Words are not all created equal: a new measure of ECB communication

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Abstract

We develop a field-specific dictionary to measure the stance of the European Central Bank (ECB) monetary policy (dovish, neutral, hawkish) and the state of the Eurozone economy (positive, neutral, negative) through the content of ECB press conferences. In contrast with traditional textual analysis, we propose a novel approach using term-weighting and contiguous sequence of words (n-grams) to better capture the subtlety of central bank communication. We find that quantifying ECB communication using our field-specific weighted lexicon helps to predict future ECB monetary decisions when considering an augmented Taylor rule. Regarding European stock market volatility, we find that markets are more (less) volatile on the day following a conference with a negative (positive) tone about the euro area economic outlook. Our indicators significantly outperform a textual classification based on the Loughran–McDonald or Apel–Blix Grimaldi dictionaries and a media-based measure of economic policy uncertainty.

Keywords : ECB, central banking, textual analysis, monetary policy, stock market volatility, interest rates, Taylor rule
JEL Classification : E43, E52, G12

1 Introduction

> *"What matters for transparency is therefore clarity as well as openness. For a new and supranational institution like the ECB, it is particularly important that it sends clear and coherent messages to the markets and the wider public."*

Otmar Issing (Executive Board Member of the European Central Bank) - 1999

In recent years, central banks have moved towards greater transparency (Geraats 2002) in terms of objectives, procedures, rationales, models, and data. Central banks now reveal more information to the public by (i) describing the strategy that guides policy decisions, (ii) explaining current policy decisions, (iii) interpreting economic conditions and giving views on future economic outlook, and (iv) making statements about future policy (Woodford 2005). In this regard, central bank communication has become a key instrument in the central bankers' toolbox, particularly during periods of high uncertainty or when the interest rates reach the zero lower bound (Filardo & Hofmann 2014). By managing expectations, communication may improve the predictability of monetary policy and reduce volatility in financial markets (see Blinder et al. (2008) for a survey, and Sturm & De Haan (2011) among others).

Since its creation in 1998, the European Central Bank (ECB) has placed a strong focus on transparency, using various channels of communication to send "clear and coherent messages to the markets and the wider public." While interviews, speeches, press releases (and more recently webcasts and tweets) have developed over time, the main channel of communication used by the ECB is the press conference held

after the Government Council meeting. Every six weeks,[1] the President and the Vice President of the ECB explain their monetary policy decision and answer questions from journalists during a press conference. While every word pronounced by central banks officials is closely scrutinized by decision makers and market participants, converting qualitative content into quantitative indicators remains a challenge for researchers.

Building on previous works from textual analysis, we propose a new methodology to quantify ECB communication. Manually classifying all sentences in all ECB press conferences between January 2006 and December 2014, we develop a field-specific lexicon to measure the stance of the ECB monetary policy (dovish, neutral, hawkish) and the Governing Council views on the Eurozone economic outlook (positive, neutral, negative). Using a term-weighting approach, we compute a monetary policy indicator and an economic outlook indicator by analyzing words and group of words appearing in each introductory statement. Then, we assess if our indicators contain value-relevant information, not already measured by alternative quantification from the literature, about future monetary policy decisions or future European stock market returns and volatility.

We find that quantifying ECB communication using a field-specific weighted lexicon helps in predicting future ECB monetary decisions and market volatility. A dovish (hawkish) textual content about monetary policy and a negative (positive) economic outlook both predict a dovish (restrictive) decision at the next ECB meeting. A dovish (hawkish) monetary policy and a positive (negative) economic outlook

[1]ECB adjusted the schedule of meetings from a four-week cycle prior to 2015 to a six-week cycle from now on.

both predict a decrease (increase) in market volatility the day after the ECB statement. We also provide evidence showing that traditional approaches using equal-weighted single word lists such as the Loughran & McDonald (2011) financial dictionary (LM hereafter) and the Apel & Grimaldi (2012) central banking dictionary fail to capture the forward-looking content of the ECB introductory statement. We believe that researchers interested in quantifying central bank communication should pay specific attention to the methodology used to derive quantitative indicators from qualitative textual content. To encourage further research in this area and enhance replicability, all data used in this paper are available online.[2]

Our paper is organized as follows. In Section 2, we review the literature on the quantification of central bank communication and its influence on the predictability of monetary policy and financial markets. Section 3 details the data and describes how we create quantitative indicators of monetary policy and economic outlook from textual ECB statements. Section 4 reports our methodology and empirical findings about future monetary policy decisions. Section 5 reports our methodology and empirical findings on market volatility and market returns. Section 6 presents robustness checks. Finally, Section 7 concludes the paper.

2 Related Literature

This article relates to three strands of the literature on central bank communication: (i) its quantification through textual analysis, (ii) its influence on the predictability of monetary policy, and (iii) its impact on asset prices and market volatility.

[2]http://www.xxxxx.com (reference withheld to ensure anonymity but provided to the editor)

Regarding the quantification of central bank communication, two main methods have been used in the literature.[3] First, central bank communication can be coded manually, following the narrative approach of monetary policy decisions proposed by Romer & Romer (1989). While researchers can convert communication into quantitative indicators on various topics, for example, the importance that policymakers assign to reducing inflation relative to promoting real growth (Boschen & Mills 1995) or central bank views on exchange rate valuation (Dewachter et al. 2014), the most common classification consists of grading communication depending on monetary policy inclinations. Looking at the ECB, this approach was followed by Musard-Gies (2006) and Rosa & Verga (2007), who hand-coded each statement, according to the tone of the communication, into a discrete variable between +2 (very hawkish) and -2 (very dovish).[4] Gerlach (2007) implement a similar methodology for ECB Monthly Bulletins.

As a next step toward a better understanding of communication, and in line with the findings of Kohn et al. (2004) on the importance of central bank communication related to economic conditions and economic outlooks, Berger et al. (2011) categorize the overall monetary policy stance on a scale from -3 (strong inclination to lower rates) to +3 (strong inclination to increase rates) using four subcategories: overall policy intention, price stability, real economy, and monetary sector. Likewise, Conrad & Lamla (2010) classify each sentence of the ECB statements into four categories

[3]Other methods used on the literature for topics detection include unsupervised topic classification (Latent Dirichlet Allocation in Jegadeesh & Wu (2015) or Latent Semantic Analysis in Boukus & Rosenberg (2006)). Machine learning methods for sentiment analysis have also been considered by Moniz & de Jong (2014))

[4]+1 (hawkish), 0 (neutral), -1 (dovish)

(price developments, real economy, monetary aggregates, exchange rate) and three tendencies (positive, neutral, negative).

While manual classification is easy to implement, it presents several drawbacks. First, manual scoring is by definition subjective. For example, considering 62 ECB press conferences between 1999 and 2004, Carlo Rosa and Giovanni Verga (in Rosa & Verga (2007)) disagree on 14 (22.58%) statements. Second, converting a document into a discrete class variable prevents from consideration of the smooth evolution of central bank communication.[5] Third, except when classified data are publicly available, the results are not easily reproducible, limiting further research and comparability.

To solve (partly) those issues, another strand of literature relies on dictionary-based and word-count approaches. The simplest example is provided by Jansen & De Haan (2007), who quantify communication regarding risks to price stability by simply counting the frequency of the word "*vigilance*" in ECB communications. A more standard approach consists of counting the number of positive and negative words in central bank communication using a pre-defined list of signed words from the Harvard IV-4 psychosociological dictionary or the LM financial dictionary. Using a bag-of-words approach as in Tetlock (2007), Jegadeesh & Wu (2015) convert FOMC meeting minutes into quantitative sentiment indicator, considering both Harvard IV and LM dictionaries. Schmeling & Wagner (2015) quantify ECB press conference by computing the ratio of negative words to total words using the LM financial dictionary. A similar methodology is used, among others, by Hansen et al. (2014),

[5] If the classification is done at the sentence level instead of the document level, nearly continuous variables can be generated by aggregating/averaging across sentiments and topics.

Cannon (2015), and Jansen et al. (2016).

However, given the specificity of central bank communication in terms of the content, structure, and topics discussed, quantifying communication using a non field-specific lexicon may fail to capture all the dimensions and subtlety of central bank communication. Although the LM word lists have been increasingly popular in the latest researches, content analysis can be further improved by constructing more authoritative and extensive field-specific dictionaries (Kearney & Liu 2014).

The second step of any quantitative analysis on central bank communication is to assess whether value-relevant "soft information" can be extracted from textual content. To address this question, the main methodology consists of adding a communication variable into traditional models (Taylor rule, asset pricing, market volatility) to analyze empirically if communication improves our understanding (or forecasts) of monetary policy or financial markets.

Regarding the predictability of future monetary policy decisions, several articles find that communication successfully conveys information not included in the available macroeconomic data. Rosa & Verga (2007) and Heinemann & Ullrich (2008) prove that including central bank communication improves the forecasts of ECB interest rate decisions from a Taylor (1993) rule model. These results hold even when forward-looking macroeconomic variables and interbank interest rates are considered (Sturm & De Haan (2011)). Analyzing foreign exchange markets, Conrad & Lamla (2010) find that the Euro currency appreciates against the US dollar in response to statements about increasing risks to price stability. Jansen & De Haan (2005) show that communication triggers an increase in volatility while Dewachter et al.

(2014) provide evidence of large jumps in the exchange rate for several hours after the release. Regarding the equity market, Sadique et al. (2013) show that the Federal Reserve Beige Book tone affects stock market volatility and trading volume. At the intraday level, Jegadeesh & Wu (2015) confirm that the tone of FOMC minutes helps in predicting stock market volatility and returns. Schmeling & Wagner (2015) find that a positive (negative) tone in ECB communication is associated with an increase (decrease) in stock prices and a lower (higher) volatility.

In this paper, we depart from the existing literature by proposing a novel methodology to quantify ECB communication. We provide evidence showing that developing a field-specific lexicon significantly improves the predictability of future monetary policy. We also prove that disentangling content related to monetary policy from content related to the economic outlook improves the forecasting of both monetary policy and financial markets.

3 Quantifying ECB Communication

To quantify ECB communication, we propose a novel methodology. We first manually classify all sentences in all ECB introductory statement into two categories (monetary policy and economic outlook) and three inclinations (positive, neutral, and negative). Then, for each word (or group of words, n-grams hereafter) appearing in at least two ECB introductory statements, we compute the probability that this n-gram belongs to one of our two categories and three inclinations. Last, we compute the tone of each ECB statement by summing n-grams' probabilities, using

a term-weighting approach.

