set of economic and financial variables related to the economic environment. $\alpha = (\alpha_1, \alpha_2, \dots)$, β , ϕ , and τ are the associated vectors of coefficients, and J corresponds to the number of lags for the dependent variable accounting for the persistence of sentiment.

The variables are summarized and described in Table 2. The variable selection regarding the monetary policy decisions is inspired by Böhm et al. (2012) and Berger et al. (2011). We also include a variable aimed at capturing the unconventional monetary policy measures adopted by the ECB by building a dummy variable, taking the value of 1 for each unconventional monetary policy announcement and 0 otherwise, as well as a variable related to negative rates adoption.¹⁵ The sample period for which we estimate the model is January 1, 2010 until May 31, 2016. It is limited by data availability on Governing Council members' communications, which we discuss subsequently.

Regarding monetary policy communications, we study communications during both the press conference and the inter-meeting period. The first refers to the traditional press conference of the ECB President, previously given once a month until January 2015 (once every six weeks afterward), during which the ECB President gives the Governing Council's assessment of the economic and

¹⁵Arguably, negative rates adoption had an important signal effect, which we intend to quantitatively unveil with the inclusion of this variable.

financial conditions and further develops its monetary policy decisions. The second refers to the various communications (e.g., media interviews, testimonies, conference talks) of the ECB Governing Council members, during which they usually express their views on the future stance of the ECB monetary policy and on the economic outlook. For press conference communications, we gather an exhaustive database containing all the textual content of the ECB press conferences and build quantitative measures for the policy inclination (hawkish versus dovish) and for the economic outlook content inclination (positive economic outlook versus negative) of each communication using the central bank-specific dictionary of Picault and Renault (2017) developed specifically for that purpose. Appendix C provides further details. For inter-meeting communications, we use a daily database kindly provided by Gertler and Horvath (2018). The authors manually coded each communication from each Governing Council member for the above-mentioned period.¹⁶ We obtained these daily detailed data from 2010 to May 2016, which in turn sets our sample size.¹⁷ The daily data give us the average policy inclination and economic outlook content inclination for the day, both for the President and all other members of the Governing Council. We also include a dummy variable which takes a value of 1 on the day of the "whatever it takes" speech, which is known for being a particularly influential communication.

Control variables are included to limit the likelihood of any omitted variable bias in the estimated coefficients for our variables of interest. We include a set of inflation and macro-economic news surprises for the Eurozone and for major European countries. All of the 17 variables included for that purpose are defined as the difference between the announced value and the median expectation, as surveyed by Bloomberg, and detailed in Appendix D. We include variables to capture financial uncertainty (the level of the VSTOXX index) and fiscal stress (change in sovereign spread of peripheral economies relative to Germany). We also consider the changes in the EUR/USD exchange rate and in the EuroStoxx 50 to control for changes in general financial market conditions. Descriptive statistics of the main variables are provided in Appendix F.

In addition to the above stated variables, we add four lags of the dependent variable ($J = 4$). We do so both to limit potential auto-correlation in the residuals and to inform on the persistence of media sentiment.¹⁸ The estimates are performed considering a daily frequency.¹⁹ In our baseline

¹⁶They follow the standard of the related literature and use Reuters news to get the raw communications. See Gertler and Horvath (2018) for more details.

¹⁷Note that all the results related to the variables available for 2006–2010 are unchanged when we consider the whole period (2006–2016).

¹⁸The fourth first lags only appeared significant in most of our regressions. Without the lags, the Breusch-Godfrey LM and the Durbin's alternative tests for autocorrelation both reject the null hypothesis of no autocorrelation at the 1% level, when we consider autocorrelation of order 1 or higher (up to an order of 4).

¹⁹The sentiment value on Mondays is set at the average value over Saturday-Sunday-Monday. For days without

Table 2: Variables description

<i>Variables</i>	<i>Description</i>
ECB decisions	
Δi	Announced changes in the ECB key interest rate.
Positive interest rate surprise	Difference between the actual interest rate decided during the press conference and the market expected policy rate (Bloomberg survey median) (0 if the difference should be negative).
Negative interest rate surprise	Difference between the actual interest rate decided during the press conference and the market expected policy rate (Bloomberg survey median) (0 if the difference should be positive).
APP	Dummy variable equal to 1 if an unconventional monetary policy is announced. Detailed list in Appendix D.
Negative rate	Dummy variable equal to 1 the day a negative rate on the deposit facility is announced.
Whatever it takes	Dummy variable equal to 1 the day of Draghi's "whatever it takes" speech at the Global Investment Conference (July 26, 2012).
ECB communications	
President MP - Press Conferences	Net monetary policy (MP) inclination of the ECB President speech during the Press Conference (PC), measured using Picault and Renault (2017).
President EC - Press Conferences	Net economic outlook view (EC) inclination of the ECB President press conference speech, measured using Picault and Renault (2017).
President MP - Inter Meeting	Net monetary policy (MP) inclination of the ECB President communications in the inter-meeting period, manually coded, based on Gertler and Horvath (2018).
President EC - Inter Meeting	Net economic view (EC) inclination of the ECB President communications in the inter-meeting, manually coded, based on Gertler and Horvath (2018).
Other members MP - Inter Meeting	Net monetary policy (MP) inclination of the members of the Governing Council inter-meeting (IM) communications (excluding President), manually coded, based on Gertler and Horvath (2018).
Other members EC - Inter Meeting	Net economic view (EC) inclination of the members of the Governing Council inter-meeting (IM) communications (excluding President), manually coded, based on Gertler and Horvath (2018).
Macro-economic surprises	Difference between the announced macroeconomic data and its median expectation (from Bloomberg's surveys). Detailed list in Appendix D.
Financial variables	
Financial uncertainty	Level of the VSTOXX index
Fiscal stress	Changes in the following: the average of the 10-years bond yield for Portugal, Spain, Italy, and Greece minus the 10-years bond yield for Germany.
Δ EURUSD	Change in the log of the average EUR / USD exchange rate (USDs per EUR).
Δ EUROSTOX	Change in the log of the average EUROSTOXX 50 level.

model, we include the contemporaneous values for all our variables except for the variables related to the inter-meeting communications, for which we consider the lag of the variables. First, this allows us to take into account the potential delay of the treatment of the information of these communications by journalists. These communications are indeed likely to be treated with less importance than a regular press conference and thus be read and processed with less priority; the influence they may have on journalists' writings cannot be expected to always be immediately apparent.²⁰ Second, it allows us to avoid potential simultaneity issues. Governing Council members arguably have some flexibility over their speeches, and they might also react to media sentiment (or to the market developments of the day), with Governing Council members attempting to offset a more negative media sentiment (or an adverse market development) by communicating more positively.

We perform our baseline estimates using standard OLS²¹ with Newey-West standard errors to account for heteroskedasticity and potential remaining auto-correlation in the residuals.²²

3.2 Results

We perform our estimates by first including only the variables related to the ECB communication, disentangling between communications of the President versus those of the other members of the Governing Council (Model 1). We then add variables related to the ECB monetary policy decisions (Model 2) and the different controls for the economic and financial environment (Models 3 and 4).²³ Table 3 presents the results, where column i shows the estimates of Model i .

The first observation from Table 3 is that media sentiment exhibits some persistence. Higher media optimism on a given day increases media sentiment for the following four days. This is

any sentiment observation (which represents about 1.6% of our sample), we simply linearly interpolate the missing value. The results are not dependent on these choices.

²⁰Blinder et al. (2008) acknowledge a potential media reaction delay to central banker communications and present it as a challenge to identify what represents the timing of a monetary policy "event". We will more deeply investigate this aspect in what follows.

²¹Standard unit root tests lead us to infer that our data are stationary.

²²In the final model (including lags for the dependent variable), the results from both the Breusch-Godfrey LM and the Durbin's alternative tests for autocorrelation do not allow us to conclude that autocorrelation is absent in the residuals. We chose to deal with this concern by using Newey-West standard errors, and we will consider alternative approaches in the robustness section. Newey-West tests are performed using fixed-b critical values and the truncation parameter rule $S = 1.3 T^{1/2}$ ($S = 52$ in our case), as recommended in Lazarus et al. (2018). Standard Newey-West tests lead to very similar conclusions. Regarding heteroscedasticity, the Breusch-Pagan test for heteroscedasticity rejects the null hypothesis of homoscedasticity at the 5% level (but not at the 1%), while the White test for heteroscedasticity cannot reject the null hypothesis of homoscedasticity at the 10% level.

²³Only macro-economic surprises that appeared close to significance (p-value less than 0.20) were kept in the final estimations displayed here, which leads us to consider four surprises out of the seventeen.

Table 3: Results - Media Sentiment determinants

	[1]	[2]	[3]	[4]
MSI_{t-1}	0.295*** (0.033)	0.295*** (0.033)	0.293*** (0.033)	0.266*** (0.031)
MSI_{t-2}	0.070*** (0.027)	0.070*** (0.027)	0.071*** (0.027)	0.050* (0.026)
MSI_{t-3}	0.044 (0.031)	0.044 (0.031)	0.045 (0.032)	0.030 (0.031)
MSI_{t-4}	0.087*** (0.024)	0.087*** (0.024)	0.086*** (0.024)	0.062*** (0.024)
President MP - Press Conferences _t	-0.445*** (0.130)	-0.483*** (0.136)	-0.479*** (0.137)	-0.401*** (0.122)
President EC - Press Conferences _t	0.542* (0.320)	0.603* (0.325)	0.583* (0.326)	0.554* (0.306)
Other members MP - Inter Meeting _{t-1}	-0.074*** (0.027)	-0.072*** (0.028)	-0.077*** (0.027)	-0.066** (0.029)
Other members EC - Inter Meeting _{t-1}	0.023 (0.044)	0.022 (0.044)	0.025 (0.043)	0.012 (0.045)
President MP - Inter Meeting _{t-1}	-0.174*** (0.042)	-0.174*** (0.042)	-0.166*** (0.043)	-0.166*** (0.041)
President EC - Inter Meeting _{t-1}	0.224** (0.088)	0.224** (0.088)	0.224** (0.088)	0.217** (0.091)
Δi		-0.405 (0.529)	-0.391 (0.528)	-0.736 (0.631)
Negative Interest Surprise		1.591*** (0.491)	1.589*** (0.490)	1.733*** (0.609)
Positive Interest Surprise		1.319** (0.529)	1.265** (0.532)	0.829 (0.706)
APP		-0.126* (0.074)	-0.120 (0.075)	-0.151 (0.142)
Negative Rate		0.196*** (0.036)	0.195*** (0.036)	0.166*** (0.037)
Whatever it takes		0.373*** (0.042)	0.368*** (0.043)	0.163*** (0.054)
Macro-economic surprises	No	No	Yes	Yes
Financial uncertainty				-0.012*** (0.002)
Fiscal stress				-0.135** (0.052)
Δ EUROSTOX				3.352*** (0.920)
Δ EURUSD				1.635 (1.612)
Constant	-0.044** (0.018)	-0.044** (0.018)	-0.044** (0.018)	0.241*** (0.049)
Adjusted R^2	0.152	0.150	0.152	0.188
Obs.	1630	1630	1630	1630

Note: Newey-West Standard Errors in parenthesis. ***, **, and * represent statistical significance at respectively 1%, 5%, and 10%. MSI is the Media Sentiment Index. All control variables are defined in Table 2.

important in that it implies that any factor that affects media sentiment on a given day can be expected to affect media sentiment with a certain degree of persistence.

