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Do the ECB's Introductory Statements Help Predict Monetary Policy? Evidence from a Tone Analysis*

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October 7, 2020

Abstract

In this paper, we examine whether a tone shock derived from European Central Bank communication helps predict ECB monetary policy decisions. To this purpose, we first use a bag-of-words approach and several dictionaries on the ECB's Introductory Statements to derive a measure of tone. Next, we orthogonalise the tone measure on the latest data available to market participants to compute the tone shock. Finally, we relate the tone shock to future ECB monetary policy decisions. We find that the tone shock is significantly and positively related to future ECB monetary policy decisions, even when controlling for market expectations of monetary policy and the Governing Council's inter-meeting communication. Further extensions show that the predictive ability of the tone shock is robust to (i) the normalization of the tone measure, (ii) alternative market expectations of monetary policy, and (iii) the horizon of macroeconomic variables used in the Taylor-type monetary policy rule. These findings highlight an additional channel through which ECB communication improves monetary policy predictability, suggesting that the ECB may have private information that it communicates through its Introductory Statements.

JEL Codes: E52; E58.

Keywords: Central Bank Communication; European Central Bank; Tone; Taylor Rule.

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October 6, 2020

Abstract

In this paper, we examine whether a tone shock derived from European Central Bank communication helps predict ECB monetary policy decisions. To this purpose, we first use a bag-of-words approach and several dictionaries on the ECB's Introductory Statements to derive a measure of tone. Next, we orthogonalise the tone measure on the latest data available to market participants to compute the tone shock. Finally, we relate the tone shock to future ECB monetary policy decisions. We find that the tone shock is significantly and positively related to future ECB monetary policy decisions, even when controlling for market expectations of monetary policy and the Governing Council's inter-meeting communication. Further extensions show that the predictive ability of the tone shock is robust to (i) the normalization of the tone measure, (ii) alternative market expectations of monetary policy, and (iii) the horizon of macroeconomic variables used in the Taylor-type monetary policy rule. These findings highlight an additional channel through which ECB communication improves monetary policy predictability, suggesting that the ECB may have private information that it communicates through its Introductory Statements.

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1 Introduction

Since the seminal paper by Gürkaynak et al. (2005), it has been known that monetary policy announcements move long term interest rates following the adjustment of market expectations. This adjustment occurs because central bank communication provides information about the changing economic environment, strategy of the central bank, and respective policy reactions, making monetary policy more predictable (Allard et al., 2013). Following this line of thought, studies examine the impact of European Central Bank (ECB) communication on market expectations of future monetary policy. As a case in point, Rosa and Verga (2007) analyse the impact of the Introductory Statements by the ECB at the monthly press conference. They find that the predictive ability of these statements is similar to that implied by market-based measures of monetary policy expectations. Sturm and de Haan (2011) examine ECB communication within a Taylor monetary policy rule and find that communication is informative about future monetary policy decisions. Neuenkirch (2012) shows that ECB communication helps improve the management of the expectations of future interest rates. Finally, Tobback et al. (2017) develop a content-based indicator of the media perception of ECB policies and add it into an extended Taylor rule. They find a positive role for ECB communication in enhancing the accuracy of market expectations.

A parallel strand of the literature has developed quantitative tools to measure, on a numerical scale, the qualitative information contained in central bank statements. This approach quantifies the tone contained in central bank communication by counting the number of positive and negative words using a predefined list from the Harvard IV-4 Psychosociological Dictionary or Loughran and McDonald (2011) (LM) Financial Dictionary. As an illustration, Lucca and Trebbi (2009) analyse the content of Federal Open Market Committee (FOMC) statements using the semantic orientation scores estimated from a large information set obtained from search engines. Hansen and McMahon (2016) study how FOMC communication on the economic conditions and forward guidance affects economic and financial variables. Finally, Schmeling and Wagner (2019) explore whether the tone of ECB communication matters for asset prices. They find that stock prices increase when the tone becomes more positive.

In this paper, we combine these two strands of the literature by testing whether the tone conveyed through ECB communication helps market participants predict ECB monetary policy decisions. Since the tone of central bank communication can be considered as qualitative information that might be related to signals such as the future path of the policy rate, market participants pay attention not only to the content (i.e. to explicit information about ECB monetary policy decisions), but also to the tone of ECB state-

ments (i.e. to implicit information about the economic outlook or future monetary policy).

Against this background, we examine how the tone of ECB communication is related to future monetary policy decisions for 2000M2-2018M04. For this purpose, we first measure the tone of ECB communication using several dictionaries that convert the qualitative information contained in ECB statements into a quantitative measure. We use the most informative verbal communication of the ECB's Governing Council (GC): the Introductory Statement to the press conference. Second, since the tone of ECB communication is likely to be related to the economic and financial conditions, we orthogonalise the tone measure with the latest data available to market participants at the time of the press conference. We consider the residual from this regression as a tone shock orthogonal to the economic conditions. Finally, we investigate how the tone shock is useful for predicting the ECB's monetary policy decisions by including it in a forward-looking Taylor monetary policy rule, such as in Hayo and Neuenkirch (2010). However, whereas Hayo and Neuenkirch (2010) classify Federal Reserve communication into three categories depending on whether it indicates likely increases, decreases, or no change in the target rate, we use an automated bag-of-words approach that distinguishes more objectively between words and phrases with a different tone to quantify the tone of the ECB's Introductory Statements.