3.1 Field-specific lexicon generation

Several issues exist when popular lexicons used in the finance literature, such as the Harvard IV or LM dictionary, are applied to quantify ECB communication. First, as Rosa & Verga (2007) and Berger et al. (2011) already pointed out, the ECB employs a very standardized form of communication, both in terms of structure and keywords used. Comparing words used in ECB communication over time, Amaya & Filbien (2015) document an increase in speech similarity, consistent with a standardization of communication. In this regard, applying a non-field specific lexicon may fail to capture all specificities of central bank communication. For example, in the LM dictionary,[6] the word "*downward*" is classified as negative while "*upward*" is not classified, whereas both words are perfect opposites[7] in the ECB's introductory statements. Second, considering single words (unigrams) rather than a contiguous sequence of n words (n-grams) might cause improper classification of tone. For example, "lower unemployment" (May 2007) will be classified as negative using the LM dictionary due to the presence of the negative word "unemployment." Similarly, "risks to financial stability" (Sept. 2012) will be considered as positive using the LM dictionary due to the presence of the positive word "stability."

To address these limits, we generate a field-specific lexicon designed to quantify

[6]We used the latest update of their dictionary available on Bill McDonald's website http://www3.nd.edu/ mcdonald/Word_Lists.html

[7]Two examples: "the range for real GDP growth this year has been revised upwards" (Sept. 2010) and "the ranges for real GDP growth in 2011 and 2012 have been revised downwards" (Sept. 2011).

central bank communication. More precisely, we consider all sentences in all ECB introductory statements released between January 2006 and December 2014, covering 68 speeches from Jean-Claude Trichet and 38 speeches from Mario Draghi. For each of the 7,333 individual sentences, we follow a standard textual analysis methodology by (i) converting all words to lower case, removing numbers and punctuation (ii) using a Porter (1980) stemming algorithm to reduce inflected words to their word roots (e.g, "increasing" to "increas", "unemployment" to "unemploy"), and (iii) removing a set of 32 stop words (e.g, a, the, an, of, to...). Then, following Kohn et al. (2004), we classify manually all 7,333 sentences pronounced during ECB introductory statements into seven categories and inclinations: (1) monetary policy hawkish, (2) monetary policy neutral, (3) monetary policy dovish, (4) economic outlook positive, (5) economic outlook neutral, (6) economic outlook negative, and (7) none.[8] The first three categories are grouped into a topic labeled *Monetary Policy* (MP) and refer to the monetary policy decisions of the ECB Governing Council, without considering references to past decisions.[9] This topic also includes references to the short and medium term views of the Governing council on the expected path of monetary policies (see Appendix A.1 for selected sentences). The next three categories are

[8]Each sentence is classified into the category that matters most, even though in a few cases, a sentence may include information about monetary policy and economic outlook. For example, the sentence "Monetary developments therefore continue to require very careful monitoring, particularly against the background of improved economic conditions and continued strong property market developments in many parts of the euro area" (Jan. 2007) contains "monetary policy hawkish" information justified by an "economic outlook positive" part. In this specific example, we consider that "what matters most" is the "monetary policy hawkish" tonality.

[9]For example, the sentence "The information that has become available since our last meeting has further underpinned the reasoning behind our decision to increase interest rates in [...]" appeared six times between November 2006 and August 2008. We consider this sentence as "not related to monetary policy nor economic outlook" as it does not convey new information to market participants.

grouped into a topic labeled *Economic Outlook* (EC hereafter; see Appendix A.2 for selected sentences) and focus on policy makers' descriptions of the current economic situation and their views on the future economic outlook. The last category (*None*, see Appendix A.3 for selected sentences) groups sentences not directly relevant to either monetary policy decisions or the Governing Council's economic outlook. This category also includes sentences presenting data that have already been released before ECB statements (HICP inflation, real GDP growth, monetary aggregates...) without any forward-looking statement or additional information.

For each n-gram n (from 1-gram to 10-grams) appearing at least twice in our sample, we count the frequency of occurrence of that n-gram in each of the seven categories defined previously, and we compute the probability that it belongs to category c (MP or EC) with the inclination i (dovish, neutral, hawkish for MP – positive, negative, neutral for EC).

$$P_n^{c,i} = \frac{number\ of\ occurrence\ {}_n^{c,i}}{total\ number\ of\ occurence\ {}_n} \tag{1}$$

Table 1 presents, for a selected sample of n-grams, the total number of occurrence (#) and the associated probabilities $P_n^{i,c}$. For example, the bigram "consumption growth" appears 22 times in our sample: 20 times (91%) in sentences classified manually as "economic outlook positive" and 2 times (9%) in sentences classified as "economic outlook negative[10]."

[10]"Consumption growth" was classified in "negative economic outlook" sentences during two speeches (Jan. 2010, Feb 2010): "In addition, low capacity utilisation rates are likely to dampen investment, and unemployment in the euro area is expected to increase somewhat further, thereby lowering consumption growth." The trigram "lowering consumption growth" has a probability of 1 of being associated with a "negative economic outlook" in our lexicon, in such a way that all

We define our field-specific lexicon by considering only n-grams with a probability over 0.5 in one of our six classes of interest (MP hawkish/neutral/dovish – EC positive/neutral/negative). With this exclusion, our final field-specific lexicon, denoted *n'*, is composed of 34,052 n-grams.[11]

3.2 Monetary policy and economic outlook indicators

For a given introductory statement s, we analyze all words and groups of words pronounced by the ECB President, and we consider a term-weighted approach using our field-specific lexicon. More precisely, we define the probability for a statement s of being classified in the category c with the inclination i as:

$$P_s^{c,i} = \frac{\sum_{n'=1}^{l} P_{n',s}^{c,i} * Occurrence_{n',s}}{\sum_{n'=1}^{l} P_{n',s}^{c} * Occurrence_{n',s}} \tag{2}$$

where l=34,052 (number of n-grams in our field-specific lexicon). For c = MP, i = *(hawkish, neutral, dovish)* and $\sum_{c=1}^{3} P_s^{MP,c} = 1$. For c = EC, i = *(positive, neutral, negative)* and $\sum_{c=1}^{3} P_s^{EC,c} = 1$. In order to improve the accuracy of our classification and to avoid multiple counting, we consider only the highest n-gram when multiple imbricated n-grams are found in a speech.[12]

sentences are properly classified.

[11]For example, we do not consider the bigram "world economy" as it appears 39 times, of which 18 times are EC positive (46.15%), 18 times are EC negative (46.15%), and 3 times are NONE (7.7%), in such a way that it does not convey clear information about the tonality of ECB communication by itself. However, the fourgram "adverse development world economy" is included in our lexicon as it appears 100% of the time in "EC negative" sentences.

[12]For example, as shown previously, both "consumption growth" and "lowering consumption growth" are part of our lexicon. However, in the sentence "thereby lowering consumption growth"

Figure 1 shows, for all introductory statements between January 2006 and December 2014, the probabilities obtained from Equation 2 for our two categories of interest (Monetary Policy and Economic Outlook). Starting with the content related to monetary policy decisions and the expected path of the monetary policy stance, our indicator is closely related to the evolution of the ECB monetary policy. First, from January 2006 to September 2008, a period during which the ECB main refinancing rate increased from 2.25% to 4.25%, ECB communication about monetary policy was clearly hawkish. Then, starting in October 2008 and up to May 2010, the tone of the monetary policy became dovish. This period was associated with a large decrease in the ECB key interest rate, from 4.25% to 1%. Communication then became neutral for a few months before a strong return of hawkish communication, when the ECB started to increase its interest rate from March to September 2011. After that period, and up to the end of 2014, ECB communication became dovish, with both a decrease of the key interest rate and the implementation of various non-conventional monetary policies (long-term refinancing operations (LTRO), targeted long-term refinancing operations (TLTRO), forward guidance, quantitative easing...).

[Insert Figure 1 about here]

Regarding the economic outlook, our indicator captures both the subprime crisis and the eurozone crisis. Interestingly, the economic outlook starts deteriorating in September 2007, nearly one year before the Lehman Brothers bankruptcy, due

(January and February 2010), we will consider only probabilities associated with the trigram "lowering consumption growth" ($P^{EC,nega} = 1$) without considering probabilities associated with the bigram "consumption growth."

to, amongst other things, "risk in financial markets on confidence" (Oct. 2007), "prolonged financial market volatility and re-pricing of risk on the real economy" (Nov. 2007), and "uncertainty about the potential impact on the real economy" (Dec. 2007). Regarding the eurozone crisis, the economic outlook became more and more negative starting in September 2011, characterized by a "moderation in the pace of global growth" (Sept. 2011), a "significant downward revision to forecasts" (Nov. 2011), and a "further intensification of the tensions in euro area financial markets" (Dec. 2011).

Finally, we aggregate the information content of the introductory statement into two indicators. We define two variables labeled I_s^{MP} and I_s^{EC} by computing, for each statement s, the difference between the hawkish (positive) probability $P_s^{MP,hawk.}$ ($P_s^{EC,posi.}$) and the dovish (negative) probability $P_s^{MP,dovi.}$ ($P_s^{EC,nega.}$):

$$(I_s^{MP}, I_s^{EC}) = \begin{cases} I_s^{MP} = P_s^{MP,hawk.} - P_s^{MP,dovi.}, I_s^{MP} \in [-1,1] \\ I_s^{EC} = P_s^{EC,posi.} - P_s^{EC,nega.}, I_s^{EC} \in [-1,1] \end{cases} \tag{3}$$

Figure 2 displays the evolution of I_t^{MP} compared to the ECB Main Refinancing Operation rate (MRR) and the evolution of I_t^{EC} with the euro area industrial production (excluding construction).

[Insert Figure 2 about here]

3.3 Comparison with alternative measures of tone

We relate our new indicators to two alternative measures for the content of the ECB introductory statements. First, using the LM dictionary, we compute, for a given statement s, the tone LM_s as the difference between the number of positive and negative words in the introductory statement divided by the total number of words identified. By construction, $LM_s \in [-1, +1]$ and is equal to 0 for a neutral speech. A positive (negative) value of LM_s represents a statement with a relatively positive (negative) wording. Second, in line with Apel & Grimaldi (2012), Bennani & Neuenkirch (2017) divided a list of monetary policy-relevant keywords into dovish or hawkish categories. With their classification adjusted for the content of introductory statements, we use a similar calculation for LM_s to assess the monetary inclination of the introductory statement. This measure is labeled BN_s. Figure 3 displays these two alternative measures with our new indicators. Table 2 provides the pairwise correlation coefficients and their significance level. For the overall sample, the correlations are elevated (between 0.70 and 0.88) and significant at the 1% confidence level. The measure LM_s captures more efficiently the information content related to the economic outlook while BN_s, following Bennani & Neuenkirch (2017) objective, successfully measures the monetary policy content of the introductory statements. However, starting mid-2011, the two alternative measures fail to consider negative communications following the sovereign debt crisis and the dovish tone, in line with the non-standard policies that have been implemented, such as the three-year LTRO, the forward guidance, and the TLTRO. Between June 2011 and December 2014, the correlations between the different measures range from 0.35 to 0.66 but are still sig-

nificant at the 1% or 5% confidence levels.