Regarding the ECB press conference communications, the tonality of President speeches during the press conference significantly affects media sentiment. Both the economic outlook tone and monetary policy inclination are found to have an impact on media sentiment, though the coefficient associated to the former variable is statistically significant only at the 10% level. A more hawkish tone during the press conference is significantly associated with a decrease in media sentiment, while a more positive communication on the economic outlook during the press conference is associated with an increase in media sentiment. The effect actually appears stronger when we add controls for monetary policy decisions (column 2 with respect to column 1).

Regarding the inter-meeting communications, we find that communications of the President, both on the economic outlook and the future stance of monetary policy, significantly affect media sentiment. More dovish communications are associated with a decrease in media sentiment, and positive communications on the economic outlook increase media sentiment. Communications of other Governing Council members on the future monetary policy stance also appear to matter for media sentiment. The effect consistently goes in the same direction as the effect of the communications of the President (but it appears to be about three times lower) in our last estimate (Model 4). Inter-meeting communications about the economic outlook of the members of the Governing Council other than the President are not significantly linked to media sentiment on the next day in our regressions. The fact that we find a lower effect for the communications of Governing Council members other than the President on the monetary policy stance and no effect for their communications on the economic outlook may indicate that communications from Governing Council members other than the President are perceived as less important than communications from the President. It could be also that these differences reflect a difference in media attention. These two interpretations are naturally difficult to isolate from each other. They should also be taken with caution, insofar as standard Wald tests reject the null hypothesis of equality of the coefficients only when we consider those associated with the variables related to communications on the economic outlook.²⁴

Regarding the monetary policy decisions, we find that interest rate surprises affect media sentiment. This is in line with the results of Berger et al. (2011) who found that the tone of news reports is generally more negative when the policy decision surprises the financial market analysts. We robustly detect this effect only for negative interest rate surprises; when the decided policy

²⁴For the coefficients of the variables related to communications on the monetary policy stance, the p-value of the standard Wald test is about 0.12.

rate is lower than the market expectation, media sentiment decreases. We do not find an effect for positive interest rate surprises when we control for financial variables (Model 4), although this could arguably be due to the imperfect nature of such controls in this case (which may also react to the interest rate surprise). As in Berger et al. (2011), interest rates moves *per se* do not appear to matter. The announcements of asset purchase programs also do not appear to systematically affect media sentiment in our baseline estimates. However, we find that the adoption of a negative rate in June 2014 and the "whatever it takes" speech of Mario Draghi are both associated with a significantly important increase in media sentiment.

In terms of economic magnitude, further analysis reveals that events related to the press conference usually have more impact on media sentiment than standard inter-meeting communications. For example, based on column (4), a one standard deviation increase in the tone of the press conference in terms of hawkishness decreases media sentiment by about 0.13. This is about a fourth of the MSI standard deviation on the analyzed period, and it could make the MSI move from one decile to another. The effect is of comparable magnitude to the effect of a one standard deviation decrease in the tone of the press conference regarding the economic outlook (0.09 decrease in MSI). A negative interest rate surprise of 25 basis points is associated with a decrease in media sentiment of about 0.44. As a comparison, a one standard deviation increase in the VS-TOXX leads "only" to a 0.08 decrease in media sentiment. Direct and contemporaneous effects of events linked to the press conference on the MSI thus appear of particularly important magnitude when compared to the effect that alternative broader variables have on the MSI. Standard moves in the tone of inter-meeting communications impact media sentiment with less magnitude; a one standard deviation increase in the tone of President communications related to monetary policy inclination decreases media sentiment from about 0.03, an effect almost similar to a one standard deviation decrease in the tone of President communications related to economic outlook (0.02 decrease in MSI). Exceptional communications can, however, have very important impacts on media sentiment. Considering column (3), the "whatever it takes" speech contemporaneously moved the MSI index from about 0.37, about five times more than a one standard deviation increase in the VSTOXX.

While such an analysis sheds light on the *direct* and *contemporaneous* effect (or next-day effect for inter-meeting communications) of our variables on media sentiment, in Appendix E, Table 7, we analyzed and took into account the potential effect of ECB communications on media sentiment up to 4 days after the communication by including more lags for our variables of interest in the regression. The tone of the press conference in terms of monetary policy inclination appears to significantly move media sentiment several days after the press conference. A much larger effect

of the President speech on media sentiment is unveiled through this analysis. On average, a one standard deviation increase in the tone of the press conference in terms of hawkishness will have decreased media sentiment by about 0.64 after five days,²⁵ and thus it will have decreased media sentiment by more than a standard deviation. Other newly included lags are usually not found to affect media sentiment, suggesting that the ECB communications move media sentiment only at the timing we initially set.²⁶

3.3 Robustness and interpretation of the results

The most important result that arose in the previous section is that both press conference and inter-meeting communications significantly affect media sentiment. This is especially true for those related to the monetary policy inclination, with hawkish (dovish) communications decreasing (increasing) media sentiment. In this section, we test for its robustness and further discuss its interpretation.

To test the robustness of our results, we performed a set of alternative regressions, shown in Table 8 of Appendix E. We first performed the same estimates with a standard Huber-White matrix for the residuals. All the coefficients (including the ones related to monetary policy decisions) either maintained the same significance level or saw it increase when we did so (column (1)). We then performed the same estimates but included the lag of all the control variables instead of their contemporaneous value.²⁷ The coefficients for the variables related to inter-meeting communications as well as their associated statistical significance were barely affected (column (2)). We then dealt with the potential remaining autocorrelation in the residuals with alternative methods.

²⁵The figure is computed based on the estimates of column (4) of Table 7 and takes into account the persistence of the MSI.

²⁶An exception is the second lag of the variable capturing the tonality of the inter-meeting communications of the President regarding the economic outlook, which is statistically significant at the 5% level, while being negative. This suggests that the positive effect of these communications on sentiment reverses over the next day. A standard Wald test cannot reject the hypothesis that this coefficient is equal to the opposite of the coefficient related to the first lag of the same variable, at conventional statistical significance levels. In addition, the second lag of the variable capturing the tonality of the inter-meeting communications of the Governing Council members other than the President regarding the economic outlook appears statistically significant at the 5% level in all regressions (columns (1) to (4)). This suggests that these also affect media sentiment, but with more delay than those of the President, possibly owing to a difference in media attention. Regarding policy decisions, the "whatever it takes speech" is also found to positively affect media sentiment the day after it arouse, and the asset purchase programs are found to positively impact media sentiment the day after as well as three days after their announcements (coefficient statistically significant at the 1% level). The MSI is also found to decrease three days after a positive interest rate surprise, reinforcing the interpretation that interest rate surprises negatively affect media sentiment. These latter results are all available on request.

²⁷Compared to the previous specification including several lags for all variables, such a specification has the advantage of being much more parsimonious.

First, we kept three lags for each variable related to ECB communications and ECB decisions, adding only the lags of the control variables which appeared statistically significant (up to three lags). Such a specification has the advantage of being more parsimonious than the ones previously tested on Table 7, while autocorrelation tests cannot here reject the null hypothesis that there is no autocorrelation in the residuals at a 10% significance level.²⁸ Column (5) of Table 7 presents the results with a Huber-White matrix for the residuals, and column (6) presents the results with a standard covariance matrix. The previous key results are unaffected with the former specification, while with the second specification the statistical significance of the coefficients of the variables related to Governing Council communications and the variable capturing the tone of the President on the economic outlook during the press conference now slightly overpasses the conventional 10% level. In fact, the variance of most coefficients increases with the second specification, and some variables for which the impact on media sentiment may seem self-evident to some observers (such as the dummy for the "whatever it takes" speech or the fiscal stress variable) also lose statistical significance at the 10% level. Second, we repeated the same estimates without the lags for the dependent variable. While these were included to limit serial correlation in the residuals, remaining serial correlation together with the presence of the lags could bias downward the other coefficients (Wilkins, 2018). We ran the baseline regression without the lagged dependent variables, using respectively OLS with Newey-West standard errors, OLS with a Huber-White matrix for the residuals, the Prais-Winsten estimator, and an ARMAX model estimated through maximum likelihood; the conclusions remained broadly unchanged.²⁹

To assess the robustness of our results to alternative sentiment measures, we built our index with other dictionary approaches and then performed the same regressions. We first included only the negative words when building the sentiment score. In a second specification, we selected the positive and negative words used to build our sentiment measure in equation 1 from a generic well-known dictionary, the Harvard-IV dictionary. In a third specification, we used the Vader sentence-level classifier.³⁰ Though the Vader approach and Harvard-IV dictionary are not built specifically for a financial context, using them here allows us to have an idea of the extent to

²⁸Durbin's alternative tests for autocorrelation (Breusch-Godfrey LM tests for autocorrelation) of the order 1 till 5 all reject the null hypothesis at the 20% threshold (at the 18% threshold).

²⁹In all specifications, the coefficients of the variables related to ECB communications that were statistically significant at the 5% level remained significant at this level, with the exception of the communications of the Governing Council members (other than President) related to monetary policy inclination with the ARMAX specification. The coefficient of the variable related to the tone of the President on the economic outlook during the press conference was statistically significant at the 5 or 10% level in all specifications but the Prais-Winsten specification. The results are available on request.

³⁰See Shapiro et al. (2020) for a general discussion on Vader and on the Harvard-IV dictionary.

which our results are dependent on the dictionary we used. Results are displayed in columns (3), (4), and (5) of Table 8. Most key findings remain irrespective of the approach chosen. The press conference and inter-meeting communications of the President related to monetary policy inclination are still found to affect media sentiment, with coefficients statistically significant at 1% levels except with the Harvard IV-4 dictionary. The same applies for the inter-meeting communications of other Governing Council members, related to monetary policy inclination. The effect of all communications related to the economic outlook cannot however be seen as robust when using the Harvard-IV and Vader dictionary.³¹ In a final robustness check, we gave a different weight to each newspaper article based on a proxy for an audience of professional investors.³² The last column of Table 8 shows that the results are mostly unaffected by this change.