To the best of our knowledge, this paper offers original contributions on various dimensions. On the one hand, it overcomes the absence of ECB voting records and minutes of the meeting.¹ On the other hand, it analyses a specific component of ECB communication, a tone shock, that has not yet been used in the literature to assess its informativeness about future monetary policy decisions. The closest study to ours is Picault and Renault (2017), who find that ECB communication about the Eurozone economy helps explain future monetary decisions. However, our study differs from theirs in many aspects. First, we use monthly real-time Reuters' polls collected from individual forecasters at the time of the ECB's Introductory Statements, whereas Picault and Renault (2017) use quarterly forecasts from the Survey of Professional Forecasters. Second, we use a tone shock to analyse how ECB communication helps predict monetary policy decisions, whereas they use a raw measure of tone likely to be correlated with macroeconomic and financial variables. Third, we control for the monetary policy expectations of market participants to check whether ECB communication adds information beyond that contained in the mar-

¹The literature uses voting records and minutes of the meeting to assess the effect of central bank communication on monetary policy predictability, such as for the Bank of England and FOMC (see, e.g., Gerlach-Kristen, 2004; El-Shagi and Jung, 2015a; Jung, 2016). Since November 2015, the ECB has published an account of its monetary policy meetings. The released information, however, is less granular than the minutes published by other major central banks.

ket expectations. Finally, we use four dictionaries to compute several tone shocks.

Our results show that the tone shock of the Introductory Statements helps market participants predict ECB monetary policy decisions even when controlling for (i) market expectations of monetary policy, (ii) negation patterns when computing the tone measure, and (iii) the ECB's GC inter-meeting communication. This suggests that the tone shock conveys relevant information for market participants about future ECB monetary policy decisions. Further extensions show that the predictive ability of the tone shock is robust to (i) the normalization of the tone measure, (ii) alternative market expectations of monetary policy, and (iii) the horizon of the macroeconomic variables used in the Taylor monetary policy rule. However, we find that the horizon of predictive ability of the tone shock differs when using other dictionaries, and that the announcement of the unconventional policy measures do not provide additional insights to market participants about ECB future rate movements. Finally, we provide additional evidence indicating that the results are robust to various specifications.

We show that ECB communication matters to explain future monetary policy decisions, most likely because of existence of asymmetric information (de Haan et al., 2007). Specifically, the ECB may have private information about exogenous shocks to output and inflation, the policy strategy, and the (outlook for future) policy decisions that it communicates through its Introductory Statements. Romer and Romer (2000) find the existence of central bank private information beyond what is known to forecasters for the US Federal Reserve. They conclude that the central bank possesses superior information about the economy since it invests considerable resources into monitoring the economy. Our results suggest similar evidence for the ECB.

The remainder of the paper is structured as follows. Section 2 reviews the tone shock of ECB communication, Section 3 describes the data and methodology, Section 4 provides the main results, and Section 5 presents further extensions and robustness tests. The last section concludes.

2 Tone shock of ECB introductory statements

We provide different measures of the ECB tone shock at the meetings during 2000M02-2018M04 using the (i) Introductory Statements to the press conference and (ii) two dictionaries. We first use the Bennani and Neuenkirch (2017)'s (BN) dictionary that reflects the monetary inclination of ECB communication. Bennani and Neuenkirch (2017) use speeches of the members of the ECB's GC during 1999M1-2014M4 to extract keywords that convey a hawkish and dovish tone in a monetary policy context. They identify 26

hawkish words and 32 dovish words. Second, Picault and Renault (2017) (PR) develop a field-specific weighted lexicon designed to assess the tone of ECB communication. They include 34,052 n-grams with assigned probabilities reflecting a hawkish/neutral/dovish monetary policy tone. The probabilities were provided based on the manual classification of phrases from the ECB’s Introductory Statements into three inclinations and the number of occurrences (frequencies) of n-grams in each inclination context. On the one hand, phrases such as “*this will lead to a strengthening of the euro.*”² and “*annual HICP inflation continued to decline*”³ convey a hawkish and dovish tone, respectively, according to the BN dictionary. On the other hand, the following n-grams “*the signals coming from the monetary analysis confirmed the need for an ample degree of monetary accommodation to secure a sustained return of inflation rates towards levels that are below, but close to, 2% over the medium term.*”⁴ and “*Risks to the medium-term outlook for price stability remain on the upside, relating in particular to stronger than currently expected wage developments in a context of ongoing robust growth in employment and economic activity*”⁵ convey a dovish and hawkish tone, respectively, according to the PR dictionary. As the first step, we express the tone of each Introductory Statement when using the BN dictionary as follows:

$$tone_{t,BN} = \frac{\#haw_{t,BN} - \#dov_{t,BN}}{\#haw_{t,BN} + \#dov_{t,BN}}; \quad (1)$$

where $tone_{t,BN}$ reflects the tone of the Introductory Statement made at press conference t when using the BN dictionary. $\#haw_{t,BN}$ ($\#dov_{t,BN}$) denotes the count of words with a hawkish (dovish) tone, as categorized in the BN dictionary. Following Picault and Renault (2017), we compute the ECB tone when using the PR dictionary as:

$$tone_{t,PR} = haw_{t,PR} - dov_{t,PR}; \quad (2)$$

where $haw_{t,PR}$ and $dov_{t,PR}$ expresses the hawkish and dovish probabilities, respectively. Figure A4 in the Appendix shows the absolute frequency of hawkish and dovish words over 2000M02-2018M04 when using the BN dictionary, while Figure A5 shows the hawkish and dovish probabilities when using the PR dictionary.

Figure 1 shows that the measures of tone computed with the BN and PR dictionaries exhibit a similar pattern over time. Interestingly, some events related to the global financial crisis and ECB monetary policy are reflected through the level of tones. For instance, the negative value observed in 2009 for both measures of tone could be related to fears

²ECB Press Conference, 3 February 2000.