[Insert Figure 3 about here]

[Insert Table 2 about here]

4 Explaining and Forecasting ECB Monetary Policy Decisions

4.1 Methodology

To assess the relation between the information content of the introductory statements and monetary policy decisions, we test empirically the explanatory power of our two indicators (I_t^{MP} and I_t^{EC}) compared to LM_t and BN_t on both contemporaneous and future monetary policy decisions. More precisely, we consider the following Equation:

$$ECB_t = \alpha + \beta_1 I_t^{MP} + \beta_2 I_t^{EC} + \rho ECB_{t-1} + \epsilon_t \tag{4}$$

where ECB_t is the ECB monetary policy decision at time t, I_t^{MP} and I_t^{EC} are our indicators of communication, α is a constant, and ϵ_t is an error term. We include the lagged decision ECB_{t-1} to control for the smoothing of monetary policy. In a forward-looking approach, Equation 4 is rewritten as:

$$ECB_{t+m} = \alpha + \beta_1 I_t^{MP} + \beta_2 I_t^{EC} + \rho ECB_t + \epsilon_t \tag{5}$$

with $m = 1$ for the next Governing Council monetary policy decision and $m = 2$ the two-period-ahead decision. To control for available economic information at the time of the introductory statement, we consider a forward-looking Taylor (1993) monetary policy rule (Orphanides (2001)) with contemporaneous and forward-looking measures of inflation and output gap as in Jansen & De Haan (2009):

$$ECB_t = \alpha + \beta_1 I_t^{MP} + \beta_2 I_t^{EC} + \gamma_1(\pi_t - \pi^*) + \gamma_2(y_t - y^*) + \gamma_3\, \pi_t^e + \gamma_4\, y_t^e + \rho ECB_{t-1} + \epsilon_t \quad (6)$$

$$ECB_{t+m} = \alpha + \beta_1 I_t^{MP} + \beta_2 I_t^{EC} + \gamma_1(\pi_t - \pi^*) + \gamma_2(y_t - y^*) + \gamma_3\, \pi_t^e + \gamma_4\, y_t^e + \rho ECB_t + \epsilon_t \quad (7)$$

where $(\pi_t - \pi^*)$ is the inflation gap defined as the difference between the current level of inflation (euro area HICP) available at the time of the statement[13] and the ECB inflation target $\pi^* = 2\%$. The 12-month ahead inflation forecast from the ECB Quarterly Survey to Professional Forecasters (SPF) is used as a proxy for inflation expectations π_t^e. The output gap $(y_t - y^*)$ is measured by the difference between the euro area industrial production (excluding construction, as in Gerlach (2007))[14] and the potential output y^* (from the trend of a Hodrick–Prescott filter).[15]

[13]The HICP inflation flash estimate is released at the end of the ongoing month but is subject to important revisions. The official HICP is available approximately 15 days after the end of the next month. To account for publication delay, we consider the official HICP data with a one-month lag. Our results are robust to alternative measures of inflation such as the HICP flash estimate or the unrevised HICP.

[14]Industrial production for a month m is released around 13 days after the end of month $m + 1$. Again, to account for publication delay, we consider industrial production with a two-month lag.

[15]The smoothing parameter λ is set to 14,400.

Following Sauer & Sturm (2007), the output gap expectations y_t^e are derived from the European Commission Economic Sentiment Indicator (ESI) minus its long term average. The month-over-month difference of all macroeconomic variables is used in the estimation for stationarity. Appendix A.4 presents the macroeconomic variables and A.5 provides descriptive statistics and correlations.

If the central bank communication does not provide any information additional to previously released macroeconomic data, then both our indicators I_t^{MP} and I_t^{EC} should not be significant in Equations 6 and 7. If central bank communication conveys relevant information, we expect a positive coefficient for I_t^{MP}: more hawkish (dovish) communication should be associated with more hawkish (dovish) monetary policy. We also expect a positive coefficient for I_t^{EC}: an optimistic (pessimistic) economic outlook from the Governing Council should be associated with a more hawkish (dovish) monetary policy.

We consider two variables to measure the ECB monetary policy (ECB_t). First, we focus on interest rate decisions using the first difference of the Main Refinancing Operation interest rate (MRR hereafter, $\Delta MRR_t = (-0.75, -0.5, -0.25, -0.15, 0, +0.25)$). During our sample period, the Governing Council increased the MRR by 25 basis points on ten occasions and decreased it on ten occasions (once by 75 basis points, once by 50 basis points, six times by 25 basis points, and twice by 15 basis points). However, focusing on the MRR fails to consider non-standard policies implemented right after the beginning of the financial crisis. In the spirit of Jansen & De Haan (2009) and in order to account for the non-standard ECB policies, we create a variable $Decision_t$ (with $Decision_t = (-2, -1, 0, +1)$), taking the value of 0 when there

is no change in the monetary policy stance, +1 for a hawkish monetary policy decision (an increase of the key interest rate by 25 basis points in our sample), -1 for a dovish monetary policy decision (either through a standard or a non-standard measure), and -2 for a very dovish decision with both a decrease of the key interest rate and a non-standard monetary measure. Appendix A.6 lists all the non-standard policies announced during ECB press conferences and considered in our sample period. Figure 4 presents both measures of ECB monetary policy (ΔMRR_t and $Decision_t$).

[Insert Figure 4 about here]

4.2 Empirical findings

As our two monetary policy measures ECB_t are discrete variables with six outcomes for ΔMRR_t and four outcomes for $Decision_t$, we use an ordered probit model to estimate the coefficients $\alpha, \beta_1, \beta_2, \gamma_1, \gamma_2, \gamma_3, \gamma_4$ and ρ from Equations 4 to 7. We compare the performance of our indicators with two measures of tone using either the generic LM dictionary (LM_t) or the central bank-specific BN dictionary (BN_t).

Table 3 and 4 summarize the results from a maximum likelihood estimation of Equations 4 and 6 (contemporaneous relationship). After controlling for both backward- and forward-looking macroeconomic variables, we find that I_t^{EC} is significant at the 1% level for ΔMRR_t and $Decision_t$, while I_t^{MP} is significant at the 5% level when considering the change of the MRR. Hawkish/positive (dovish/negative) communication is associated with an increase (decrease) in ECB MRR and a more hawkish (dovish) monetary policy decision (standard and non-standard). As ex-

pected, we also find that the inflation gap ($\pi_t - \pi^*$) is significant at the 5% confidence level. However, we do not find that our indicators strongly improve the explanation of the current monetary policy compared to a sentiment indicator from the LM dictionary. Thus, when explaining current ECB monetary policy, the use of the LM dictionary seems to be sufficient to capture ECB sentiment. However, when using forward-looking macroeconomic variables, our indicators significantly improve the two alternative measures (LM_t and BN_t) and previous results from Jansen & De Haan (2009).

[Insert Tables 3, 4 about here]

Tables 5 and 6 summarize the results from a maximum likelihood estimation of Equations 5 and 7 (future monetary policy decisions) for $m = 1$ and $m = 2$. We find that I_t^{EC} is significant at the 1% confidence level while I_t^{MP} does not convey relevant information to explain future policy decisions.[16] A positive (negative) economic outlook at time t forecasts a hawkish (dovish) ECB policy at time t+1 and t+2. This result is consistent with Sturm & De Haan (2011), who empirically find that quantifying communication helps in predicting the next policy decision of the ECB. Compared to the two alternative measures, our field-specific quantification of the content of ECB introductory statements significantly improves the predictability of future monetary policy decisions. Deriving tonality and topics using our field-specific lexicon provides a significantly better fit compared to a model where sentiment is

[16]For $m = 1$ and when we consider $Decision_t$ as the dependent variable, I_t^{MP} is significant at the 10% confidence level. In all other cases, I_t^{MP} is not significant.

computed using the LM dictionary or the modified version of the BN words list.

[Insert Tables 5, 6 about here]

5 Forecasting Stock Market

5.1 Methodology

In this section, we analyze stock market reactions to monetary policy statements. More precisely, we assess whether ECB communication explains the evolution of stock market return and volatility on statement days and/or predicts stock market return and volatility after ECB statements. For both contemporaneous relationship and forecast, we also analyze which components of ECB communication (monetary policy and/or economic outlook), if any, impact stock markets. For all regressions, we compare our results when ECB communication is quantified using the Loughran–McDonald and the Apel–Blix Grimaldi approaches.

We use daily closing values of the Eurostoxx50 (Eurostoxx) to compute stock market return and the "European VIX" (VSTOXX) for stock market volatility (Figure 5). We measure ECB decision surprise as the difference between the Bloomberg consensus prior to the decision and the ECB rate announcement (MRR_t).

$$Surprise_t = MRR_t - Consensus_t \tag{8}$$

[Insert Figure 5 about here]

To explain the link between monetary policy and stock market return on the day of the press conference (d=0) and on the day after the announcement (d=1), we consider the following model:

$$R_{t+d} = \alpha + \beta_1 * R_{t-d-1} + \beta_2 * Surprise_t + \beta_3 * I_t^{MP} + \beta_4 * I_t^{EC} + \epsilon_t \qquad (9)$$

where R_{t+d} represents the variation of the EuroStoxx50 on day $t+d$ relative to the announcement date t. On the press conference day ($d = 0$) and given the previous results from Rosa (2011) on FOMC statement, we expect β_2 to be negative as a positive surprise about the main refinancing rate (i.e, a rate higher than expected) should lead to a decrease in stock market prices. In the same way, we expect β_3 to be negative if our monetary policy indicator incorporates information about future monetary policy stances not included in the surprise. We expect β_4 to be positive, as good news about the economic outlook should improve companies' rationally discounted future cash flows.[17] On the day after the announcement ($d = 1$), we do not make any hypothesis about the significance or sign of the coefficients. If information about the current decision, economic outlook, and future monetary stance is correctly integrated into the market closing price, we should not find any price predictability after the announcement.

To explain the link between monetary policy and stock market volatility, we consider a model similar to Equation 9 (replacing R_{t+d} by VOL_{t+d} and R_{t+d-1} by

[17]Bad news about the economic outlook can also be good news for stock markets (Boyd et al. 2005) if investors anticipate a more dovish monetary policy in the future due to a worsening of the economic situation. However, we conjecture that the indirect effect – from bad economic outlook to dovish monetary policy – should already be captured by our MP indicator.