Focusing on the interpretation of our results, we then test for potential non-linearities in the effect of communications on sentiment. One might expect that hawkish communications decrease media sentiment only when a restrictive monetary policy seems unwarranted (e.g, when inflation is below its target), and that they should be positively associated with sentiment only when such a policy seems warranted. Evidence of such effects would affect the interpretation of our main result. To test this hypothesis, we create a dummy variable equal to 1 when CPI inflation is above the ECB 2% inflation target (0 otherwise) and we interact each central bank communication variable with this dummy variable. We add both the dummy variable and the interaction terms to equation 3. Detailed results are presented in Table 9 in Appendix E. The results do not strongly point out the presence of non-linearity in the effect of communications; none of the interactive terms are significant at the 5% level. This confirms the interpretation of the results of the previous section: more hawkish communications make media content more pessimist, and more dovish communications make media content more optimist, unconditional on inflation being above or below the target.³³ While such an interpretation may appear puzzling to some observers, it is also consistent with some recent central banker comments. Powell (2018), for example, recognized that "looser policy leading to more positive sentiment in markets and tighter policy depressing sentiment" was a possible simple link between monetary policy and risk sentiment: our results

³¹The fact that the adjusted R^2 is lower for the estimates performed with these three alternative measures (relative to our initial measure) can be seen as a factor justifying the relevance of our initial measure choice.

³²A key issue here is that there is no standardized data on the worldwide audience for newspapers. We used data from Erdos & Morgan's Professional Investment Community Study of 2010. We computed the daily sentiment score for each newspaper and then built a daily weighted average, using a weight of 0.59 for The Wall Street Journal, 0.35 for The Financial Times, 0.28 for Barron's, 0.24 for The New York Times, 0.12 for The Times.

³³Note that, when performing the same estimates with the available data for 2006-2016, we get the same results: the tone of press conference communications related to monetary policy inclination is linearly and significantly associated to media sentiment, with no evidence of non-linearity.

suggest that a similar direct link applies for media sentiment on monetary policy.

4 Media sentiment and inflation expectations

We now focus on the relevance of media sentiment for financial markets' long-term inflation expectations.

4.1 Empirical strategy

It is usually considered that any factor affecting financial market long-term inflation expectations does so because the central bank is not perceived either as completely *willing* or as completely *able* to keep inflation in line with its target in the future.³⁴ The fact that financial market expectations for Euro area inflation in five years for the next five years have been falling below the ECB inflation target since 2014 (Draghi, 2014) can be interpreted as a sign that investors see the ECB as less able to keep inflation in line with its 2 percent target. If media sentiment is, as one may expect, correlated with investor perceptions, the MSI gives a unique opportunity to directly test this hypothesis that long-term inflation expectations do respond to investor perceptions on monetary policy and its relevant environment. Following this intuition, we test whether daily variations in the MSI affect financial markets' long-term inflation expectations. We adopt a framework close to Tetlock (2007) and Garcia (2013) who analyze the effect of investor sentiment proxied by media content on the stock returns of the next day, but we focus our attention on financial market inflation expectations.

We measure inflation expectations using daily data on inflation-linked forward swap rates in the Euro area from Thomson Reuters (see e.g. Garcia and Werner, 2018, Ambler and Rumler, 2019, or Beechey et al., 2011 for a similar measure). We focus our analysis on the 5-year forward inflation compensation five years ahead (5-y to 5-y forward rate henceforth) and 10-year forward inflation-linked swap rate (10-y forward rate henceforth), insofar as they represent inflation expectations for the long-term and as such are of primary relevance to policymakers. The 5-y to 5-year forward rate is often seen as the most relevant measure of financial market inflation expectations in the Euro area and it receives a considerable attention from policymakers, central bankers (Draghi, 2014),

³⁴For example, in Beechey et al. (2011), the fact that long-term inflation expectations respond to inflation surprises in the US while they do not in the Eurozone before 2008 can be interpreted as evidence that the ECB is perceived as more *willing* to keep inflation at a target than the Fed. Garcia and Werner (2018) note that the lack of evidence that long-term inflation expectations responded to macroeconomic news before the global financial crisis for the ECB was interpreted as a sign that the central bank was perceived as *credible* in achieving its inflation target (thus willing or able to achieve it).

and market participants (Rennison, 2019).³⁵ Inflation expectations daily changes in basis points ($f_t^m - f_{t-1}^m$) for inflation expected in five years for the next five years ($m = 5/5$) or for the average inflation expected for the next 10 years ($m = 10/0$) are assumed to be linked to media sentiment through the following model:

$$f_{t+1}^m - f_t^m = c + \sum_{i=0}^n \beta_i (f_{t-i}^m - f_{t-i-1}^m) + \sum_{i=0}^n \phi_i \text{MSI}_{t-i} + \sum_{i=0}^m \alpha_i X_{t-i} + \sigma \text{dow}_t + \epsilon_t \quad (4)$$

where c is a constant, X_t a set of exogenous variables defined thereafter, dow_t are days-of-the-week dummy variables, ϵ_t is the error term. We follow Natoli and Sigalotti (2018) to deal with persistence and heteroskedasticity common with such financial variables and model the squared variance σ_t^2 using a GARCH(1,1) model given by:

$$\sigma_t^2 = \gamma_0 + \gamma_1 \epsilon_{t-1}^2 + \gamma_2 \sigma_{t-1}^2 \quad (5)$$

$X_t = (\text{ECB_decisions}_t, \text{ECB_comm}_t, \text{Macro_surprises}_t, \text{Financials}_t, \text{News_Sent})$ is the set of exogenous variables considered, where ECB_decisions_t , ECB_comm_t , Macro_surprises_t are, respectively, the ECB monetary policy decisions, the ECB communications, and the macroeconomic surprises. In our context, it is particularly important to control for central bank communications, central bank decisions, and macroeconomic surprises. Without doing so, an apparent effect of sentiment on inflation expectations could be a reflection of these factors. To better purge the effect of economic news broadly defined, we also include two sentiment indexes of (domestic and international) economic news through the vector News_Sent_t : the index calculated by Bor-toli et al. (2018) from the content of the French newspaper *Le Monde*, and the index of Shapiro et al. (2020) focusing on the US. For a similar purpose, we will also consider the financial variables previously defined Financials_t .

The coefficients in each regression are estimated by Maximum Likelihood with the same sample period as in the previous sections (January 1, 2010 until May 31, 2016), taking only trading days into consideration. We consider $n = 5$ lags for the dependent variable and the MSI . The model is first estimated without the X vector of controls, and these are then added with lags (m) chosen with parsimony considerations so that they match any potential statistically significant lag of our variable of interest.

4.2 Results

Results are displayed in Table 4.

³⁵The five- and ten-year maturities are also considered to concentrate a significant amount of liquidity relative

Table 4: 5Y-5Y and 10Y Inflation Expectations and Media Sentiment

	5Y-5Y [1]	5Y-5Y [2]	5Y-5Y [3]	10Y [4]	10Y [5]	10Y [6]
$f_t^m - f_{t-1}^m$	0.094*** (0.026)	0.089*** (0.026)	0.081*** (0.027)	0.152*** (0.027)	0.145*** (0.028)	0.145*** (0.029)
$f_{t-1}^m - f_{t-2}^m$	0.074*** (0.026)	0.076*** (0.027)	0.082*** (0.027)	0.030 (0.028)	0.038 (0.030)	0.038 (0.030)
$f_{t-2}^m - f_{t-3}^m$	-0.019 (0.028)	-0.031 (0.028)	-0.029 (0.028)	0.010 (0.029)	-0.001 (0.030)	0.001 (0.030)
$f_{t-3}^m - f_{t-4}^m$	-0.015 (0.026)	-0.010 (0.026)	-0.015 (0.026)	0.013 (0.026)	0.014 (0.027)	0.007 (0.027)
$f_{t-4}^m - f_{t-5}^m$	-0.031 (0.026)	-0.024 (0.026)	-0.025 (0.026)	-0.041 (0.028)	-0.034 (0.028)	-0.036 (0.028)
MSI_{t-1}	0.202** (0.083)	0.216*** (0.082)	0.186** (0.087)	0.209*** (0.074)	0.234*** (0.075)	0.231*** (0.084)
MSI_{t-2}	-0.225** (0.088)	-0.217** (0.089)	-0.217** (0.090)	-0.129 (0.079)	-0.133* (0.078)	-0.161** (0.079)
MSI_{t-3}	-0.038 (0.092)	-0.023 (0.094)	-0.010 (0.093)	-0.109 (0.082)	-0.108 (0.083)	-0.080 (0.085)
MSI_{t-4}	-0.013 (0.090)	-0.005 (0.093)	-0.006 (0.094)	-0.005 (0.071)	0.005 (0.075)	0.008 (0.077)
MSI_{t-5}	0.029 (0.082)	-0.011 (0.083)	0.003 (0.085)	0.040 (0.083)	-0.007 (0.082)	0.008 (0.083)
Constant	-0.058 (0.042)	0.145 (0.136)	0.211 (0.240)	-0.060 (0.043)	0.225* (0.129)	0.119 (0.235)
ARCH						
ARCH(1)	0.058*** (0.009)	0.056*** (0.008)	0.058*** (0.009)	0.098*** (0.010)	0.107*** (0.011)	0.094*** (0.011)
GARCH(1)	0.941*** (0.008)	0.944*** (0.008)	0.942*** (0.008)	0.898*** (0.010)	0.891*** (0.010)	0.904*** (0.010)
Constant	0.013* (0.007)	0.010 (0.006)	0.011 (0.007)	0.041*** (0.010)	0.038*** (0.010)	0.029*** (0.009)
Day-of-the-week	Yes	Yes	Yes	Yes	Yes	Yes
ECB Press conference communications	No	Yes	Yes	No	Yes	Yes
ECB Inter-meeting communications	No	Yes	Yes	No	Yes	Yes
Monetary Policy Decisions	No	Yes	Yes	No	Yes	Yes
Macro. Surprises	No	Yes	Yes	No	Yes	Yes
News-sent	No	Yes	Yes	No	Yes	Yes
Financial Variables	No	No	Yes	No	No	Yes
$\log - likelihood$	-3244.551	-3221.753	-3209.509	-3176.578	-3149.496	-3138.629
Obs.	1572	1572	1572	1572	1572	1572

Note: Standard Errors in parenthesis. ***, **, and * represent statistical significance at respectively 1%, 5%, and 10%. 5Y-5Y (10Y) is the 5-y to 5-y (10 years) forward rate from inflation-linked swaps. Day-of-the-week are dummy variables for each day of the week, News-sent are the economic news indexes of Shapiro et al. (2020) and Bortoli et al. (2018). MSI is the Media Sentiment Index. All other control variables are defined in Table 2.

to all other inflation swap instruments. See Garcia and Werner (2018) for a thorough discussion.