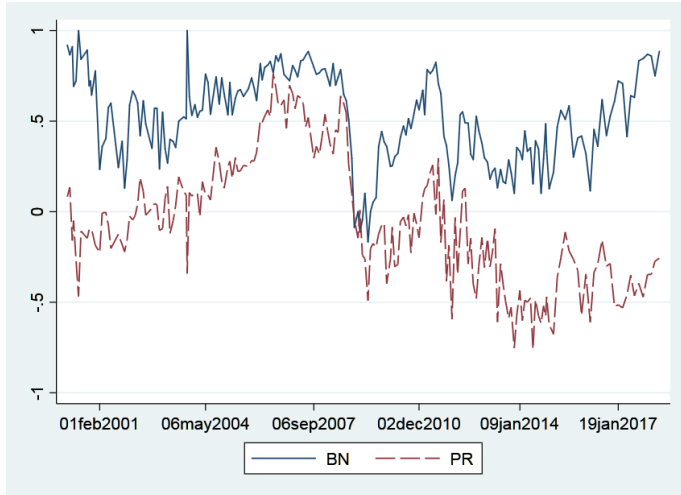
³ECB Press Conference, 5 February 2009.

⁴ECB Press Conference, 26 April 2018.

⁵ECB Press Conference, 12 April 2007.

of the propagation of the global financial crisis in the euro area, whereas the minimum value observed for the PR tone in June 2014 might be explained by the beginning of the zero lower bound of nominal interest rates.

Figure 1: Tone measures of the ECB’s Introductory Statements (2000M02-2018M04)



Since the ECB’s tone might be endogenous to the business cycle and might contain information about the current and future states of the economy, we compute the tone shocks by orthogonalising the measures of tone obtained from eqs. (1) and (2) on a set of macroeconomic and financial variables. In the next step, we regress $tone_{t,dic}$ (where dic : BN or PR) on the last macroeconomic and financial data available to market participants at the time of press conference t . The equation takes the following form:

$$tone_{t,dic} = \alpha + \beta tone_{t-1,dic} + \sum_{i=-1}^2 \gamma_i \pi_{t,i} + \sum_{i=-1}^2 \lambda_i y_{t,i} + \eta Stoxx_t + \psi EPU_t + \theta MRR_t + \varepsilon_{tone_{t,dic}}; \quad (3)$$

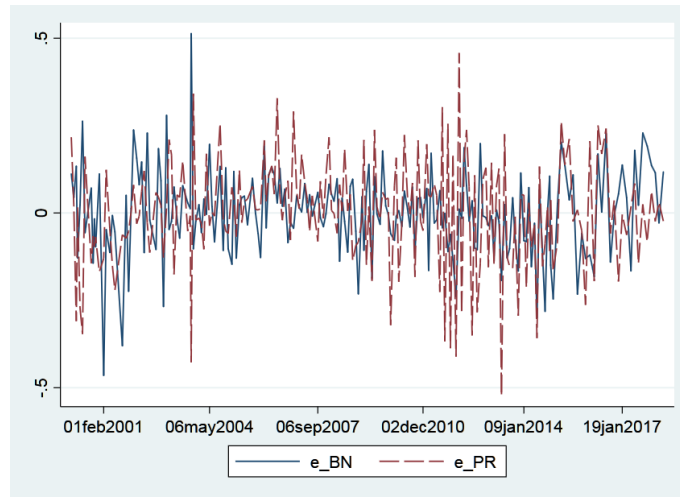
where $tone_{t-1,dic}$ is the lagged value of the tone measure. $\pi_{t,i}$ and $y_{t,i}$ represent the values of inflation and real output growth over different forecast horizons. We distinguish among the horizons using index i , which is between -1 and 2. The numbers -1 and 0 represent the lagged and the current values of GDP dynamics and the HICP, collected from the Euro Area Real-Time Database, respectively.⁶ The numbers 1 and 2 represent the expected values of GDP and the HICP one-quarter and two-quarters ahead, respectively. Reuters collect these forecasts from individual contributors just before the ECB press conference. We choose forecasts with horizons close to one quarter and two quarters (i.e. two to five months and five to eight months, respectively), and we compute the series of average forecasts for each horizon (see Table A1 in the Appendix). $Stoxx_t$ is the log of the Euro Stoxx 50 index, which reflects the volatility of financial markets in the euro area, and EPU_t the log of the euro area Economic Policy Uncertainty index as measured by Baker

⁶Source: <https://sdw.ecb.europa.eu/browseExplanation.do?node=9689716>.

et al. (2016). Finally, we also control for the main refinancing rate, MRR_t , given that the tone might differ with the level of interest rates. Hence, we consider that past, contemporaneous, and future economic and financial conditions could affect the ECB tone (for summary statistics, see Table A2 in the Appendix). Finally, $\varepsilon_{tone_{dic,t}}$ reflects the tone shock, which is orthogonal to the set of macroeconomic and financial variables used in eq. (3).

Table A3 in the Appendix shows that the first-stage regression has many insignificant regressors and offsetting signs for the GDP and inflation forecasts. Hence, we apply a stepwise regression algorithm (with a 5% significance level) to reduce the number of variables and obtain a cleaner first-stage regression (Table A4). We find that the smoothing coefficient β related to the lagged value of the ECB tone shock is positive and highly significant, thus showing the persistence of the tone of ECB communication over time. Interestingly, the ECB tone computed with the BN and PR dictionary is mostly related to inflation. Specifically, the ECB tone is positively and significantly related to future inflation, whereas for the current output growth, it has a positive relationship with the tone computed with the BN dictionary only. Finally, higher economic policy uncertainty is associated with lower ECB tone. Figure 2 shows the residuals obtained from eq. (3), which reflect the tone shocks computed with the BN and PR dictionaries. We find that both tone shocks follow a similar pattern over time.