VOL_{t+d-1}) and a model where we consider the absolute surprise (instead of the surprise), as in Rosa (2011):

$$VOL_{t+k,t+l} = \alpha + \beta_1 * VOL_{t+k-1} + \beta_2 * |Surprise_t| + \beta_3 * I_t^{MP} + \beta_4 * I_t^{EC} + \epsilon_t \quad (10)$$

where VOL_{t+d} represents the variation of the VSTOXX index on day $t+d$ relative to the announcement date t. On the press conference day ($d = 0$), we expect β_2 to be positive since an unexpected decision should increase market volatility. We expect β_3 to be positive, as a more dovish monetary policy, especially during a period of high uncertainty such as the 2008-2012 period, should decrease market volatility. We expect β_4 to be negative since a better economic outlook should reduce volatility. After the announcement ($d = 1$), we do not make any hypothesis about the significance or the signs of the coefficients.

To control for other macroeconomic news and to account for potential pre-release/post-release drift, we add to previous models a dummy variable and a surprise variable when macroeconomic news (euro area quartely GDP, euro area monthly unemployment, FOMC meeeting, US nonfarm payroll, US jobless claims...) is published between one day before and one day after the ECB press conference. For example, during our sample period, we find that euro area GDP releases coincide with ECB press conferences on 10 occasions (exact same day) and are released one day before or one day after ECB press conferences on 8 occasions. As controlling for other macroeconomic announcements does not affect our conclusions, we do not report the detailed results for the sake of simplicity.

5.2 Empirical findings

Table 7 presents our results for d=0 (contemporaneous relationship) for both the EuroStoxx and the VSTOXX. We also present results using the LM and BN dictionaries to quantify ECB communication.

[Insert Table 7 about here]

We find that, similarly to Ehrmann & Fratzscher (2007) and Ranaldo & Rossi (2010), monetary policy communications significantly affect asset prices and volatility. Regarding the content of the introductory statement, our MP indicator is significant and of the expected sign at the 5% level for all models. When ECB statements about monetary policy are hawkish (dovish), stock markets increase (decrease) and volatility decreases (increases) on announcement day. Our EC indicator is also significant at the 10% level for models [1] and [5]: a positive (negative) economic outlook is associated with higher (lower) stock market return and lower (higher) volatility. For both stock prices and volatility, we find that the approach we used to derive our MP and EC indicators significantly outperforms sentiment-based indicator derived by considering the Loughran–McDonald dictionary and the Apel–Blix Grimaldi dictionary. This finding reinforces our results from the previous section on forecasting monetary policy.

Then, we analyze if ECB statement at day t helps in predicting stock markets at day $t+1$. Table 8 presents our results for d=1 for the EuroStoxx and the VSTOXX. We do not find any significant results when considering MP and EC to forecast stock returns on the next trading day. Information seems to be instantaneously integrated

into stock prices in such a way that there is no predictability on the day following ECB announcements, consistent with the efficient market hypothesis. However, we find significant results regarding the volatility of financial markets. Economic Outlook and Monetary Policy indicators derived from ECB statements at date t help in predicting volatility at day t+1, at the 5% level and at the 10% level, respectively.[18]

[Insert Table 8 about here]

This result holds only when ECB communication is measured using I_t^{MP} and I_t^{EC} indicators and disappears when communication is quantified through the LM and BN dictionaries. To identify the persistent impact of ECB communication on market volatility, the methodology used to derive quantitative forward-looking information from soft data is therefore of utmost importance. As "all words are not created equal," we provide empirical evidence showing that our weighted field-specific lexicon approach helps in capturing all the subtlety of central bank communication and improves our understanding of the impact of communication on financial markets.

[18]Interestingly, while for d=0 monetary policy is significant at the 5% level and economic outlook only at the 10% level, the situation reverses for d=1. We conjecture that this result could be explained by differences in the speed at which market participants process the "soft information" included in ECB statements, focusing first on monetary policy and monetary stance, and then more slowly incorporating information related to the economic outlook. We encourage further research in this area.

6 Robustness check

In this section, we first provide a robustness check showing the results of a real time implementation of our methodology. Then, we present results comparing our indicator with two other measures of uncertainty used in the literature: the number of word related to "uncertainty" from the LM dictionary, as in Jegadeesh & Wu (2015), and a media-based measure of economic policy uncertainty from Baker et al. (2016).

6.1 Real-time lexicon generation

In the methodology presented in Section 3, we classify all sentences in all ECB introductory statements from 2006 to 2014 in order to construct our field-specific lexicon. N-gram probabilities are computed on the full sample period in such a way that I_t^{MP} and I_t^{EC} indicators are in reality ex-post measures. Sentences classified after a period t may impact n-gram probabilities in t. To check the robustness of our indicators, we simulate a real-time implementation of our methodology, where only sentences classified in t are used to compute $P_n^{i,c}$ from Equation 1. This approach is equivalent to a situation where a human analyzes and classifies each sentence of an introductory statement when it is pronounced before updating n-gram probabilities and computing $P_n^{i,c}$. We denote those two real-time (unrevised) indicators RT_t^{MP} and RT_t^{EC}.

Figure 6 presents together the full lexicon indicators I_s^c and the real-time lexicon indicators RT_s^c. To confirm previous findings on the predictability of monetary pol-

icy, we replace our initial measures with their real-time equivalent in the empirical estimations from Section 4. To also consider the real-time information available to central bankers, we use the HICP flash estimate as our measure of inflation π_t in Equations 4 to 7. Appendix A.7 and A.8 present a summary of the results. We find that the economic content of the introductory statements remains significant at the 1% confidence level. A negative (positive) real-time economic outlook predicts a dovish (hawkish) monetary policy decision at the next ECB meeting.

[Insert Figure 6 about here]

However, the monetary policy indicator RT_s^{MP} is no longer significant. This finding is consistent with the fact that our real-time monetary indicator underestimates the dovish tonality of ECB communication after the Lehman Brothers bankruptcy (from September 2008 to September 2009). As in any supervised learning approach, a sufficient number of observations (classified sentences) is necessary to derive n-gram weights and to capture correctly, in real time, the tonality of ECB communication.

6.2 Alternative measure of uncertainty

We also consider two alternative text-based measures of uncertainty in order to confirm (invalidate) our results on explaining (forecasting) market volatility. More precisely, we compute a measure of uncertainty by counting, in each ECB statement, the number of words included in the "uncertain words list" from the Loughran–McDonald dictionary (as in Jegadeesh & Wu (2015)). We denote this indicator ULM_t. We also consider the European media-based measure of economic policy

uncertainty from Baker et al. (2016).[19] We denote this indicator UBB_t.

Table A.9 presents the results from Equation 10 ($d = 0$), where we compare our indicators I_t^{MP} and I_t^{EC} to ULM_t and UBB_t. The results confirm that using our field-specific lexicon approach provides a better proxy of market uncertainty around ECB communication compared to other text-based indicators that are used in the literature. ULM_t and UBB_t do not successfully explain the evolution of market volatility on ECB announcement days. In an unreported test, we also find that our approach gives better results after the announcement (forecasting volatility).

7 Conclusion

Central bank communication has become a key instrument in the central bankers' toolbox. However, deriving quantitative indicators from soft textual data remains a challenging issues for both practitioners and academics. In this paper, we propose a novel approach using groups of words' term-weighting to better capture the subtlety of central bank communication We develop a publicly available field-specific lexicon to measure the stance of the monetary policy (dovish, neutral, hawkish) and the Governing Council's view on the Eurozone economy (positive, neutral, negative). Computing two indicators for each press conference, we construct a continuous time series quantifying the tone of the ECB communications between 2006 and 2014.

We find that the content of the introductory statements helps in predicting future

[19] http://www.policyuncertainty.com/media/Europe_Policy_Uncertainty_Data.xlsx - The European Uncertainty index is computed by counting the frequency of uncertainty-related words in news reports from Le Monde and Le Figaro for France, Handelsblatt and Frankfurter Allgemeine Zeitung for Germany, Corriere Della Sera and La Repubblica for Italy, El Mundo and El Pais for Spain, and The Times of London and Financial Times for the United Kingdom.

ECB standard and non-standard monetary decisions, even after controlling for both backward- and forward-looking macroeconomic variables. A dovish (hawkish) textual content about monetary policy and a negative (positive) economic outlook both predict a dovish (restrictive) decision at the next ECB meeting. Quantifying ECB communication also helps in forecasting market volatility. A hawkish (dovish) textual content about monetary policy and a negative (positive) economic outlook predict an increase (decrease) in market volatility the day after the ECB statement. Our indicators significantly outperform a textual classification based on the Loughran–McDonald financial dictionary, the Apel–Blix Grimaldi dictionary, and a media-based measure of economic policy uncertainty.

Our results also shed light on the fact that researchers should be very cautious when relying on existing word lists to quantify central bank structured communication. As all words are not all created equal, we provide evidence that developing a field-specific weighted lexicon helps in capturing the forward-looking information contained in central bank communications.

References

Amaya, D. & Filbien, J.-Y. (2015), 'The similarity of ECB's communication', *Finance Research Letters* **13**, 234–242.

Apel, M. & Grimaldi, M. (2012), 'The information content of central bank minutes', *Riksbank Research Paper Series* (92).

Baker, S. R., Bloom, N. & Davis, S. J. (2016), 'Measuring economic policy uncertainty', *The Quarterly Journal of Economics* **131**(4), 1593–1636.

Bennani, H. & Neuenkirch, M. (2017), 'The (home) bias of european central bankers: new evidence based on speeches', *Applied Economics* **49**(11), 1114–1131.

Berger, H., de Haan, J. & Sturm, J.-E. (2011), 'Does money matter in the ECB strategy? New evidence based on ECB communication', *International Journal of Finance & Economics* **16**(1), 16–31.

Blinder, A. S., Ehrmann, M., Fratzscher, M., De Haan, J. & Jansen, D.-J. (2008), 'Central bank communication and monetary policy: A survey of theory and evidence', *Journal of Economic Literature* **46**(4), 910–45.

Boschen, J. F. & Mills, L. O. (1995), 'The relation between narrative and money market indicators of monetary policy', *Economic Inquiry* **33**(1), 24–44.

Boukus, E. & Rosenberg, J. V. (2006), 'The information content of FOMC minutes', *Working Paper* .

Boyd, J. H., Hu, J. & Jagannathan, R. (2005), 'The stock market's reaction to unemployment news: Why bad news is usually good for stocks', *The Journal of Finance* **60**(2), 649–672.

Cannon, S. (2015), 'Sentiment of the FOMC: Unscripted', *Economic Review-Federal Reserve Bank of Kansas City* p. 5.

Conrad, C. & Lamla, M. J. (2010), 'The high-frequency response of the eur-usd exchange rate to ECB communication', *Journal of Money, Credit and Banking* **42**(7), 1391–1417.