Columns (1) and (4) correspond to the estimates of equation 4 for our two inflation expectations measures, without the vector of controls X . We find in both cases that the first lag of our sentiment measure has a positive and significant effect on next day inflation expectations. An exogenous increase in our measure of media sentiment on monetary policy at day t will thus increase the 5-y to 5-y and the 10-y inflation expectations in $t + 1$. We also observe in both cases that the positive effect at day $t + 1$ seems to at least partly reverse at day $t + 2$: the second lag of the MSI is negative for both measures and statistically significant at the 1% level for the 5-y to 5-y inflation swap measure. We also find that changes in inflation expectations exhibit some persistence with a statistically significant coefficient for the first lag for both measures, while the second lag appears to be statistically significant for the 5-y to 5-y inflation swap. This is not surprising in itself, as we are dealing with inflation swaps, which are over-the-counter instruments, where daily changes are relatively small and arbitrage opportunities limited. In columns (2) and (5), we added the first two lags for our control variables ($m = 2$) except financial variables. Doing so only slightly affects the magnitude of our coefficient estimates but renders the second lag of the MSI now statistically significant at the 10% confidence level when the dependent variable is the change in the 10-year inflation expectations (column (5)). Lastly, in columns (3) and (6), we included financial variables in the regressions to make sure our results are not driven by any other market relevant information that would matter for next-days inflation expectations. The results remained unchanged.

4.3 Robustness and interpretation

In separate estimates³⁶, we used a GARCH(2,2) to model the variance in equation 5 and obtained similar results. We also tried to estimate equation 4 directly through OLS with Newey-West or Hubert-White standard errors. While these showed coefficients for the MSI of slightly higher magnitude, the key observation was not changed; the MSI was found to increase next day inflation expectations while the effect reversed the day after. In all cases, Wald tests could not reject the null hypothesis that the coefficient associated with the first lag of the MSI was equal to the opposite of the one associated with the second lag of the MSI , thereby clearly suggesting the presence of a reversal pattern. We also repeated the estimates with Jordà (2005)'s local projections and reached the same conclusion. We did not find evidence of non-linearities, when considering a different impact depending on whether inflation is below or above its target, or for moves of the MSI at press conference days.

The effect we unveiled in this section is of low magnitude when compared to stocks or exchange

³⁶All results are available upon request.

rates daily changes: a positive two-standard deviations increase in the *MSI*, which could make the *MSI* move from 6 deciles, is found to increase the next-day 5-y to 5-y (10-y) forward rate from less than a basis point, namely around 0.20 bps (0.24 bps). It has to be recalled, however, that this concerns long-term inflation swaps, for which the daily changes are usually small, and which, if anchored, should barely respond to news. In addition, we are analyzing an impact on the next trading day. The magnitude we find is in line with previous findings on the effects of central banks' communications or macroeconomic surprises on inflation swaps. Beechey et al. (2011) find that long-term inflation expectations (nine to ten years ahead inflation compensation) were unresponsive to macroeconomic surprises in the Euro area before the global financial crisis, while the effects found in Garcia and Werner (2018) for macroeconomic surprises after 2013 are typically less than a basis point, with, for example, German and Spanish surprises in flash estimates leading to a change in 5-y to 5-y inflation compensation of around 0.6 and 0.5 basis point in the day of their release on average over their sample period. The observed response for the change in the 5-y to 5-y forward rate is still about thrice its unconditional mean from our sample period (-0.082), and is as such comparable in magnitude to the results obtained in Tetlock (2007).³⁷ As in Tetlock (2007) or Garcia (2013), the effect of a sentiment shock reverses, but quicker in our case. The small effect we find suggests nonetheless that media sentiment on monetary policy is of limited economic relevance to understand financial market's inflation expectations.

5 Conclusion

Communication is a key part of monetary policy. While there is a clear consensus that communications from central bankers impact financial markets, little is known about the role of media coverage in this transmission. In this paper, we shed light on this particular point.

We built a new measure of the media sentiment on the ECB monetary policy and its relevant environment, using advanced natural language processing methods with a database of about 25,000 newspaper articles. The resulting index is, to our knowledge, the first index measuring media sentiment on the ECB monetary policy and its relevant environment, on a continuous basis. A key innovation we have introduced is the purging of each article from news re-transcription, to capture journalist interpretation. We used a rich external dataset on inter-meeting communications to analyze the determinants of our index. We found that media sentiment is affected by the content

³⁷In Tetlock (2007), the effect of a two-standard deviations change in his sentiment index on the next day's Dow Jones returns is 16.2 basis points, that is, a bit more than thrice the unconditional mean of Dow Jones returns in his sample period (5.4 basis points).

of the press conference and by inter-meeting interventions of the President as well as interventions of other members of the Governing Council related to monetary policy inclination. We analyzed the relevance of our index for inflation expectations and found that media sentiment on monetary policy has predictive power for the daily changes in the 5-years to 5-years inflation swap rate as well as for the 10-years inflation swap rate. The magnitude of the effect we found do not suggest that media sentiment on monetary policy is economically important to understand financial markets' inflation expectations.

Anecdotal evidence already suggests that media coverage matters for central bankers. For example, in 2013, the ECB signed a contract to monitor print media, online media, broadcast, and social media and to perform a media analysis/reputation tracking.³⁸ The ECB itself announced on its website that "the conclusions drawn from [this] analysis help shape the ECB's communication strategy." This paper provides an empirical analysis unveiling the effect of different kinds of communications and decisions on media coverage. It stresses in particular the key importance of the communications of the President, especially those during the press conference related to monetary policy inclination. In addition, it provides empirical evidence suggesting that media sentiment also matters in the context of central banking and that the economic importance of media sentiment is negligible in this context. We find a reversal pattern for the effect of sentiment on next-days inflation expectations, as observed in Tetlock (2007) or Garcia (2013) in another context.

Naturally, our analysis suffers from the traditional limits of text analysis methods, which could, in turn, lead us to underestimate the magnitude of the media effect. Qualitative differences between words, sentences and articles are in particular neglected. Furthermore, although we only selected media known for their analysis (in contrast to newswire services), removed all re-transcriptions, controlled for several news variables and several indexes of central bank communications, and looked at the relationship with next-day inflation expectations rather than contemporaneous relations, we cannot firmly eliminate the possibility that the effect may be driven by news. In further research, it would be interesting to assess with alternative methods the magnitude of the media channel and to investigate the links between media sentiment on monetary policy and households or business' expectations.

³⁸Germany-Frankfurt-on-Main: ECB - Provision of media monitoring and analysis services 2013/S 170-294141

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Appendix A - Measuring Media Sentiment

.1 Example of media sentiment measurement for two articles

We present two examples of texts from which the MSI is built, in which we indicate:

- **Positive** words (from LM dictionary) in blue
- **Negative** words (from LM dictionary) in red
- Exact re-transcriptions of ECB members' words removed with part-of-speech tagging crossed out

The first article below has a sentiment score which belongs to the last decile of the MSI distribution. The sentiment of the original text is about -2,7 (in the 7th decile of our MSI measure) while purged out from re-transcriptions, it amounts to about -3,6 (in the last decile).

The Wall Street Journal, September 9, 2011

FRANKFURT — The ECB opened the door to interest-rate cuts if needed to bolster a **weakening** economic recovery —a dramatic U-turn from its decision to raise interest rates just two months ago. ~~Economic risks have "intensified" to the downside with "enormous" uncertainty, ECB President Jean-Claude Trichet told reporters after the central bank held its main policy rate at 1.5%. He called the ECB's reassessment of the economic outlook "significant" and highlighted~~ **weakening** global growth, **declines** in equity markets and **strains** in euro-zone government bond markets as **trouble** spots. At the same time, Mr. Trichet **defended** the ECB's two rate hikes earlier this year, saying they were needed to keep inflation in check. He also launched an uncharacteristically passionate defense of the ECB's recent decision to buy Italian and Spanish bonds, saying the moves were needed to restore **smooth** transmission of the ECB's interest-rate decisions to financial markets and the economy. ~~"We stand ready to do whatever is necessary," Mr. Trichet said, adding that the ECB will "monitor very closely all developments."~~ Until Thursday, the ECB had only said that it would closely monitor what it saw as upside risks to inflation. Those risks are now balanced, Mr. Trichet said. At 2.5%, annual inflation is still above the ECB's 2% target. But ECB staff economists expect it to fall to 1.7% in 2012, according to revised projections released Thursday. "This is an ECB that's worried" about the economy, said Nick Matthews, economist at Royal Bank of Scotland. "It's clear that the ECB has an **easing** bias and may be cutting rates by the end of the year" Mr. Matthews said. The euro zone expanded just 0.7%, at an annualized rate, in the second quarter as the region's two largest economies, Germany and France posted little or no growth. A **collapse** in business and consumer sentiment last month raised a grimmer prospect: The euro zone may be headed toward another recession. The risks of renewed **contraction** in the world's advanced economies "has gone up" the Organization for Economic Cooperation and Development said Thursday. The Paris-based organization of developed and large developing economies urged central banks with the "scope" to do so to consider **easing** rates. But recent data suggest some of the gloom may be overblown in Europe. German industrial production jumped 4% in July from June, though business sentiment slid that month. Consumer spending in the euro zone rose in July. The economy is softening but isn't falling back into **recession** yet, analysts say. Euro-zone gross domestic product "is expected to increase very moderately in the second half of this year" Mr. Trichet said. ECB staff **cut** their 2012 growth forecast to 1.3% from 1.7%. If the economy **stabilizes** even at **weak** growth rates, then the ECB will likely keep interest rates steady, some economists said. "It may take **contraction** for them to actually **cut** rates" said Howard Archer, economist at consultancy IHS Global Insight. The ECB raised rates in April and again in July even as other major developed-country central banks such as the Federal Reserve, the Bank of England and the Bank of Japan held rates at crisis-era lows closer to zero. The Bank of England voted Thursday to keep rates at a record-low 0.5%, but didn't announce any plans to resume its asset-purchase program, known as quantitative easing. The ECB's sudden shift opens it to renewed **criticism** that—as in July 2008 when

it increased rates just weeks before the **collapse** of Lehman Brothers—officials didn’t recognize early **warning** signs on the economy and **overestimated** inflation risks, **exacerbating** the slowdown. The ECB made the right call, Mr. Trichet said Thursday. "We think what we did was appropriate" he said, referring to this year’s rate hikes. "We preserved a solid anchoring of inflation expectations." Mr. Trichet vigorously **defended** the ECB’s decision, made one month ago, to reactivate its government bond purchase program and expand it to include Italian and Spanish bonds. The ECB has bought more than 50 billion in government bonds since restarting the program, which had been dormant for four months. That **provoked** a backlash in Germany, where government bond purchases by central banks are seen as an inflationary taboo that puts central bankers in the realm of fiscal policy. The head of Germany’s central bank, Jens Weidmann, voted against reactivating the purchases. German President Christian Wulff, whose position is largely ceremonial, has called the ECB’s bond purchases politically and legally questionable. The head of German’s center-left SPD party, Sigmar Gabriel, has also blasted the move. His voice rising uncharacteristically, Mr. Trichet said the ECB has displayed an “impeccable, impeccable” adherence to price **stability** during its 12-year history. “I would very much like to hear the congratulations for an institution that has delivered price **stability** in Germany...which is **better** than has ever been **achieved** in this country” he said, responding to a question about Mr. Gabriel’s criticism. Mr. Trichet repeated his insistence that euro-zone parliaments approve changes to Europe’s 440-billion rescue fund that would allow it to purchase bonds in financial markets, alleviating the ECB of that task. The ECB President **dismissed concerns** that the euro zone **suffers** from a **lack** of liquidity in its banking system, and **rejected claims** that the region’s banks are in **urgent** need of more capital. International Monetary Fund managing director Christine Lagarde caused a stir last month when she said European banks needed **urgent** recapitalization. “I will not dramatize the situation as has been done by some” Mr. Trichet said, without referring specifically to Ms. Lagarde’s comments.