Figure 2: Tone shocks of the ECB’s Introductory Statements (2000M02-2018M04)



3 Data and methodology

3.1 Data

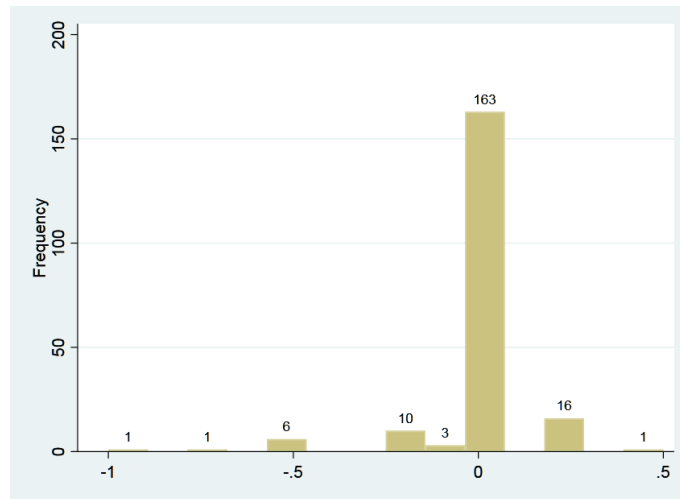
The data on ECB policy decisions as well as macroeconomic and financial variables reflecting the current and future states of the economy are collected from February 2000

to April 2018. We start in February 2000 because of the availability of data on Reuters' polls' macroeconomic projections. Since we focus on the predictability of ECB interest rate decisions, the dependent variable, dR_t , is a discrete transformation of the ECB rate change, Δi_t :

$$dR_t = \begin{cases} +1 & \Delta i_t > 0 \\ 0 & \text{for } \Delta i_t = 0 \\ -1 & \Delta i_t < 0 \end{cases} ; \quad (4)$$

The transformation expresses the direction of the policy rate change but does not consider the size of the change. This approach does not lead to a large loss of information given that the ECB usually leaves its rate unchanged or adjusts it by 25 bp (in absolute value) (see Figure 3). We do not consider more categories (e.g. interest rate changes higher or lower than 25 bp) as this would result in categories with few observations.

Figure 3: Distribution of the ECB rate decisions (2000M02-2018M04)



Regarding the independent variables, we consider Reuters' forecasts of the euro area HICP and GDP two-quarters ahead as well as the two measures of tone shocks, $\varepsilon_{tone_{t,BN}}$ and $\varepsilon_{tone_{t,PR}}$, computed from eq. (3). Finally, the information conveyed by the tone shock may already be included in the monetary policy expectations of market participants. In such a case, the tone shock would not help predict ECB monetary policy decisions. Hence, we need to control for market expectations of monetary policy to test whether the tone shock provides additional information. Following Gerlach-Kristen (2004), we express market expectations of ECB monetary policy using the term structure of market rates. Specifically, we use the difference between the Euribor 3- and 12-month market rates.

3.2 Methodology

The baseline specification is in the form of a monetary policy rule à la Taylor (1993), augmented with interest rate smoothing (Clarida et al., 2000):

$$i_t = \rho i_{t-1} + (1 - \rho) i_t^*; \quad (5)$$

where i_t is the ECB's interest rate and i_t^* is the interest ("target") rate desired by the central bank. Rearranging the terms in eq. (5), we obtain:

$$\Delta i_t = (\rho - 1) i_{t-1} + (1 - \rho) i_t^*; \quad (6)$$

We specify the "target" rate, i_t^* , as a linear function of a set of macroeconomic and financial variables. The specification is composed of three blocks of variables: (i) information on the future state of the economy (i.e. the two-quarters ahead forecasts of inflation and GDP), (ii) a measure of the ECB tone shock computed with the BN or PR dictionaries, and (iii) the term structure of the market rates, measured as the difference between the long- and short-term Euribor rates. We replace the change in interest rate in eq. (6), Δi_t , with its discrete transformation, dR_t . At $t + n$, this gives:

$$dR_{t+n} = \beta_i i_t + \underbrace{\beta_\pi E_t \pi_{t+k} + \beta_y E_t y_{t+k} + \beta_{\varepsilon, dic} \varepsilon_{tone_{t, dic}} + \beta_{term} (i_{t,L} - i_{t,S})}_{i_t^*} + \epsilon_{t+n}; \quad (7)$$

where the dependent variable dR_{t+n} is the ECB rate change at press conference $t + n$ ($n = \{1, 2\}$ stands for the n -th subsequent meeting). i_t is the initial ECB policy rate and $\varepsilon_{tone_{t, dic}}$ is the ECB tone shock computed with the BN or PR dictionary. $E_t \pi_{t+k}$ and $E_t y_{t+k}$ represent market expectations of inflation and output growth two-quarters ahead ($k = 6$ months), respectively, collected by Reuters after press conference t .⁷ $(i_{t,L} - i_{t,S})$ is the term structure of the market rates, which represents the difference between the Euribor 12-month and 3-month rates after the press conference. Finally, ϵ_{t+n} is the error term. The estimation aims to test whether the ECB tone shock helps predict ECB's monetary policy decision at $t + 1$ and $t + 2$, controlling for the adjustment of market expectations following the press conference at time t . Since the dependent variable, dR_{t+n} , is discrete, we follow the methodology used in the literature (El-Shagi and Jung, 2015b; Jung, 2016) and use an ordered logistic model to estimate eq. (7).