Dewachter, H., Erdemlioglu, D., Gnabo, J.-Y. & Lecourt, C. (2014), 'The intra-day impact of communication on euro-dollar volatility and jumps', *Journal of International Money and Finance* **43**, 131–154.

Ehrmann, M. & Fratzscher, M. (2007), 'Communication by central bank committee members: Different strategies, same effectiveness?', *Journal of Money, Credit and Banking* **39**(2-3), 509–541.

Filardo, A. J. & Hofmann, B. (2014), 'Forward guidance at the zero lower bound', *BIS Quarterly Review March* .

Geraats, P. M. (2002), 'Central bank transparency', *The Economic Journal* **112**(483), F532–F565.

Gerlach, S. (2007), 'Interest rate setting by the ECB, 1999-2006: Words and deeds', *International Journal of Central Banking* **3**(3), 1–46.

Hansen, S., McMahon, M. & Prat, A. (2014), 'Transparency and deliberation within the fomc: a computational linguistics approach', *Center for Economic Performance* .

Heinemann, F. & Ullrich, K. (2008), 'Does it pay to watch central bankers' lips? the information content of ECB wording', *Swiss Journal of Economics* pp. 05–070.

Jansen, D.-J. & De Haan, J. (2005), 'Talking heads: the effects of ECB statements on the euro–dollar exchange rate', *Journal of International Money and Finance* **24**(2), 343 – 361.

Jansen, D.-J. & De Haan, J. (2007), 'The importance of being vigilant: Has ECB communication influenced euro area inflation expectations?', *Working Paper* .

Jansen, D.-J. & De Haan, J. (2009), 'Has ECB communication been helpful in predicting interest rate decisions? An evaluation of the early years of the economic and monetary union', *Applied Economics* **41**(16), 1995–2003.

Jansen, D.-J., Moessner, R. et al. (2016), 'Communicating dissent on monetary policy: Evidence from central bank minutes', *DNB Working Paper Series* (512).

Jegadeesh, N. & Wu, D. (2015), 'Deciphering fedspeak: The information content of FOMC meetings', *Working Paper* .

Kearney, C. & Liu, S. (2014), 'Textual sentiment in finance: A survey of methods and models', *International Review of Financial Analysis* **33**, 171–185.

Kohn, D. L., Sack, B. P. et al. (2004), 'Central bank talk: does it matter and why?', *In: Bank of Canada (Ed.), Macroeconomics, Monetary Policy and Financial Stability* pp. 175–206.

Loughran, T. & McDonald, B. (2011), 'When is a liability not a liability? Textual analysis, dictionaries, and 10-ks', *The Journal of Finance* **66**(1), 35–65.

Moniz, A. & de Jong, F. (2014), Predicting the impact of central bank communications on financial market investors' interest rate expectations, *in* 'European Semantic Web Conference', Springer, pp. 144–155.

Musard-Gies, M. (2006), 'Do ECBs statements steer short-term and long-term interest rates in the euro zone?', *The Manchester School* **74**.

Orphanides, A. (2001), 'Monetary policy rules based on real-time data', *The American Economic Review* **91**(4), pp. 964–985.

Porter, M. F. (1980), 'An algorithm for suffix stripping', *Program* **14**(3), 130–137.

Ranaldo, A. & Rossi, E. (2010), 'The reaction of asset markets to swiss national bank communication', *Journal of International Money and Finance* **29**(3), 486 – 503.

Romer, C. D. & Romer, D. H. (1989), Does monetary policy matter? A new test in the spirit of Friedman and Schwartz, *in* 'NBER Macroeconomics Annual 1989, Volume 4', MIT Press, pp. 121–184.

Rosa, C. (2011), 'Words that shake traders: The stock market's reaction to central bank communication in real time', *Journal of Empirical Finance* **18**(5), 915–934.

Rosa, C. & Verga, G. (2007), 'On the consistency and effectiveness of central bank communication: Evidence from the ECB', *European Journal of Political Economy* **23**(1), 146 – 175.

Sadique, S., In, F., Veeraraghavan, M. & Wachtel, P. (2013), 'Soft information and economic activity: Evidence from the beige book', *Journal of Macroeconomics* **37**, 81–92.

Sauer, S. & Sturm, J.-E. (2007), 'Using Taylor rules to understand european central bank monetary policy', *German Economic Review* **8**(3), 375–398.

Schmeling, M. & Wagner, C. (2015), 'Does central bank tone move asset prices?', *Working Paper* .

Sturm, J.-E. & De Haan, J. (2011), 'Does central bank communication really lead to better forecasts of policy decisions? New evidence based on a Taylor rule model for the ECB', *Review of World Economics* **147**(1), 41–58.

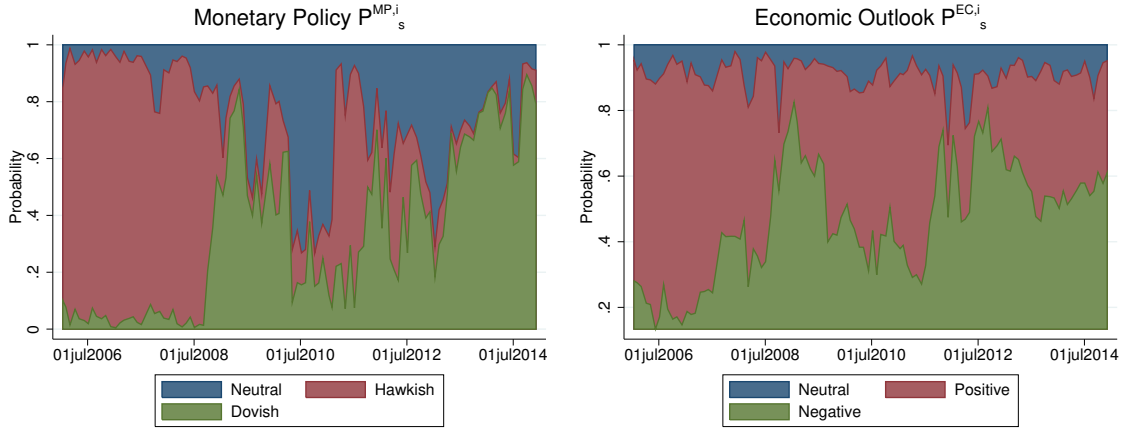
Taylor, J. B. (1993), 'Discretion versus policy rules in practice', *Carnegie-Rochester Conference Series on Public Policy* **39**(0), 195 – 214.

Tetlock, P. C. (2007), 'Giving content to investor sentiment: The role of media in the stock market', *The Journal of Finance* **62**(3), 1139–1168.

Woodford, M. (2005), 'Central bank communication and policy effectiveness', *NBER Working Paper Series* p. 11898.

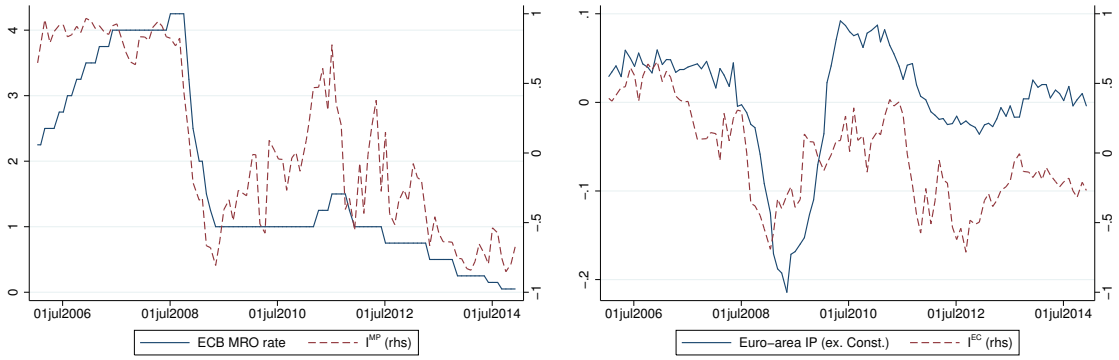
Figures

Figure 1: Speech Probabilities for each category c and inclination i



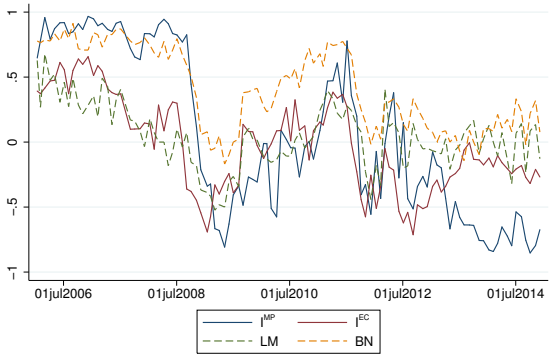
Notes: The two figures present for each category c (Monetary Policy, MP or Economic Outlook, EC) and each ECB introductory statement s, the inclinations i probabilities $P^s_{c,i}$. Regarding MP, the inclinations are hawkish, neutral or dovish. For EC, the inclinations are positive, neutral or negative. For each categories, the sum of probabilities for the three inclinations is equal to one.

Figure 2: ECB communication on Monetary Policy (I_t^{MP}) and Economic Outlook (I_t^{EC})



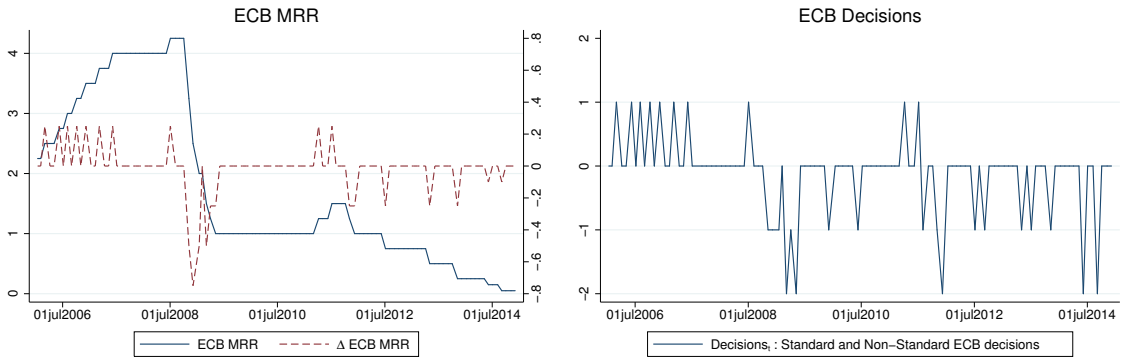
Notes: The two figures present the two indicators of ECB communication between 2006 and 2014. The first indicator I_t^{MP} assesses the inclination of monetary policy decisions and is plotted on the same graph as the ECB main refinancing rate. The second indicator I_t^{EC} captures the inclination of the Governing Council view on the economic outlook of the euro area and is plotted on the same graph as the euro area industrial production excluding construction.