The second article below has a sentiment score which belongs to the first decile of the MSI distribution (very positive). Its score is about 0.017.

The Financial Times, September 4, 2013

Watch out for some upbeat comments - maybe even a joke? - from Mario Draghi today. Plenty has gone right recently for the ECB president - with the economic data, that is, not with the politics in his native Italy. Wednesday’s purchasing managers’ indices showed the eurozone’s recovery becoming firmly established. Unlike previous, German-led **upturns** the return to solid expansion territory is broad-based. Much of the **improvement** has been in Italy and Spain. The PMIs are watched closely by financial markets, and the turnaround explains why European shares have **outperformed** US shares over the past month. Tensions over Syria have knocked Europe’s equity rally recently. And the US Federal Reserve’s plan to scale back its asset purchases, or quantitative easing, could become a big **problem** for the eurozone and the ECB if it results in tighter monetary conditions in Europe. But the **strength** of equity rallies in countries such as Greece - still up almost 20 per cent year to date - highlight the shift in investor sentiment towards Europe’s monetary union. The big exception? Italy’s shares are back down to early January levels. That is hard to explain on economic grounds alone. True, Spain has made more **progress** in **improving** competitiveness by reducing unit labour costs. But Italy’s PMIs are almost as **strong** as Spain’s. Both have seen modest **improvements** in credit conditions recently amid clear signs that the eurozone fragmentation story - which resulted in widely diverging borrowing costs across the region - has gone into reverse. The only explanation is that markets remain spooked by Italian politics - especially **threats** that Silvio Berlusconi could bring down the administration led by Enrico Letta. As long as Italy’s government looks wobbly, investors will fret about reform prospects, and Mr Draghi will keep the country on his **worry** list.

.2 Top 20 word occurrences

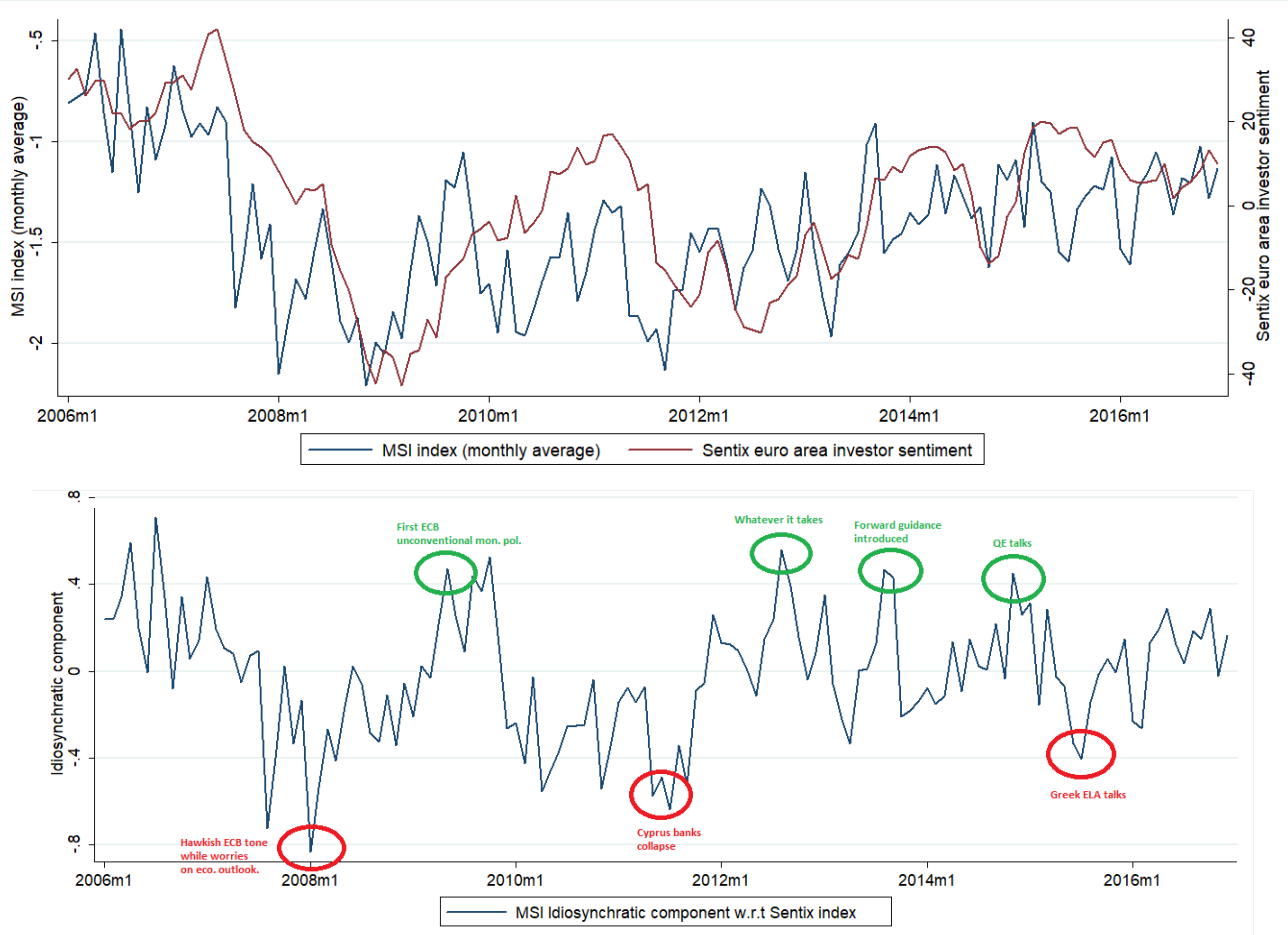
Positive		Negative	
Word	<i>Occurrences</i>	Word	<i>Occurrences</i>
strong	8664	crisis	17534
good	7206	cut	14255
despite	6941	bailout	8697
stability	6113	negative	8688
boost	5977	late	7888
better	5615	easing	7632
highest	4935	unemployment	6715
gains	4351	concerns	6574
positive	4278	fears	5585
able	4193	weak	5551
leading	3684	losses	5353
stronger	3640	warned	5337
best	3585	decline	4825
gained	3378	deficit	4821
greater	3082	problems	4798
strength	2397	lost	4492
great	2371	recession	4291
gain	2362	dropped	4214
benefit	1797	problem	4209
progress	1770	default	4143

Note: The table shows the 20 words from the Loughran and McDonald (2011) dictionary with the highest number of occurrences in our database. Top positive (first column) and top negative (second column) words are shown.

Appendix B - Sentix investor confidence index versus MSI

We first plot the monthly Sentix investor confidence index for the Eurozone together with the MSI average at the monthly frequency (Figure 3, upper part), and then the residual component of our index after having regressed it on the Sentix investor confidence index (Figure 3, lower part).

Figure 3: MSI (monthly average) versus Sentix investor economic confidence for the Euro area



Notes: the top graph shows the media sentiment indicator aggregated at a monthly frequency versus the Sentix investor economic confidence index for the Euro area. The bottom graph shows the residuals of the regression of the media sentiment index on the Sentix investor confidence index, labelled "idiosyncratic component with respect to Sentix index". The events corresponding to important highs and lows are commented.

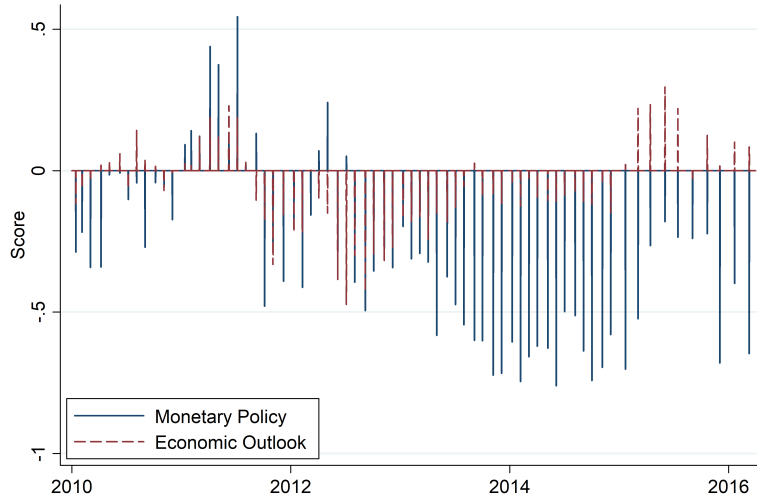
The residual component shows the idiosyncratic information to our index with respect to the Sentix investor confidence index. We observe that it contains relevant information on monetary policy perception. Focusing on the post-crisis period, the largest peak arises during the "whatever it takes" speech of Mario Draghi in the summer of 2012. Our MSI index soars the month of Draghi speech while investor sentiment stays at a low level. After that period, it peaks again when

forward guidance is introduced in 2013 and when *QE* talks start in late 2014. We also see that in 2009 the idiosyncratic component of our index remains significantly positive for some months, possibly revealing that the confidence in the central bank solving the financial crisis was relatively high (in the context of a falling investor economic sentiment). The lowest peak arises in January 2008, when markets become relatively pessimistic on the economic outlook, while Trichet remains hawkish in his communication and the ECB does not cut rate in the January meeting, contrasting with the accommodating policy decided by the FeD few days before.

Appendix C - Data on ECB communications

Press conference communications are extracted from the ECB website. We measure their qualitative content in terms of monetary policy inclination (hawkish versus dovish) and communication *vis-à-vis* the economic outlook (positive versus negative). To do so, we apply the field-specific dictionary developed in Picault and Renault (2017), which aims at capturing these two aspects of the ECB member’s speeches, and is exactly built from the ECB members communications’ wording. In contrast to standard methods, it uses contiguous sequence of words and a specific term-weighting approach to quantify the content of communication. This ECB-specific dictionary has been shown to better capture the central bankers’ communication subtleties compared to the traditional alternatives and is thus a natural candidate to extract the qualitative content of the ECB communications. With the monetary policy inclination dictionary, we build a variable reflecting the hawkish/dovish inclination of the President speeches during the press conference as well as a variable reflecting its communication on the economic outlook during the press conference. The classification of the ECB press conferences’ content is presented in Figure 4.