⁷Two working days after press conference t at the latest.

4 Empirical results

4.1 Baseline model

Table 1 shows the estimated results of eq. (7) for 2000M02-2018M04, i.e. the predictive ability of the tone shock of the ECB's monetary policy decision one and two-meetings ahead. To ease the concern that we use too many variables and over-fit the model, we include each block of variables progressively in the empirical specification.

Table 1: Baseline results (2000M02-2018M04)

BN tone shock						
Variable	dR_{t+1}			dR_{t+2}		
	(1)	(2)	(3)	(4)	(5)	(6)
β_i	-0.11 (0.17)	-0.11 (0.18)	0.34** (0.17)	-0.09 (0.17)	-0.07 (0.18)	0.3 (0.17)
β_π	0.24 (0.34)	0.22 (0.38)	-0.37 (0.43)	0.09 (0.34)	0.04 (0.36)	-0.49 (0.41)
β_y	0.61*** (0.16)	0.62*** (0.17)	0.86*** (0.19)	0.5*** (0.14)	0.5*** (0.15)	0.69*** (0.17)
$\beta_{\varepsilon_{BN}}$		3.14** (1.26)	2.43* (1.32)		1.19 (1.56)	0.34 (1.44)
β_{term}			5.73*** (1.18)			4.81*** (1.14)
mfx_{+1}		0.027** (0.013)	0.018 (0.012)		0.010 (0.013)	0.003 (0.012)
Pseudo- R^2	0.084	0.1	0.22	0.0527	0.054	0.14
Accuracy	0.792	0.805	0.814	0.797	0.810	0.819
χ^2	17.86	21.9	43.41	13.94	13.46	30.07
Obs.	212	200	199	212	200	199

PR tone shock						
Variable	dR_{t+1}			dR_{t+2}		
	(7)	(8)	(9)	(10)	(11)	(12)
β_i	-0.11 (0.17)	-0.09 (0.18)	0.37** (0.17)	-0.09 (0.17)	-0.09 (0.19)	0.32* (0.18)
β_π	0.24 (0.34)	0.18 (0.36)	-0.42 (0.43)	0.09 (0.34)	0.06 (0.37)	-0.52 (0.42)
β_y	0.61*** (0.16)	0.61*** (0.17)	0.87*** (0.19)	0.5*** (0.14)	0.5*** (0.15)	0.72*** (0.18)
$\beta_{\varepsilon_{PR}}$		0.72 (1.09)	0.92 (1.25)		2.21* (1.28)	2.5* (1.32)
β_{term}			5.96*** (1.16)			5.03*** (1.20)
mfx_{+1}		0.0081 (0.012)	0.0087 (0.012)		0.0251* (0.015)	0.0254* (0.014)
Pseudo- R^2	0.084	0.085	0.214	0.0527	0.065	0.165
Accuracy	0.792	0.795	0.8	0.797	0.805	0.81
χ^2	17.86	17.78	51.06	13.94	15.06	27.83
Obs.	212	200	199	212	200	199

Robust standard errors are shown in between brackets. mfx_{+1} denotes the marginal effect of a one S.D. increase of ECB tone shock on the probability of interest rate hike ($dR_{t+n} = +1$), calculated as an average across the sample (AME). *, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively.

The results show that the GDP growth forecasts help predict ECB policy rate movements. More precisely, an increase in the GDP growth forecast is associated with an increase in the policy rate at the one-meeting and two-meetings-ahead horizons. Interestingly, the inflation forecasts of market participants are not useful for predicting ECB rate decisions, regardless of the meeting horizon considered in the analysis. Moreover, market expectations of monetary policy are positively and significantly related, at the 1% level, to future

monetary policy decisions. The coefficients related to the ECB tone shocks computed with the BN and PR dictionaries, $\beta_{\varepsilon_{BN}}$ and $\beta_{\varepsilon_{PR}}$, provide relevant insights. We find that the BN tone shock helps predict the ECB rate decision at $t + 1$, whereas the PR tone shock is more helpful for predicting the ECB rate decision at $t + 2$. This might be because the BN dictionary reflects the monetary stance of the Introductory Statements in a straightforward manner using specific keywords, whereas the PR dictionary uses phrases (i.e. n-grams) to measure the tone of the Introductory Statements. As a result, the PR dictionary seems to be more helpful for predicting the ECB rate over the medium-term horizon, whereas the BN dictionary is related to future ECB monetary decisions over a shorter horizon.

Table 1 also shows the marginal effects of the tone shock (mfx_{+1}); in other words, the change in the probability of an interest rate hike following a one standard deviation (S.D.) increase in the ECB tone shock. We find that a one S.D. increase in the BN tone shock increases the probability of an ECB rate hike by 2.7% at $t + 1$, whereas a one S.D. increase in the PR tone shock increases the probability of an ECB rate hike by 2.5% at $t + 2$.⁸

Overall, the qualitative signal provided by the ECB’s Introductory Statements, which takes the form of a tone shock, helps market participants predict ECB monetary decisions beyond the information provided by market expectations of monetary policy. This is confirmed by the forecast accuracy indicator (“Accuracy”),⁹ which suggests that the number of interest rate changes correctly predicted by the model increases following the inclusion of the ECB tone shock in the Taylor-type monetary policy rule.