Figure 3: Different measures for the content of ECB introductory statements



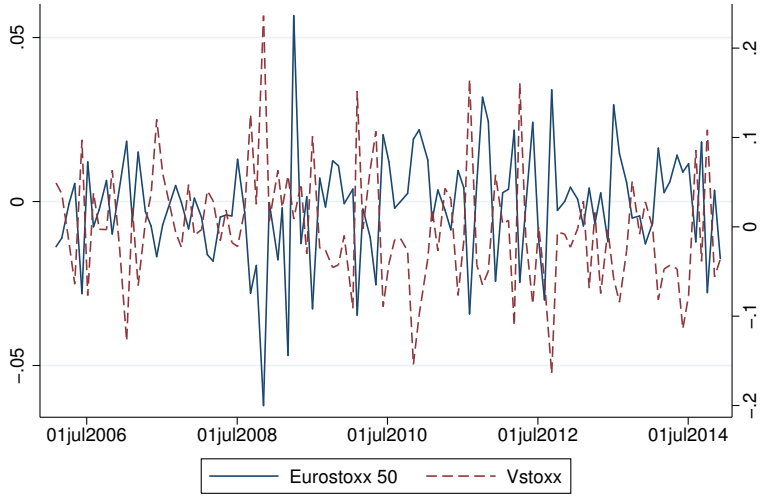
Notes: The figure presents the two indicators I_t^{MP} and I_t^{EC} with two alternative measures for the content of ECB introductory statements. The alternative measures are calculated using either the Loughran & McDonald (2011) dictionnary for LM or the Bennani & Neuenkirch (2017) list of words for BN.

Figure 4: Measures of the ECB monetary policy ECB_t



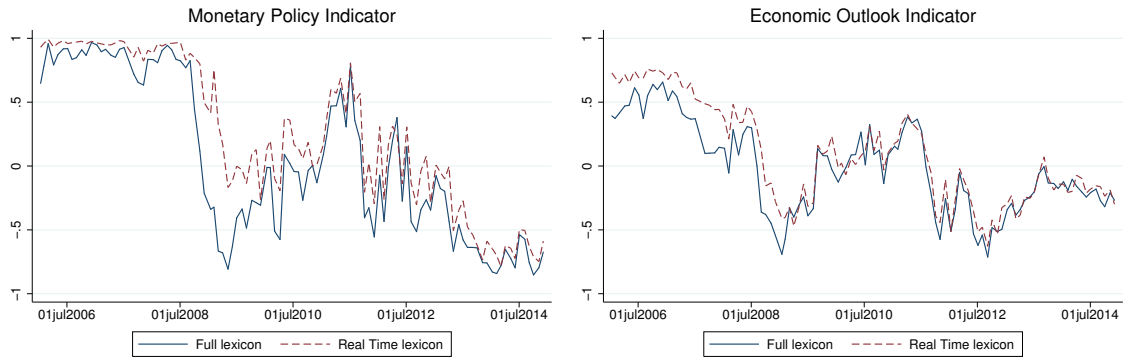
Notes: The first figure plots the evolution of the ECB main refinancing rate (MRR) and its first difference between 2006 and 2014. The second figure represents ECB monetary policy decisions between 2006 and 2014. It takes the value of 1 for a restrictive decision, 0 when the monetary policy stance remains unchanged, -1 for an accomodative decision (either a decrease of interest rates or the announcement of a non-standard measure) and -2 for a very accomodative decision (a decrease of interest rates and the announcement of a non-standard measure).

Figure 5: Variations of Stock Markets indicators



Notes: The figure presents the daily change (close to close) of the Eurostoxx 50 (lhs) and the Vstoxx (rhs) on the day of ECB press conferences between 2006 and 2014.

Figure 6: real time introductory statement indicators



Notes: The figures present the evolution of the two indicators Monetary Policy I_t^{MP} and Economic Outlook I_t^{EC} calculated using the term-weigted lexicon of 2006 to 2014 (full lexicon), against their real time equivalent RT_t^{MP} and RT_t^{EC} calculated using the term-weigted lexicon available at time t and without revisions (real time lexicon).

Tables

Table 1: Term Frequency and Probabilities - Sample n-grams

		Monetary Policy			Economic Outlook			
n-grams	#	Dovi	Neut	Haw	Posi	Neut	Nega	None
act firm time manner ensur price stabil	15	0.0	0.0	0.93	0.0	0.0	0.0	0.06
remain present lower level extend period time	11	1.0	0.0	0.0	0.0	0.0	0.0	0.0
purchas	110	0.27	0.04	0.04	0.6	0.0	0.02	0.54
cover bond purchas	4	1.0	0.0	0.0	0.0	0.0	0.0	0.0
close readi consid all avail instrument	3	1.0	0.0	0.0	0.0	0.0	0.0	0.0
decid reduc key ecb interest rate	7	1.0	0.0	0.0	0.0	0.0	0.0	0.0
decid increas key ecb interest rate	9	0.0	0.0	1.0	0.0	0.0	0.0	0.0
decid leav key ecb interest rate unchang	22	0.0	1.0	0.0	0.0	0.0	0.0	0.0
uncertainti	178	0.01	0.01	0.00	0.18	0.10	0.59	0.09
uncertainti remain elev	15	0.0	0.0	0.0	0.66	0.13	0.2	0.0
uncertainti result turmoil financi	6	0.0	0.0	0.0	0.0	0.0	1.0	0.0
improv domest demand	8	0.0	0.0	0.0	1.0	0.0	0.0	0.0
advers	38	0.0	0.0	0.0	0.1	0.0	0.85	0.05
develop	799	0.06	0.15	0.11	0.14	0.06	0.18	0.31
world economi	39	0.0	0.0	0.0	0.46	0	0.46	0.08
advers develop world economi	8	0.0	0.0	0.0	0.0	0.0	1.0	0.0
consumpt growth	22	0.0	0.0	0.0	0.91	0.0	0.09	0.0
lower consumpt growth	2	0.0	0.0	0.0	0.0	0.0	1.0	0.0
been revis	40	0.0	0.0	0.0	0.35	0.04	0.54	0.04
been revis downward	15	0.0	0.0	0.0	0.0	0.06	0.87	0.06
been revis upward	13	0.0	0.0	0.0	0.84	0.07	0.07	0.0
been revis slightli upward	3	0.0	0.0	0.0	0.75	0.0	0.0	0.25
dampen	102	0.06	0.00	0.0	0.07	0.03	0.65	0.16
dampen underli growth momentum	9	0.0	0.0	0.0	0.0	0.0	1.0	0.0

Notes: This table shows, for a list of selected n-grams, the total number of occurrence and the probabilities $P_n^{i,c}$ associated. For example, the word "uncertainty" was pronounced 178 times during ECB introductory statement between January 2006 and December 2014, of which 105 times (59%) in sentence associated with a "negative economic outlook". The 4-grams "uncertainti result turmoil financi" was pronounces 6 times and is always associated with a negative economic outlook.

Table 2: Pearson correlations for the content of ECB introductory statements

	Full Sample (106 obs.)				June 2011 to Dec. 2014 (43 obs.)			
	I_t^{EC}	I_t^{MP}	LM_t	BN_s	I_t^{EC}	I_t^{MP}	LM_t	BN_s
I_t^{EC}	1				1			
I_t^{MP}	0.712***	1			0.174	1		
LM_t	0.702***	0.610***	1		0.448***	0.351**	1	
BN_s	0.805***	0.884***	0.719***	1	0.380**	0.661***	0.592***	1

Note : Superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 3: Results from ordered probit models with the change of the ECB MRR (ΔMRR_t): Estimation of Equations 4 and 6

	Base Model			I_t^c		LM_t		BN_t	
ΔMRR_{t-1}	2.750***	2.226**	0.583	-0.420	-2.240*	-1.069	-1.702	0.521	-0.708
	(0.643)	(0.878)	(0.919)	(1.237)	(1.197)	(1.114)	(1.231)	(1.056)	(1.109)
$\Delta(y_t - y^*)$		4.177	-10.357	1.005	-19.266	-0.758	-12.288	6.703	-8.952
		(15.558)	(12.325)	(15.390)	(15.315)	(14.315)	(15.409)	(13.896)	(12.683)
$\Delta(\pi_t - \pi^*)$		0.583	0.310	0.871	0.681	0.739	0.492	0.244	0.030
		(0.496)	(0.500)	(0.541)	(0.585)	(0.589)	(0.603)	(0.543)	(0.555)
Δy_t^e			-0.022		-0.035		-0.034		-0.049
			(0.084)		(0.117)		(0.113)		(0.106)
$\Delta \pi_t^e$			4.292***		5.225***		3.019***		3.947***
			(0.949)		(1.330)		(1.115)		(1.181)
I_t^{MP}				1.143**	1.675**				
				(0.496)	(0.767)				
I_t^{EC}				3.619***	4.525***				
				(0.794)	(1.119)				
LM_t						5.704***	5.038***		
						(0.773)	(0.809)		
BN_t								3.511***	3.680***
								(0.766)	(0.875)
Observations	106	106	106	106	106	106	106	106	106
$Pseudo - R^2$	0.0683	0.0777	0.193	0.321	0.429	0.346	0.389	0.237	0.316

Notes: The tables report the results from an ordered probit model estimated with maximum likelihood between January 2006 and December 2014. The dependent variable is the change of the ECB MRR. Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 4: Results from ordered probit models with ECB Policy Variable ($Decision_t$): Estimation of Equations 4 and 6

	Base Model			I_t^c		LM_t		BN_t	
$Decision_{t-1}$	0.245*	0.166	-0.131	-0.634**	-0.903***	-0.712***	-0.815***	-0.514**	-0.750***
	(0.138)	(0.141)	(0.148)	(0.270)	(0.262)	(0.224)	(0.217)	(0.217)	(0.198)
$\Delta(y_t - y^*)$		9.911	-5.360	7.085	-6.681	1.029	-6.922	10.887	-1.358
		(12.838)	(11.822)	(13.155)	(13.660)	(14.977)	(15.922)	(13.058)	(13.224)
$\Delta(\pi_t - \pi^*)$		0.454	-0.079	-0.024	-0.523	-0.112	-0.381	-0.250	-0.656
		(0.435)	(0.457)	(0.452)	(0.503)	(0.496)	(0.493)	(0.467)	(0.470)
Δy_t^e			-0.035		-0.062		-0.022		-0.077
			(0.063)		(0.085)		(0.069)		(0.078)
$\Delta \pi_t^e$			3.387***		2.966***		1.851**		2.583***
			(0.680)		(0.834)		(0.785)		(0.801)
I_t^{MP}				1.285***	1.266***				
				(0.336)	(0.390)				
I_t^{EC}				2.129***	2.060***				
				(0.615)	(0.626)				
LM_t						5.517***	5.074***		
						(0.956)	(0.940)		
BN_t								3.425***	3.263***
								(0.561)	(0.588)
Observations	106	106	106	106	106	106	106	106	106
$Pseudo - R^2$	0.010	0.023	0.111	0.285	0.339	0.313	0.333	0.220	0.268