Figure 4: ECB Press Conference Introductory statement content

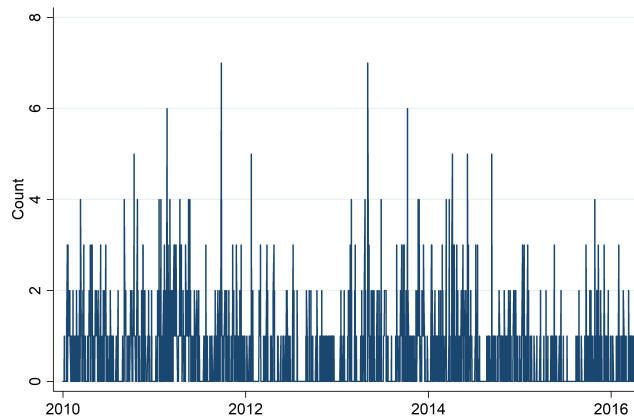


Note: The Figure presents, at a daily frequency, the monetary policy (lower value indicates a more accommodating content) and economic outlook (a lower value indicates a more negative content) inclination of the ECB Press conference Introductory Statement using Picault and Renault (2017) lexicon and methodology.

Regarding inter-meeting communications, we use data kindly provided by Gertler and Horvath (2018), who manually classified ECB inter-meeting communications in function of their monetary policy and economic outlook inclination. We obtain daily data representing the average inclination of the communications, differentiated between the communications from the President and the communications from the other members of the Governing Council (other Executive Board members and Heads of national central banks). We use them to construct two distinct daily time

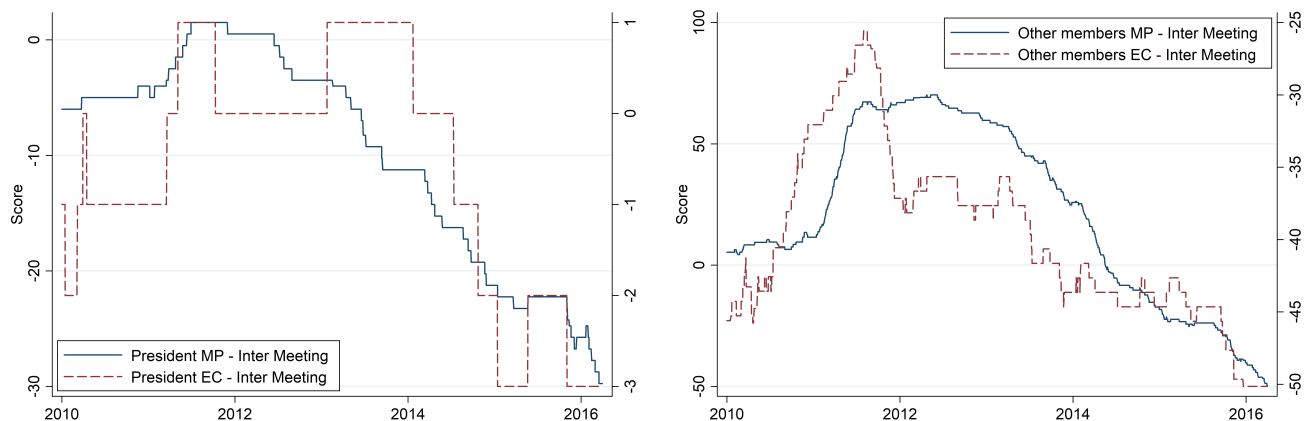
series. The the number of communications and the resulting data are displayed in Figure 5 and 6 respectively.

Figure 5: Inter-meeting communications from ECB officials



Note: The Figure presents the daily number of inter-meeting communications from ECB officials during our sample period using the Gertler and Horvath (2018) database.

Figure 6: ECB Communications tonality regarding Monetary Policy and Economic Outlook



Note: The Figure presents, at a daily frequency, the monetary policy inclination of the ECB communications (on the left - a lower value indicates a more accommodating content) and the economic outlook view of the ECB communications (on the right - a lower value indicates a more negative content). We present here the **accumulated** values for these data for readability purpose, in all estimates the first difference of these was taken.

Appendix D - List of macroeconomic surprises and unconventional monetary policies considered

Table 5: Macroeconomic surprises:

<i>Country or area</i>	<i>Variable</i>
Euro Area	Inflation surprises, flash CPI
	Business climate surprises
	Industrial confidence surprises
	PPI surprises
	Production surprises
	Unemployment surprises
France	Inflation surprises, HCPI
	Industrial production surprises
Germany	Inflation surprises, HCPI
	Business climate surprises
	Unemployment surprises
Italy	Inflation surprises, HCPI
	Manufacture confidence surprises
	Unemployment surprises
Spain	Inflation surprises, HCPI
	Industrial output surprises
	Unemployment surprises

Table 6: Unconventional monetary policies:

<i>Press release date</i>	<i>Unconventional monetary policy</i>
7 May 2009	Covered bond purchase programme (first) and 1-year LTRO
10 May 2010	Securities market programme
7 August 2011	Securities market programme, new announcement
6 October 2011	Covered bond purchase programme (second) and new LTRO
6 September 2012	Technical features of OMT
5 June 2014	Asset-backed securities purchase programme and TLTRO
4 September 2014	Asset-backed securities purchase programme and Covered bond purchase programme
22 January 2015	Public sector purchase programme
9 March 2015	Public sector purchase programme, new announcement
10 March 2016	Public sector purchase programme, new announcement (increase in size)

Note: From Moessner (2018), press release date is verified on the ECB website.

Appendix E - Media Sentiment determinants, effect of communications - Robustness and further tests

Table 7: Media Sentiment determinants, effect of communications - model with additional lags

	[1]	[2]	[3]	[4]	[5]	[6]
MSI _{t-1}	0.280*** (0.033)	0.278*** (0.034)	0.275*** (0.034)	0.238*** (0.032)	0.252*** (0.033)	0.252*** (0.025)
MSI _{t-2}	0.069*** (0.025)	0.067*** (0.026)	0.068*** (0.026)	0.048** (0.024)	0.048* (0.026)	0.048* (0.026)
MSI _{t-3}	0.045 (0.033)	0.045 (0.033)	0.047 (0.033)	0.032 (0.032)	0.032 (0.027)	0.032 (0.025)
MSI _{t-4}	0.086*** (0.024)	0.088*** (0.025)	0.087*** (0.025)	0.065** (0.026)	0.063** (0.028)	0.063** (0.025)
President MP - Press Conferences _t	-0.479*** (0.132)	-0.523*** (0.142)	-0.507*** (0.145)	-0.441*** (0.132)	-0.438*** (0.121)	-0.438*** (0.162)
President MP - Press Conferences _{t-1}	-0.525*** (0.095)	-0.510*** (0.116)	-0.515*** (0.117)	-0.383*** (0.121)	-0.367*** (0.122)	-0.367** (0.163)
President MP - Press Conferences _{t-2}	-0.409*** (0.084)	-0.465*** (0.110)	-0.471*** (0.110)	-0.345*** (0.117)	-0.364*** (0.126)	-0.364** (0.164)
President MP - Press Conferences _{t-3}	-0.402*** (0.140)	-0.330** (0.144)	-0.331** (0.144)	-0.266* (0.147)	-0.270* (0.149)	-0.270 (0.164)
President EC - Press Conferences _t	0.555* (0.329)	0.627* (0.341)	0.595* (0.332)	0.590* (0.322)	0.570** (0.284)	0.570 (0.417)
President EC - Press Conferences _{t-1}	0.198 (0.205)	0.204 (0.242)	0.213 (0.243)	0.183 (0.235)	0.196 (0.222)	0.196 (0.417)
President EC - Press Conferences _{t-2}	0.072 (0.263)	0.061 (0.299)	0.075 (0.298)	0.050 (0.301)	0.065 (0.298)	0.065 (0.421)
President EC - Press Conferences _{t-3}	0.539 (0.376)	0.419 (0.423)	0.417 (0.429)	0.512 (0.420)	0.449 (0.390)	0.449 (0.422)
Other members MP - Inter Meeting _{t-1}	-0.061** (0.029)	-0.060** (0.029)	-0.061** (0.029)	-0.052* (0.028)	-0.054* (0.032)	-0.054 (0.034)
Other members MP - Inter Meeting _{t-2}	-0.045 (0.028)	-0.043 (0.028)	-0.042 (0.028)	-0.036 (0.027)	-0.036 (0.034)	-0.036 (0.034)
Other members MP - Inter Meeting _{t-3}	0.016 (0.039)	0.016 (0.039)	0.011 (0.039)	0.028 (0.039)	0.035 (0.036)	0.035 (0.035)
Other members EC - Inter Meeting _{t-1}	0.028 (0.047)	0.020 (0.047)	0.023 (0.046)	0.019 (0.046)	0.013 (0.053)	0.013 (0.050)
Other members EC - Inter Meeting _{t-2}	0.109** (0.043)	0.105** (0.044)	0.106** (0.044)	0.083** (0.041)	0.075* (0.044)	0.075 (0.050)
Other members EC - Inter Meeting _{t-3}	-0.002 (0.050)	-0.007 (0.051)	-0.008 (0.051)	-0.044 (0.047)	-0.046 (0.046)	-0.046 (0.050)
President MP - Inter Meeting _{t-1}	-0.177*** (0.043)	-0.168*** (0.046)	-0.156*** (0.047)	-0.166*** (0.045)	-0.170*** (0.054)	-0.170** (0.075)
President MP - Inter Meeting _{t-2}	0.058 (0.063)	0.058 (0.065)	0.056 (0.068)	0.047 (0.070)	0.039 (0.069)	0.039 (0.075)
President MP - Inter Meeting _{t-3}	0.010 (0.072)	0.011 (0.074)	0.004 (0.074)	-0.000 (0.071)	0.013 (0.079)	0.013 (0.074)
President EC - Inter Meeting _{t-1}	0.228** (0.091)	0.231** (0.092)	0.230** (0.090)	0.216** (0.099)	0.227** (0.093)	0.227* (0.132)
President EC - Inter Meeting _{t-2}	-0.328*** (0.127)	-0.329** (0.128)	-0.327*** (0.127)	-0.337*** (0.124)	-0.340** (0.139)	-0.340** (0.132)
President EC - Inter Meeting _{t-3}	-0.140 (0.145)	-0.141 (0.146)	-0.145 (0.149)	-0.168 (0.148)	-0.162 (0.190)	-0.162 (0.132)
ECB decisions, t to t-3	No	Yes	Yes	Yes	Yes ⁿ	Yes ⁿ
Macro-economic surprises, t to t-3	No	No	Yes	Yes	Yes ⁿ	Yes ⁿ
Financial variables, t to t-3	No	No	No	Yes	Yes ⁿ	Yes ⁿ
Constant	-0.061*** (0.018)	-0.063*** (0.019)	-0.062*** (0.019)	0.202*** (0.052)	0.215*** (0.047)	0.215*** (0.050)
Adjusted R ²	0.165	0.159	0.158	0.197	0.197	0.197
Obs.	1630	1630	1630	1630	1630	1630