4.2 Out-of-sample predictions

The hypothesis of the forecast accuracy indicator depicted in Table 1 is that the parameters are time-invariant. We thus perform out-of-sample forecasts to confirm the forecasting performance of the baseline model. We use the baseline specification, eq. (7), to re-estimate new parameters using the rolling-window approach in order to generate recursive forecast of interest rate changes for one- and two-meetings ahead. We generate forecasts for January 2007 to June 2014, i.e. before the zero lower bound. This yields 76 observations for the estimation sample and 89 observations for the validation of forecasting performance.

⁸The ECB tone shock has symmetric effects on the probability of a rate hike and cut (i.e. these effects are similar in absolute value). To save space, we report only the marginal effects of a tone shock increase.

⁹To obtain the forecasts accuracy indicator, “Accuracy”, we regress the full sample model (eq. (7)) and compute in-sample predictions of the probabilities for each category of dR_t (+1, 0, -1). Based on these predictions, we compute the forecast accuracy of each model as the percentage of dR_{t+n} which is consistent with the predicted outcome.

Table 2: Out-of-sample forecast accuracy

	dR_{t+1}			dR_{t+2}		
	(1)	(2)	(3)	(4)	(5)	(6)
BN tone shock	0.798	0.82	0.84	0.82	0.798	0.798
	(7)	(8)	(9)	(10)	(11)	(12)
PR tone shock	0.798	0.80	0.831	0.82	0.843	0.843
Obs.	89	89	89	89	89	89

The numbers in the columns correspond to the models estimated in Table 1.

The performance of the models is in accordance with the conclusions based on the results of the full-sample estimation (Table 1). The model using the BN tone shock provides additional information to market participants for predicting ECB monetary policy decisions one-meeting ahead, whereas for two-meetings ahead, the PR tone shock adds additional information beyond that contained in a Taylor monetary policy rule. Interestingly, at dR_{t+1} (dR_{t+2}), where the PR (BN) tone shock is not significant, forecasting performance does not change substantially when adding the tone shock to the traditional Taylor rule variables.

4.3 Controlling for the ECB’s GC inter-meeting communication

Bennani et al. (2020) find that the inter-meeting verbal communication among the members of the ECB’s GC provides useful information about future ECB monetary decisions. To check whether the ECB tone shock adds additional information beyond that provided by the GC between two meetings, we compute the tone of the speeches given by GC members between meetings using the BN and PR dictionaries. Next, we derive an index by summing the tone of these speeches. Finally, we add this index into the baseline model, eq. (7), and re-estimate it.

Table 3 shows the estimated results of eq. (7) when controlling for the ECB’s GC inter-meeting communication for 2000M02-2018M04.

Table 3: Controlling for the ECB's GC inter-meeting communication (2000M02-2018M04)

BN tone shock						
Variable	dR_{t+1}			dR_{t+2}		
	(1)	(2)	(3)	(4)	(5)	(6)
β_i	-0.11 (0.17)	-0.11 (0.18)	0.33* (0.18)	-0.08 (0.18)	-0.07 (0.18)	0.29* (0.17)
β_π	0.25 (0.33)	0.23 (0.37)	-0.35 (0.43)	0.06 (0.34)	0.04 (0.36)	-0.48 (0.4)
β_y	0.61*** (0.16)	0.62*** (0.17)	0.86*** (0.19)	0.5*** (0.15)	0.5*** (0.15)	0.69*** (0.17)
$\beta_{\varepsilon_{BN}}$		3.13** (1.29)	2.41* (1.34)		1.19 (1.55)	0.32 (1.44)
β_{term}			5.74*** (1.18)			4.82*** (1.15)
$\beta_{Intermeeting}$	-0.00 (0.06)	-0.01 (0.07)	-0.02 (0.07)	0.03 (0.06)	0.00 (0.07)	-0.01 (0.07)
Pseudo- R^2	0.08	0.1	0.22	0.05	0.05	0.14
Accuracy	0.792	0.805	0.809	0.797	0.810	0.819
χ^2	18.84	22.33	43.71	15.74	15.22	34.27
Obs.	212	200	199	212	200	199

PR tone shock						
Variable	dR_{t+1}			dR_{t+2}		
	(7)	(8)	(9)	(10)	(11)	(12)
β_i	-0.15 (0.19)	-0.14 (0.19)	0.34* (0.18)	-0.14 (0.2)	-0.15 (0.2)	0.27 (0.19)
β_π	0.18 (0.37)	0.18 (0.37)	-0.41 (0.43)	0.04 (0.36)	0.06 (0.37)	-0.51 (0.42)
β_y	0.63*** (0.17)	0.63*** (0.17)	0.87*** (0.19)	0.52*** (0.16)	0.53*** (0.16)	0.73*** (0.18)
$\beta_{\varepsilon_{PR}}$		0.64 (1.08)	0.87 (1.24)		2.13* (1.27)	2.44* (1.3)
β_{term}			5.93*** (1.17)			4.99*** (1.2)
$\beta_{Intermeeting}$	0.1 (0.08)	0.09 (0.08)	0.05 (0.08)	0.11 (0.09)	0.1 (0.09)	0.07 (0.1)
Pseudo- R^2	0.088	0.089	0.214	0.057	0.07	0.167
Accuracy	0.816	0.8	0.799	0.815	0.8	0.809
χ^2	17.36	17.75	50.85	12.88	14.84	28.09
Obs.	200	200	199	200	200	199

Robust standard errors are shown in between brackets. *, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 3 shows that the ECB tone shock is positively and significantly related to ECB monetary policy decisions at $t + 1$ when using the BN dictionary and $t + 2$ when using the PR dictionary. Hence, even when controlling for the ECB's GC inter-meeting communication in the specification, the ECB tone shock still provides additional information to market participants about future ECB monetary policy. The remaining results are in line with those from the baseline model (i.e. Table 1): GDP growth forecasts and market expectations of monetary policy have a positive and significant relationship with future ECB monetary policy decisions.