Notes: The tables report the results from an ordered probit model estimated with maximum likelihood between January 2006 and December 2014. The dependent variable represents ECB monetary policy decisions $Decision_t$. Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 5: Results from ordered probit models with the change of the ECB MRR (ΔMRR_{t+m}): Estimation of Equations 5 and 7

	m = 1				m = 2			
ΔMRR_t	0.931	-1.257	-0.083	-0.420	1.841	0.016	1.139	1.505
	(0.705)	(1.021)	(0.922)	(0.936)	(1.191)	(1.205)	(1.248)	(1.195)
$\Delta(y_t - y^*)$	21.160*	15.239	20.199	22.721*	13.802	7.860	12.525	14.050
	(12.131)	(14.411)	(12.652)	(12.658)	(9.181)	(11.576)	(9.348)	(10.065)
$\Delta(\pi_t - \pi^*)$	0.007	-0.092	-0.033	-0.272	0.805*	0.892*	0.813*	0.687
	(0.434)	(0.537)	(0.439)	(0.464)	(0.474)	(0.504)	(0.482)	(0.500)
Δy_t^e	0.083	0.138	0.092	0.091	0.091	0.121	0.097	0.095
	(0.102)	(0.103)	(0.103)	(0.107)	(0.102)	(0.097)	(0.099)	(0.103)
$\Delta \pi_t^e$	2.321**	2.576**	1.776	1.429	0.287	0.276	-0.101	-0.300
	(1.168)	(1.097)	(1.159)	(1.259)	(1.190)	(1.096)	(1.228)	(1.267)
I_t^{MP}		0.004				-0.357		
		(0.371)				(0.348)		
I_t^{EC}		3.604***				2.995***		
		(0.722)				(0.710)		
LM_t			1.724**				1.194*	
			(0.744)				(0.708)	
BN_t				2.010***				1.125***
				(0.566)				(0.400)
Observations	106	106	106	106	106	106	106	106
$Pseudo - R^2$	0.139	0.326	0.175	0.209	0.0980	0.234	0.116	0.125

Notes: The tables report the results from an ordered probit model estimated with maximum likelihood between January 2006 and December 2014. The dependent variable is the one period ahead ($m = 1$) or two period ahead ($m = 2$) value of the change of the ECB MRR ΔMRR_{t+m}. Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 6: Results from ordered probit models with ECB Policy Variable ($Decision_{t+m}$): Estimation of Equations 5 and 7

	m = 1				m = 2			
$Decision_t$	-0.140	-0.910***	-0.653***	-0.583***	0.339*	-0.026	0.163	0.165
	(0.126)	(0.234)	(0.185)	(0.189)	(0.196)	(0.219)	(0.211)	(0.208)
$\Delta(y_t - y^*)$	15.972	10.023	14.341	17.240	13.651	9.457	12.135	13.611
	(12.037)	(14.080)	(12.530)	(12.683)	(9.077)	(11.301)	(9.070)	(9.692)
$\Delta(\pi_t - \pi^*)$	-0.132	-0.539	-0.271	-0.559	0.658	0.461	0.605	0.479
	(0.481)	(0.562)	(0.490)	(0.541)	(0.465)	(0.482)	(0.472)	(0.489)
Δy_t^e	0.063	0.123	0.080	0.084	0.017	0.031	0.023	0.020
	(0.089)	(0.087)	(0.087)	(0.093)	(0.088)	(0.084)	(0.087)	(0.088)
$\Delta \pi_t^e$	2.727***	2.607***	1.998**	1.968**	0.922	0.412	0.588	0.418
	(0.830)	(0.921)	(0.801)	(0.974)	(0.855)	(0.835)	(0.887)	(0.895)
I_t^{MP}		0.577*				0.256		
		(0.313)				(0.278)		
I_t^{EC}		2.592***				1.596***		
		(0.620)				(0.590)		
LM_t			2.711***				0.997	
			(0.701)				(0.615)	
BN_t				2.475***				1.082***
				(0.506)				(0.383)
Observations	106	106	106	106	106	106	106	106
$Pseudo - R^2$	0.0991	0.296	0.175	0.209	0.0855	0.172	0.0972	0.110

Notes: The tables report the results from an ordered probit model estimated with maximum likelihood between January 2006 and December 2014. The dependent variable is the one period ahead ($m = 1$) or two period ahead ($m = 2$) value of the ECB monetary policy decisions $Decision_{t+m}$. Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 7: Contemporaneous relationship regression results (d=0)

	R_t			VOL_t			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Constant	-0.0006	-0.0016	-0.0001	-0.0057	-0.0028	0.0024	0.0003
	(0.0014)	(0.0016)	(0.0025)	(0.0062)	(0.0063)	(0.0069)	(0.0103)
$Surprise_t$	0.0626	0.0562	0.0610	-0.0793			
	(0.0481)	(0.0524)	(0.0481)	(0.1377)			
$\|Surprise_t\|$					-0.1966	-0.2301**	-0.1929*
					(0.1207)	(0.1015)	(0.1105)
R_{t-1}	-0.2206	-0.1502	-0.1696				
	(0.1359)	(0.1324)	(0.1370)				
VOL_{t-1}				0.0652	0.0866	0.1317	0.1246
				(0.0957)	(0.0906)	(0.0812)	(0.0840)
I_t^{MP}	-0.0100***			0.0356**	0.0342**		
	(0.0034)			(0.0144)	(0.0150)		
I_t^{EC}	0.0125*			-0.0413	-0.0493*		
	(0.0067)			(0.0290)	(0.0292)		
LM_t		0.0050				-0.0315	
		(0.0062)				(0.0243)	
BN_t			-0.0034				0.0009
			(0.0044)				(0.0188)
Observations	106	106	106	106	106	106	106
$Adj. - R^2$	0.0726	0.0228	0.0216	0.0329	0.0519	0.0239	0.0116

Note: The table reports the results from a linear regression (d=0) of Equation 9 and Equation 10. The dependent variable on model [1], [2] and [3] is the percentage change of the Eurostoxx 50 on ECB statement days. The dependent variable on model [4], [5] and [6] is the percentage change of the VSTOXX on ECB statement day. Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

Table 8: Next day regression results (d=1)

	R_{t+1}			VOL_{t+1}			
	[1]	[2]	[3]	[4]	[5]	[6]	[7]
Constant		0.0020	0.0020	-0.0071	-0.0065	-0.0056	-0.0045
	(0.0013)	(0.0014)	(0.0025)	(0.0044)	(0.0046)	(0.0049)	(0.0081)
$Surprise_t$	-0.0192	-0.0190**	-0.0200*	0.0366			
	(0.0118)	(0.0084)	(0.0109)	(0.0420)			
$\lvert Surprise_t \rvert$					-0.0595	-0.0088	-0.0286
					(0.0554)	(0.0435)	(0.0436)
R_t	0.1456	0.1718*	0.1659				
	(0.1117)	(0.1007)	(0.1076)				
VOL_t				0.0688	0.0595	0.0944	0.0890
				(0.0725)	(0.0717)	(0.0676)	(0.0701)
I_t^{MP}	-0.0036			0.0172*	0.0174*		
	(0.0027)			(0.0095)	(0.0094)		
I_t^{EC}	0.0062			-0.0349**	-0.0378**		
	(0.0051)			(0.0172)	(0.0184)		
LM_t		-0.0046				0.0154	
		(0.0062)				(0.0208)	
BN_t			-0.0004				-0.0010
			(0.0043)				(0.0152)
Observations	106	106	106	106	106	106	106
$Adj. - R^2$	0.0201	0.0218	0.0153	0.0111	0.0133	-0.0064	-0.0119

Note: The table reports the results from a linear regression (d=1) of Equation 9 and Equation 10 The dependent variable on model [1], [2] and [3] is the percentage change of the Eurostoxx 50 on the day after ECB statement. The dependent variable on model [4], [5] and [6] is the percentage change of the VSTOXX on the day after ECB statement. Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

A Appendix

A.1 ECB Statement sentences classification : Topic Monetary Policy

Accomodative	
04/12/2008	On the basis of its regular economic and monetary analyses, the Governing Council decided to reduce the key ECB interest rates by a further 75 basis points.
02/10/2013	The Governing Council confirms that it expects the key ECB interest rates to remain at present or lower levels for an extended period of time.
13/01/2011	Accordingly, the Governing Council will continue to monitor all developments over the period ahead very closely.
04/09/2014	The newly decided measures, together with the targeted longer term refinancing operations which will be conducted in two weeks, will have a sizeable impact on our balance sheet.
Neutral	
02/11/2006	On the basis of our regular economic and monetary analyses, we decided at today s meeting to leave the key ECB interest rates unchanged.
05/11/2009	The current rates remain appropriate.
04/12/2014	In this context, early next year the Governing Council will reassess the monetary stimulus achieved, the expansion of the balance sheet and the outlook for price developments.
Restrictive	
05/10/2006	At today s meeting, we decided to increase the key ECB interest rates by 25 basis points.
06/07/2006	Therefore, if our assumptions and baseline scenario are confirmed, a progressive withdrawal of monetary accommodation remains warranted.
06/09/2007	Accordingly, the Governing Council will monitor very closely all developments.
14/01/2010	The Governing Council will also continue to implement the gradual phasing out of the extraordinary liquidity measures that are not needed to the same extent as in the past.

Note : This table displays several examples of sentences classified by the authors as related to the monetary policy content with a dovish, neutral or hawkish inclination.

A.2 ECB Statement sentences classification : Topic Economic Outlook

Positive	
07/12/2006	Domestic demand in the euro area is expected to maintain its relatively strong momentum.
05/03/2009	Over the course of 2010, the economy is expected to gradually recover.
07/07/2011	Euro area exports should continue to be supported by the ongoing expansion in the world economy.
01/08/2013	Furthermore, the overall improvements in financial markets seen since last summer appear to be gradually working their way through to the real economy, as should the progress made in fiscal consolidation.
Neutral	
03/08/2006	Turning to price developments, according to Eurostat s flash estimate, annual HICP inflation was 2.5 in July 2006, unchanged from June and May.
05/07/2007	The risks surrounding this favourable outlook for economic growth are broadly balanced over the shorter term.
03/12/2009	The Governing Council continues to view the risks to this outlook as broadly balanced.
Negative	
06/12/2007	However, the reappraisal of risk in financial markets is still evolving and is accompanied by continued uncertainty about the potential impact on the real economy.
06/11/2008	To sum up, the intensification and broadening of the financial market turmoil is likely to dampen global and euro area demand for a rather protracted period of time.
03/11/2011	In the Governing Council s assessment, the downside risks to the economic outlook for the euro area are confirmed in an environment of particularly high uncertainty.
07/03/2013	The GDP outcome for the fourth quarter of 2012 was weak, with Eurostat s second estimate indicating a contraction of 0.6 quarter on quarter.