Table 8: Media Sentiment determinants, effect of communications - Robustness

	[1] H-W	[2] lag	[3] nega sent	[4] harvard sent	[5] vader sent	[6] weighted sent
MSI_{t-1}^a	0.266*** (0.033)	0.255*** (0.033)	0.146*** (0.035)	0.160*** (0.029)	0.136*** (0.025)	0.196*** (0.030)
MSI_{t-2}^a	0.050* (0.026)	0.056** (0.026)	0.097*** (0.025)	0.036 (0.024)	0.041* (0.022)	0.069** (0.029)
MSI_{t-3}^a	0.030 (0.027)	0.027 (0.031)	0.035 (0.027)	0.034 (0.029)	0.039* (0.023)	0.015 (0.031)
MSI_{t-4}^a	0.062** (0.028)	0.070*** (0.024)	0.102*** (0.025)	0.074*** (0.028)	0.065*** (0.020)	0.094*** (0.024)
President MP - Press Conferences _t	-0.401*** (0.120)	-0.428*** (0.134)	-0.369*** (0.100)	-3.840* (2.147)	-6.587*** (1.531)	-0.405*** (0.127)
President EC - Press Conferences _t	0.554** (0.278)	0.558 (0.341)	0.702*** (0.272)	-0.998 (3.857)	3.667 (3.352)	0.652** (0.330)
Other members MP - Inter Meeting _{t-1}	-0.066** (0.032)	-0.059** (0.027)	-0.044** (0.022)	-1.427** (0.684)	-1.065*** (0.376)	-0.062** (0.028)
Other members EO - Inter Meeting _{t-1}	0.012 (0.052)	0.009 (0.042)	0.000 (0.044)	0.073 (0.727)	-0.118 (0.366)	0.021 (0.055)
President MP - Inter Meeting _{t-1}	-0.166*** (0.052)	-0.172*** (0.041)	-0.139*** (0.040)	-1.695* (0.889)	-1.883*** (0.489)	-0.144*** (0.045)
President EO - Inter Meeting _{t-1}	0.217** (0.087)	0.203** (0.091)	0.023 (0.095)	-0.799 (1.883)	0.694 (0.778)	0.085 (0.080)
Δi	-0.736 (0.648)	-0.548 (0.541)	-0.852 (0.572)	0.637 (11.491)	2.477 (6.744)	-1.192 (0.731)
Negative Interest Surprise	1.733*** (0.631)	1.682*** (0.563)	1.455*** (0.554)	28.494** (11.886)	6.742 (9.501)	2.050*** (0.695)
Positive Interest Surprise	0.829 (0.749)	1.088** (0.540)	0.327 (0.460)	2.086 (8.990)	-3.038 (5.672)	-0.468 (0.856)
APP	-0.151 (0.144)	-0.049 (0.072)	0.025 (0.079)	0.798 (1.653)	-0.602 (1.051)	-0.123 (0.168)
Negative Rate	0.166*** (0.034)	0.157*** (0.039)	0.104*** (0.029)	12.091*** (0.604)	6.692*** (0.433)	-0.029 (0.040)
Whatever it takes	0.163*** (0.056)	0.330*** (0.037)	0.004 (0.055)	1.765 (1.136)	-0.451 (0.866)	-0.139** (0.058)
Macro-economic surprises _t	Yes	No	Yes	Yes	Yes	Yes
Financial variables _t	Yes	No	Yes	Yes	Yes	Yes
Macro-economic surprises _{t-1}	No	Yes	No	No	No	No
Financial variables _{t-1}	No	Yes	No	No	No	No
Constant	0.241*** (0.045)	0.206*** (0.051)	0.165*** (0.042)	4.431*** (1.089)	2.766*** (0.773)	0.223*** (0.060)
Adjusted R^2	0.188	0.171	0.123	0.101	0.108	0.142
Obs.	1630	1630	1630	1630	1630	1630

Note: Estimates of the coefficients of equation 3, with alternative controls and alternative constructions of the MSI. In parenthesis, Huber-White Standard Errors in column (1) and Newey-West Standard Errors in columns (2), (3), (4), (5) and (6). In columns (3), (4), (5) and (6) we use alternative dependant variables so that MSI^a is built with only the negative words considered in equation 1 (column 3), or with the positive and negative words from the Harvard-IV dictionary (column 4), or using Vader classifier (column 5) or by weighting the newspapers using a proxy for their audience (column 6, see footnote 32 for details). ***, **, and * represent statistical significance at respectively 1%, 5%, and 10%. All control variables are defined in Table 2.

Table 9: Media Sentiment determinants, effect of communications when inflation is above/below its target

	[1]	[2]	[3]	[4]
MSI_{t-1}	0.290*** (0.032)	0.290*** (0.032)	0.268*** (0.031)	0.265*** (0.031)
MSI_{t-2}	0.064** (0.026)	0.063** (0.026)	0.048* (0.026)	0.048* (0.026)
MSI_{t-3}	0.036 (0.033)	0.036 (0.033)	0.025 (0.031)	0.026 (0.031)
MSI_{t-4}	0.079*** (0.024)	0.079*** (0.024)	0.060** (0.024)	0.061** (0.024)
President MP - Press Conferences _t	-0.405*** (0.129)	-0.455*** (0.139)	-0.405*** (0.126)	-0.405*** (0.126)
President EC - Press Conferences _t	0.973* (0.514)	0.976* (0.503)	1.052** (0.434)	1.016** (0.441)
Other members MP - Inter Meeting _{t-1}	-0.088*** (0.033)	-0.089*** (0.034)	-0.073** (0.033)	-0.078** (0.033)
Other members EO - Inter Meeting _{t-1}	0.046 (0.054)	0.046 (0.054)	0.063 (0.054)	0.068 (0.053)
President MP - Inter Meeting _{t-1}	-0.200*** (0.048)	-0.200*** (0.048)	-0.190*** (0.045)	-0.186*** (0.046)
President EO - Inter Meeting _{t-1}	0.184* (0.102)	0.184* (0.102)	0.166 (0.104)	0.166 (0.104)
<i>Target</i>	-0.088** (0.039)	-0.088** (0.038)	-0.046 (0.035)	-0.049 (0.035)
President MP - Press Conferences _t x <i>Target</i>	-0.081 (0.321)	-0.025 (0.311)	-0.051 (0.285)	-0.047 (0.286)
President EO - Press Conferences _t x <i>Target</i>	-0.733 (0.675)	-0.774 (0.662)	-0.847 (0.579)	-0.821 (0.585)
Other members MP - Inter Meeting _{t-1} x <i>Target</i>	0.095* (0.056)	0.102* (0.055)	0.058 (0.059)	0.062 (0.057)
Other members EO - Inter Meeting _{t-1} x <i>Target</i>	-0.103 (0.093)	-0.106 (0.093)	-0.190* (0.100)	-0.193* (0.099)
President MP - Inter Meeting _{t-1} x <i>Target</i>	0.142 (0.096)	0.141 (0.096)	0.086 (0.096)	0.097 (0.092)
President EO - Inter Meeting _{t-1} x <i>Target</i>	0.237* (0.142)	0.234* (0.142)	0.267* (0.145)	0.267* (0.145)
Δi		-0.136 (0.472)	-0.464 (0.581)	-0.455 (0.588)
Negative Interest Surprise		1.406*** (0.468)	1.593*** (0.525)	1.596*** (0.532)
Positive Interest Surprise		0.937 (0.609)	0.357 (0.805)	0.329 (0.809)
APP		-0.116 (0.079)	-0.155 (0.146)	-0.151 (0.147)
Negative Rate		0.182*** (0.035)	0.163*** (0.036)	0.162*** (0.035)
Whatever it takes		0.507*** (0.054)	0.240*** (0.061)	0.240*** (0.063)
Financial variables	No	No	Yes	Yes
Macro-economic surprises	No	No	No	Yes
Constant	-0.021 (0.017)	-0.021 (0.017)	-0.020 (0.017)	0.194*** (0.044)
Adjusted R^2	0.155	0.154	0.186	0.188
Obs.	1630	1630	1630	1630

Note: *Target* is a dummy variable equal to 1 if inflation is above the 2% target, 0 otherwise. Newey-West Standard Errors in parenthesis. ***, **, and * represent statistical significance at respectively 1%, 5%, and 10%. *MSI* is the Media Sentiment Index. All control variables are defined in Table 2.

Appendix F - Descriptive statistics

Table 10: Descriptive Statistics (2010-2016)

	Mean	S. D.	Max.	Min.	Obs.
Media Sentiment					
MSI_{gross}	-1.508	0.558	0.902	-3.945	1630
MSI	-0.071	0.543	2.338	-2.562	1630
$MSI_{NegativeWords}$	-0.065	0.452	1.574	-2.103	1630
$MSI_{HarvardIV-4}$	-0.319	9.250	32.008	-41.962	1630
MSI_{Vader}	-1.700	6.889	77.591	-63.855	1630
$MSI_{Weighted}$	-0.126	0.583	2.292	-3.139	1630
ECB Communications					
President MP - Press Conferences	-0.013	0.088	0.545	-0.761	1630
President EC - Press Conferences	-0.003	0.035	0.296	-0.473	1630
President MP - Inter Meeting	-0.015	0.167	1.000	-1.000	1630
President EC - Inter Meeting	-0.001	0.093	1.000	-1.000	1630
Other members MP - Inter Meeting	-0.034	0.376	1.000	-1.000	1630
Other members EC - Inter Meeting	-0.003	0.249	1.000	-1.000	1630
Monetary Policy Decisions					
Δi	-0.001	0.017	0.250	-0.250	1630
Negative Interest Surprise	-0.000	0.009	0.000	-0.250	1630
Positive Interest Surprise	0.000	0.006	0.250	0.000	1630
APP	0.005	0.070	1.000	0.000	1630
Negative Rate	0.001	0.025	1.000	0.000	1630
Whatever it takes	0.001	0.025	1.000	0.000	1630
Financial Variables					
Fiscal stress	0.001	0.178	1.376	-3.608	1630
Δ EURUSD	-0.000	0.006	0.030	-0.024	1630
VSTOXX	23.810	6.789	53.547	12.713	1630
Δ EUROSTOX	0.000	0.014	0.098	-0.063	1630
Δ 5Y-5Y Inflation Expectations (swap)	-0.082	2.092	10.507	-8.741	1608
Δ 10Y Inflation Expectations (swap)	-0.089	2.033	10.000	-10.500	1608

Table 11: Descriptive Statistics - Macroeconomic Surprises - **A ENLEVER DU PAPER**