4.4 Tone shock and unconventional monetary policy announcements

Since the global financial crisis, the use of interest rate policies in the euro area has been accompanied by balance sheet policies such as an expansion of the list of assets eligible as collateral, longer-term liquidity provisions, and outright purchases of specific securities. As a consequence, central bank communication has changed profoundly. According to de Haan and Sturm (2019), these changes include forward guidance on policy rates, communication about asset purchase programmes, and the management of inflation expectations.

Against this backdrop, we introduce the announcement of the ECB’s unconventional policy measures in the empirical analysis.¹⁰ We first construct a control variable for unconventional monetary policy (UMP_t) that takes the value of one when a UMP event is announced during a press conference (following Cieslak and Schrimpf (2019)) and zero otherwise. Second, we interact UMP_t with the ECB tone shock to check if the latter has stronger predictive ability regarding ECB monetary policy decisions when UMP measures are announced during a press conference. The equation is as follows:

$$dR_{t+n} = \beta_i i_t + \beta_\pi E_t \pi_{t+k} + \beta_y E_t y_{t+k} + \beta_{\varepsilon, dic} \varepsilon_{tone_{t, dic}} + \beta_{UMP} UMP_t + \beta_{\varepsilon, dic, UMP} (\varepsilon_{tone_{t, dic}, UMP} \cdot UMP_t) + \beta_{term} (i_{t,L} - i_{t,S}) + \epsilon_{t+n}; \quad (8)$$

The value of the coefficient $\beta_{\varepsilon, dic, UMP}$ shows whether the ECB tone shock has stronger relationship with future ECB monetary policy decisions when an unconventional measure is announced during a press conference. Table 4 presents the estimated results of eq. (8) for 2000M02-2018M04.

¹⁰We do not consider Wu and Xia (2016)’s shadow rate as a proxy of unconventional measures and thus, as a dependent variable in the estimation. Indeed, the latter does not necessarily correspond to explicit ECB monetary policy decisions; it rather reflects market perception of ECB monetary policy.

Table 4: Unconventional monetary policy announcements (2000M02-2018M04)

BN tone shock						
Variable	dR_{t+1}			dR_{t+2}		
	(1)	(2)	(3)	(4)	(5)	(6)
β_i	-0.11 (0.17)	-0.12 (0.18)	0.33* (0.17)	-0.09 (0.17)	-0.08 (0.18)	0.29* (0.17)
β_π	0.24 (0.34)	0.36 (0.39)	-0.24 (0.45)	0.09 (0.34)	0.12 (0.37)	-0.43 (0.42)
β_y	0.61*** (0.16)	0.63*** (0.16)	0.88*** (0.19)	0.5*** (0.14)	0.5*** (0.15)	0.7*** (0.17)
$\beta_{\varepsilon_{BN}}$		3.79*** (1.30)	3.01** (1.38)		1.55 (1.64)	0.61 (1.52)
β_{UMP}		2.58 (1.79)	2.78* (1.59)		1.72 (1.45)	1.7 (1.28)
$\beta_{\varepsilon_{BN,UMP}}$		2.21 (6.45)	2.78 (5.66)		2.69 (5.14)	3.16 (4.33)
β_{term}			5.73*** (1.21)			4.8*** (1.15)
pseudo- R^2	0.08	0.112	0.230	0.05	0.057	0.15
Accuracy	0.792	0.810	0.814	0.797	0.805	0.819
χ^2	17.86	31.5	44.59	13.94	15.78	30.5
Obs.	212	200	199	212	200	199

PR tone shock						
Variable	dR_{t+1}			dR_{t+2}		
	(7)	(8)	(9)	(10)	(11)	(12)
β_i	-0.11 (0.17)	-0.1 (0.18)	0.37** (0.17)	-0.09 (0.17)	-0.1 (0.19)	0.31* (0.18)
β_π	0.24 (0.34)	0.28 (0.36)	-0.33 (0.43)	0.09 (0.34)	0.15 (0.39)	-0.43 (0.44)
β_y	0.61*** (0.16)	0.62*** (0.16)	0.89*** (0.18)	0.5*** (0.14)	0.51*** (0.15)	0.73*** (0.18)
$\beta_{\varepsilon_{PR}}$		0.97 (1.11)	1.19 (1.27)		2.5* (1.36)	2.77** (1.39)
β_{UMP}		1.18 (0.82)	1.57** (0.8)		0.86 (0.71)	1.05 (0.68)
$\beta_{\varepsilon_{PR,UMP}}$		-1.24 (3.03)	-1.15 (2.83)		-2.73 (2.67)	-2.72 (2.36)
β_{term}			6.02*** (1.19)			5.05*** (1.22)
pseudo- R^2	0.08	0.09	0.21	0.05	0.07	0.17
Accuracy	0.792	0.814	0.814	0.797	0.82	0.809
χ^2	17.86	22.86	51.9	13.94	17.5	27.87
Obs.	212	200	199	212	200	199

Robust standard errors are shown in brackets. *, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively.