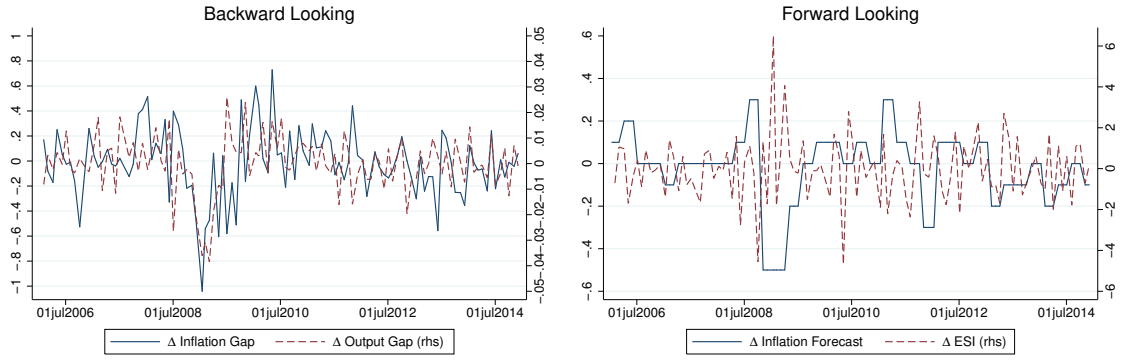
Note : This table displays several examples of sentences classified by the authors as related to the economic outlook content with a positive, neutral or negative inclination.

A.3 ECB Statement sentences classification : Topic NONE

Data sentences	
09/01/2014	According to Eurostat s flash estimate, euro area annual HICP inflation was 0.8% in December 2013, compared with 0.9% in November.
06/06/2012	The June 2012 Eurosystem staff macroeconomic projections for the euro area foresee annual real GDP growth in a range between 0.5% and 0.3% for 2012 and between 0.0% and 2.0% for 2013.
04/04/2012	The annual growth rate of M3 was 2.8% in February 2012, compared with 2.5% in January.
Repetition	
Each speech	Ladies and gentlemen, the Vice President and I are very pleased to welcome you to our press conference.
Each speech	Let me now explain our assessment in greater detail, starting with the economic analysis.
+70 times	Over the medium term, inflation expectations remain firmly anchored in line with price stability.
29 times	we will continue to monitor very closely all developments over the period ahead.
Other Topic or explanation	
08/07/2010	A lagged response of loans to non financial corporations to developments in economic activity is a normal feature of the business cycle.

Note : This table displays several examples of sentences classified by the authors as not related to either the monetary policy or economic content.

A.4 Macroeconomic Variables



Notes: The two figures present the macroeconomic variables used as independent variables in our model at a monthly frequency between 2006 and 2014. The first part focuses on backward looking variables with the month-to-month variation of the output (rhs) and inflation gaps. The second part presents forward looking variables namely the month-to-month variations of inflation forecasts and Economic Sentiment Indicator (ESI, rhs).

A.5 Descriptive Statistics

	Mean	Std. Deviation	Min.	Max.	ADF t-statistic
R_t	1.712	1.354	.05	4.25	-0.127
ΔR_t	-.016	.149	-.75	.25	**-6.590**
$(\pi_t - \pi^*)$	-.001	.010	-.026	.021	-0.955
$\Delta(\pi_t - \pi^*)$	-.001	.003	-.010	.007	**-7.928**
$(y_t - y^*)$	.001	.037	-.117	.078	-1.540
$\Delta(y_t - y^*)$	-.000	.011	-.038	.026	**-9.189**
Δy_t^e	-.0068299	1.56758	-4.679339	6.495041	**-14.150**
$\Delta \pi_t^e$	-.0186916	.172731	-.5	.3	**-3.794**
$\Delta Eurostoxx_t$	-0.002	.017	-.062	.057	**-11.344**
ΔVOL_t	-.003	-.067	-1.644	.236	**-10.057**

Notes: The ADF test null hypothesis H_0 assumes the existence of a unit root. Values in bold reject H_0 at the 1% confidence level (the 99% critical value is equal to -3.508) with 0 lag.

Correlation Matrix

	$\Delta(y_t - y^*)$	$\Delta(\pi_t - \pi^*)$	Δy_t^e	$\Delta \pi_t^e$
$\Delta(y_t - y^*)$	1.0000			
$\Delta(\pi_t - \pi^*)$	0.2415	1.0000		
Δy_t^e	-0.1698	-0.1729	1.0000	
$\Delta \pi_t^e$	0.3861	0.3718	-0.2153	1.0000
I_t^{MP}	0.2875	0.2564	-0.1515	0.4212
I_t^{EC}	0.1580	0.2501	-0.1689	0.4151
LM_t	0.2530	0.2495	-0.1973	0.5266
BN_t	0.2308	0.3303	-0.1570	0.5059

Note : This table displays Pearson correlation coefficients of our independant variables between 2006 and 2014 at a monthly frequency.

A.6 ECB Non Standard Policies Announcements

Date	Reference	Wording from Introductory Statement
05/07/2009[1]	CBPP1	the Governing Council decided today to proceed with its enhanced credit support approach.
	1Y LTRO	we will conduct liquidity-providing longer-term refinancing operations with a maturity of 12 months
08/04/2011	6M LTRO	the Governing Council today also decided to conduct a liquidity-providing supplementary longer-term refinancing operation (LTRO) with a maturity of approximately six months
10/06/2011	LTRO	The Governing Council has decided to conduct two longer term refinancing operations LTROs , one with a maturity of approximately 12 months in October and the other with a maturity of approximately 13 months in December.
	CBPP2	Furthermore, the Governing Council has decided to launch a new covered bond purchase programme CBPP2 .
12/08/2011[1]	3Y LTRO	First, to conduct two longer-term refinancing operations (LTROs) with a maturity of 36 months and the option of early repayment after one year.
	Collaterals	Second, to increase collateral availability by reducing the rating threshold for certain asset-backed securities (ABS).
	Reserve Ratio	Third, to reduce the reserve ratio, which is currently 2 , to 1 .
09/06/2012	OMT	the Governing Council today decided on the modalities for undertaking Outright Monetary Transactions OMTs in secondary markets for sovereign bonds in the euro area.
07/04/2013	FG	The Governing Council expects the key ECB interest rates to remain at present or lower levels for an extended period of time.
06/05/2014[1]	TLTRO	targeted longer term refinancing operations
	SMP	we have decided to suspend the weekly fine tuning operation sterilising the liquidity injected under the Securities Markets Programme.
	ABS	preparatory work related to outright purchases of asset backed securities
09/04/2014[1]	ABS	In addition, the Governing Council decided to start purchasing non financial private sector assets.
	CBPP3	the Eurosystem will also purchase a broad portfolio of euro denominated covered bonds issued by MFIs domiciled in the euro area under a new covered bond purchase programme CBPP3 .

[1] : The Governing Council also announced an interest rate cut before the Press Conference.

A.7 Results from Equation 6 using the real time indicators RT_s^c

	Monetary policy decisions ECB_t	
	ΔMRR_t	$Decision_t$
ECB_{t-1}	-0.817	-0.786***
	(1.185)	(0.267)
$\Delta(y_t - y^*)$	-12.182	-3.238
	(14.383)	(13.452)
$\Delta(\pi_t - \pi^*)$	0.368	-0.285
	(0.558)	(0.521)
Δy_t^e	-0.040	-0.049
	(0.106)	(0.075)
$\Delta \pi_t^e$	4.727***	3.418***
	(1.047)	(0.915)
I_t^{MP}	0.355	0.523
	(0.454)	(0.342)
I_t^{EC}	3.040***	2.240***
	(0.783)	(0.657)
Observations	106	106
$Pseudo - R^2$	0.353	0.294

Notes: The tables report the results from an ordered probit model estimated with maximum likelihood between January 2006 and December 2014. The dependent variable is, for the upper part, the change of the ECB MRR and, for the lower part, ECB monetary policy decisions. Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

A.8 Results from Equation 7 using the real time indicators RT_s^c

	Monetary policy decisions ECB_t			
	ΔMRR_{t+m}		$Decision_{t+m}$	
	m=1	m=2	m=1	m=2
ECB_t	-1.197	0.542	-0.789***	0.023
	(0.987)	(1.052)	(0.220)	(0.198)
$\Delta(y_t - y^*)$	14.665	10.922	11.500	13.815
	(14.195)	(11.057)	(13.302)	(10.791)
$\Delta(\pi_t - \pi^*)$	1.433**	0.378	-0.073	-0.087
	(0.629)	(0.557)	(0.573)	(0.446)
Δy_t^e	0.129	0.099	0.125	0.029
	(0.102)	(0.096)	(0.086)	(0.089)
$\Delta \pi_t^e$	1.918*	0.153	2.499***	0.743
	(1.112)	(1.196)	(0.899)	(0.946)
I_t^{MP}	-0.394	-0.473	-0.103	0.006
	(0.415)	(0.372)	(0.373)	(0.321)
I_t^{EC}	3.366***	2.246***	2.980***	1.609***
	(0.707)	(0.622)	(0.657)	(0.508)
Observations	106	106	106	106
$Pseudo - R^2$	0.322	0.181	0.290	0.156

Notes: Coefficients are maximum likelihood estimations of an ordered probit model between January 2006 and December 2014. The dependent variable is the one period ahead ($m = 1$) or two period ahead ($m = 2$) value of, for the upper part, the change of the ECB MRR and, for the lower part, ECB monetary policy decisions . Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.

A.9 Regression results - Market Volatility and Text-Based Market Uncertainty

	VSTOXX		
	[1]	[2]	[3]
VOL_{t-1}	0.0866	0.1038	0.1229
	(0.0906)	(0.0867)	(0.0838)
$Surprise_t$	-0.1966	-0.1800	**-0.1832***
	(0.1207)	(0.1094)	(0.1101)
I_t^{MP}	**0.0342****		
	(0.0150)		
I_t^{EC}	**-0.0493***		
	(0.0292)		
ULM_t		1.7542	
		(1.5764)	
UBB_t			-0.0086
			(0.0118)
Observations	106	106	106
$Adj. - R^2$	**0.0519**	0.0204	0.0164

Note: The table reports the results from a linear regression of contemporaneous market volatility (Equation 10). Robust standard errors are reported in parenthesis and superscripts ***, **, and * indicate statistical significance at the 1%, 5% and 10% level, respectively.