	Mean	S. D.	Max.	Min.	Obs.
Euro Area					
Flash CPI	-0.000	0.000	0.005	-0.004	1630
Buss. climate	0.001	0.035	0.500	-0.380	1630
Indus. confidence	0.005	0.211	3.000	-2.000	1630
PPI	-0.000	0.000	0.004	-0.004	1630
Production (YoY)	-0.000	0.002	0.032	-0.033	1630
Unemployment	-0.000	0.000	0.003	-0.002	1630
France					
HCPI	-0.000	0.000	0.003	-0.003	1630
Industrial Production (YoY)	0.000	0.003	0.035	-0.027	1630
Germany					
HCPI	-0.000	0.000	0.004	-0.006	1630
Buss. climate	0.012	0.258	4.700	-2.500	1630
Unemployment	-0.000	0.000	0.001	-0.002	1630
Italy					
HCPI	-0.000	0.001	0.008	-0.008	1630
Manuf. confidence	0.012	0.395	10.400	-3.600	1630
Unemployment	-0.000	0.001	0.006	-0.007	1630
Spain					
HCPI	0.000	0.001	0.009	-0.007	1630
Indus. Output	-0.000	0.001	0.031	-0.020	1630
Unemployment	0.000	0.001	0.007	-0.009	1630

Table 12: Inflation swaps - Additionnal Robustness Checks

	[1] 5Y-5Y	[2] 5Y-5Y	[3] 5Y-5Y	[4] 10Y	[5] 10Y	[6] 10Y
$f_t^m - f_{t-1}^m$	0.076*** (0.028)	0.086*** (0.032)	0.086*** (0.031)	0.144*** (0.030)	0.138*** (0.035)	0.138*** (0.033)
$f_{t-1}^m - f_{t-2}^m$	0.081*** (0.027)	0.095*** (0.034)	0.095*** (0.033)	0.029 (0.031)	0.045 (0.032)	0.045 (0.035)
$f_{t-2}^m - f_{t-3}^m$	-0.029 (0.028)	-0.010 (0.032)	-0.010 (0.030)	0.003 (0.030)	-0.004 (0.030)	-0.004 (0.030)
$f_{t-3}^m - f_{t-4}^m$	-0.016 (0.025)	-0.032 (0.026)	-0.032 (0.031)	0.007 (0.025)	-0.025 (0.025)	-0.025 (0.033)
$f_{t-4}^m - f_{t-5}^m$	-0.023 (0.026)	-0.024 (0.031)	-0.024 (0.031)	-0.039 (0.026)	-0.025 (0.028)	-0.025 (0.030)
MSI $_{t-1}$	0.172** (0.087)	0.295** (0.118)	0.295*** (0.103)	0.225*** (0.083)	0.281** (0.109)	0.281*** (0.095)
MSI $_{t-2}$	-0.208** (0.090)	-0.251** (0.099)	-0.251** (0.103)	-0.151* (0.080)	-0.162* (0.094)	-0.162* (0.098)
MSI $_{t-3}$	-0.019 (0.092)	-0.083 (0.093)	-0.083 (0.102)	-0.059 (0.086)	-0.078 (0.091)	-0.078 (0.096)
MSI $_{t-4}$	0.005 (0.094)	0.045 (0.094)	0.045 (0.104)	0.022 (0.078)	0.022 (0.098)	0.022 (0.099)
MSI $_{t-5}$	-0.015 (0.083)	0.030 (0.097)	0.030 (0.105)	-0.007 (0.078)	0.001 (0.085)	0.001 (0.098)
Constant	0.109 (0.234)	-0.049 (0.257)	-0.049 (0.310)	-0.007 (0.222)	-0.185 (0.246)	-0.185 (0.302)
Day-of-the-week	Yes	Yes	Yes	Yes	Yes	Yes
ECB Press conference communications	Yes	Yes	Yes	Yes	Yes	Yes
ECB Inter-meeting communications	Yes	Yes	Yes	Yes	Yes	Yes
Monetary Policy Decisions	Yes	Yes	Yes	Yes	Yes	Yes
Macro. Surprises	Yes	Yes	Yes	Yes	Yes	Yes
News-sent	Yes	Yes	Yes	Yes	Yes	Yes
Financial Variables	Yes	Yes	Yes	Yes	Yes	Yes
ARCH						
ARCH(1)	0.073*** (0.013)			0.187*** (0.035)		
ARCH(2)	0.036** (0.016)			-0.172*** (0.031)		
GARCH(1)	-0.012 (0.038)			1.559*** (0.110)		
GARCH(2)	0.903*** (0.034)			-0.574*** (0.104)		
Constant	0.019 (0.013)			0.002 (0.002)		
Log-Likelihood	-3209.509	-3336.919	-3336.9186	-3125.36	-3270.862	-3270.8616
Obs.	1578	1578	1578	1578	1578	1578

Note: In columns (1) and (4) the model is estimated through maximum likelihood using a GARCH(2,2) specification. In columns (2) and (5) equation (4) is estimated through OLS with Newey-West standard errors, thus without any explicit modeling of the variance. Columns (3) and (6) present a similar regression with Huber-White standard errors. ***, **, and * represent statistical significance at respectively 1%, 5%, and 10%. All other control variables are defined in Table 2.

Table 13: MSI Determinants - specification without lags

	[1]	[2]	[3]	[4]
President MP - Press Conferences _t	-0.456*** (0.171)	-0.456*** (0.124)	-0.273** (0.120)	-0.267** (0.119)
President EC - Press Conferences _t	0.936** (0.439)	0.936** (0.393)	0.486 (0.296)	0.472* (0.281)
Other members MP - Inter Meeting _{t-1}	-0.078** (0.035)	-0.078** (0.038)	-0.067** (0.032)	-0.041 (0.032)
Other members EO - Inter Meeting _{t-1}	-0.022 (0.052)	-0.022 (0.052)	-0.008 (0.051)	-0.000 (0.050)
President MP - Inter Meeting _{t-1}	-0.222*** (0.077)	-0.222*** (0.040)	-0.173*** (0.049)	-0.160*** (0.050)
President EO - Inter Meeting _{t-1}	0.277** (0.138)	0.277*** (0.096)	0.300*** (0.091)	0.307*** (0.089)
Δi	-0.889 (0.996)	-0.889 (0.986)	-0.668 (0.645)	-0.620 (0.528)
Negative Interest Surprise	1.558 (1.665)	1.558 (1.005)	1.393** (0.632)	1.336*** (0.489)
Positive Interest Surprise	1.432 (2.317)	1.432 (0.889)	1.002 (1.056)	0.780 (0.853)
APP	-0.110 (0.210)	-0.110 (0.194)	-0.214 (0.158)	-0.203 (0.147)
Negative Rate	0.407 (0.514)	0.407*** (0.046)	0.147*** (0.039)	0.216*** (0.065)
Whatever it takes	-0.001 (0.517)	-0.001 (0.049)	0.057 (0.151)	0.066 (0.225)
Financial uncertainty	-0.021*** (0.002)	-0.021*** (0.003)	-0.022*** (0.002)	-0.022*** (0.003)
Δ EUROSTOX	2.635** (1.033)	2.635*** (0.819)	2.003** (0.880)	1.895** (0.896)
Δ EURUSD	2.835 (2.117)	2.835 (1.874)	0.630 (1.909)	0.732 (1.894)
Fiscal stress	-0.089 (0.080)	-0.089 (0.061)	-0.108** (0.055)	-0.114** (0.052)
Constant	0.432*** (0.048)	0.432*** (0.072)	0.444*** (0.056)	0.444*** (0.096)
Variance Equation				
AR(1)				1.170*** (0.037)
AR(2)				-0.194*** (0.035)
MA(1)				-0.924*** (0.017)
Constant _{Variance}				0.484*** (0.012)
Adjusted R^2	0.104	0.104	0.062	
Obs.	1630	1630	1630	1630

Note: In column (1) the model is estimated with OLS and standard standard errors, in column (2) with OLS with Newey-West Standard Errors, in column (3) with the Prais-Winsten specification, in column (4) with an ARMAX specification. ***, **, and * represent statistical significance at respectively 1%, 5%, and 10%.

Table 14: Media determinants - remove small words

	[1] baseline	[2] diff < 2 removed	[3] diff < 3 removed	[4] 1st decile removed
MSI _{t-1} ^a	0.266*** (0.031)	0.265*** (0.036)	0.248*** (0.032)	0.271*** (0.030)
MSI _{t-2} ^a	0.050* (0.026)	0.046** (0.022)	0.032 (0.026)	0.050** (0.025)
MSI _{t-3} ^a	0.030 (0.031)	0.031 (0.032)	0.066* (0.036)	0.031 (0.031)
MSI _{t-4} ^a	0.062*** (0.024)	0.046* (0.024)	0.053** (0.023)	0.059** (0.023)
President MP - Press Conferences _t	-0.401*** (0.122)	-0.327*** (0.119)	-0.277** (0.121)	-0.417*** (0.128)
President EC - Press Conferences _t	0.554* (0.306)	0.630** (0.315)	0.600* (0.340)	0.548 (0.337)
Other members MP - Inter Meeting _{t-1}	-0.066** (0.029)	-0.077** (0.030)	-0.063** (0.028)	-0.074** (0.031)
Other members EO - Inter Meeting _{t-1}	0.012 (0.045)	0.054 (0.056)	0.031 (0.061)	0.026 (0.043)
President MP - Inter Meeting _{t-1}	-0.166*** (0.041)	-0.163*** (0.044)	-0.156*** (0.042)	-0.195*** (0.047)
President EO - Inter Meeting _{t-1}	0.217** (0.091)	0.173** (0.083)	0.172* (0.088)	0.250** (0.108)
Δi	-0.736 (0.631)	-0.940 (0.636)	-0.952 (0.585)	-0.774 (0.677)
Negative Interest Surprise	1.733*** (0.609)	1.739*** (0.613)	1.901*** (0.584)	1.835*** (0.655)
Positive Interest Surprise	0.829 (0.706)	0.622 (0.672)	0.683 (0.658)	0.780 (0.760)
APP	-0.151 (0.142)	-0.082 (0.133)	-0.046 (0.117)	-0.143 (0.148)
Negative Rate	0.166*** (0.037)	0.057 (0.037)	0.050 (0.035)	0.108*** (0.037)
Whatever it takes	0.163*** (0.054)	0.089 (0.058)	0.106* (0.055)	0.157*** (0.056)
Macro-economic surprises _t	Yes	Yes	Yes	Yes
Financial variables _t	Yes	Yes	Yes	Yes
Constant	0.241*** (0.049)	0.120** (0.048)	0.057 (0.045)	0.228*** (0.054)
Adjusted R^2	.188	.162	.133	.191
Obs.	1630	1630	1630	1630

Note: Estimates of the coefficients of equation 3, specification with all controls. In parenthesis, Newey-West Standard Errors. In column (1) is our baseline estimate (last column of Table 3 in the paper), in column (2) the same estimate is run, removing from the MSI all articles where the absolute value of the difference between the number of positive words and the number of negative words is 1 or 0, in column (3) where the difference is 2, 1 or 0, in column (4) we removed all the articles that have a score (in absolute value) lower than the value of the first decile. ***, ** and * represent statistical significance at respectively 1%, 5% and 10%.