The results in Table 4 suggest that the ECB tone shock has the same predictive ability about future ECB monetary policy decisions regardless of whether a UMP is announced during a press conference. This is shown by the non-significant value of the coefficient related to the interaction term, $\beta_{\varepsilon_{dic,UMP}}$. To gain further insights, we plot graphically the marginal effects for $UMP = 1$ compared with the effects for $UMP = 0$ to analyse

the interaction between the ECB tone shock and UMP. We find that neither effect is significantly different from zero.¹¹ This result is in accordance with those of Bennani et al. (2020), who show that future ECB policy rate changes cannot be explained by the communication of ECB unconventional monetary policy announcements.

5 Extensions

5.1 Alternative dictionaries

To test whether the findings in Table 1 are robust to the choice of the dictionary used to compute the tone measure, we use another two dictionaries: (i) the Loughran and McDonald (2011) (LM) dictionary and (ii) the Apel and Blix-Grimaldi (2014) (ABG) dictionary.

The results suggest that the predictive ability of the ECB tone shock is sensitive to the dictionary used to compute it. We find that a tone shock computed with the LM dictionary is useful for predicting ECB rate movements in the medium term (i.e. at $t + 2$), whereas the tone shock computed with the ABG dictionary is more helpful for predicting the ECB policy decisions over a shorter horizon (i.e. at $t + 1$). These results might be explained by the list of words used by the LM and the ABG dictionaries. The LM dictionary uses thousands of words to measure more broadly the monetary stance of the ECB statements, while the ABG dictionary has a short list of keywords that directly reflects the monetary stance of the Introductory Statements.

5.1.1 The Loughran and McDonald dictionary

The Loughran and McDonald (2011) dictionary was developed to assess the tone of financial and economic documents, and it has been proven to be relevant in the context of central bank communication (e.g. Hansen and McMahan (2016)). The LM dictionary contains 354 (2355) words that convey a positive (negative) tone in financial and economic contexts. For instance, phrases such as “*the underlying strength of the euro area*”¹² and “*concerns about the emergence and intensification of protectionist pressures*”¹³ convey a positive and negative tone, respectively, according to the LM dictionary. We consider that positive (negative) and hawkish (dovish) words have a similar implication in terms of monetary policy predictability; that is, they imply a future restrictive (accommodative) monetary policy. We follow the steps related to eq. (1) to measure the LM tone, to eq. (3) to compute the LM tone shock, and finally, to eq. (7) to assess the predictive ability of

¹¹To save space, the marginal effects are available upon request.

¹²ECB Press Conference, 14 June 2008.

¹³ECB Press Conference, 5 February, 2009.

the LM tone shock for future ECB monetary policy decisions. Table A6 in the Appendix provides the results of the estimation for 2000M02-2018M04.

The findings show that the LM tone shock measuring the ECB monetary policy stance is positively and significantly related to ECB monetary policy decisions two-meetings ahead. Moreover, higher GDP growth forecasts and market expectations of monetary policy are associated to future higher ECB rate decisions.

5.1.2 The Apel-Blix Grimaldi dictionary

Apel and Blix-Grimaldi (2014) (ABG) construct two quantitative measures, hawk and dove, using an automated search on each set of the Riksbank’s minutes from the 82 monetary policy meetings that were held from January 2000 to February 2011. They design a context-specific list that consists of combinations of a noun and an adjective such as “higher inflation” and “lower growth”. They obtain 55 hawkish and dovish two-word combinations. For instance, phrases such as “*the main risks relate to the possibility of a renewed increase in oil prices*”¹⁴ and “*while the period of slow growth has been relatively long*”¹⁵ convey a hawkish and dovish tone, respectively, according to the ABG dictionary. We follow Apel and Blix-Grimaldi (2014) and use these combinations to measure the monetary inclination of the Introductory Statements as follows:

$$tone_{t,ABG} = \frac{\#haw_{t,ABG} - \#dov_{t,ABG}}{\#haw_{t,ABG} + \#dov_{t,ABG}}, \quad (9)$$

where $\#haw_{t,ABG}$ and $\#dov_{t,ABG}$ are the number of hawkish and dovish combinations in the Introductory Statements delivered at meeting t . We compute the ABG tone shock by replicating the steps related to eqs. (3) and (7). Table A7 in the Appendix shows the result of the estimation including the ABG tone shock for 2000M02-2018M04. The results highlight the usefulness of the GDP growth forecasts and market expectations for predicting ECB rate movements. The ABG tone shock also provides relevant information to market participants about upcoming ECB policy decisions. Specifically, we find that the coefficient $\beta_{\varepsilon_{ABG}}$ is positive and significant at $t + 1$, but non-significant at $t + 2$. This shows that the ABG dictionary is more suited to predict ECB monetary policy decisions over a short-term horizon.

5.2 Tone shock and current-looking Taylor-rule

The baseline results (Table 1) show that with two-quarters-ahead macroeconomic projections, GDP growth forecasts help predict ECB rate movements, whereas this is not the case for inflation forecasts. Moreover, the predictive ability of the ECB tone shocks

¹⁴ECB Press Conference, 8 March 2007.

¹⁵ECB Press Conference, 7 October 2004.

computed with the BN and PR dictionaries might be conditional on the forecast horizon of the macroeconomic variables used in the Taylor rule. Therefore, we test if these results hold with a different horizon of the macroeconomic variables, notably one corresponding to the current quarter. We re-estimate eq. (7) with $k=0$ (current-looking Taylor rule).¹⁶ Table A8 in the Appendix shows the results of the estimation for 2000M02-2018M04.

Table A8 shows that the results are similar to those in the baseline specification: GDP growth forecasts and the term structure of market rates help predict ECB rate movements, whereas the coefficient of the inflation forecast, β_π , is not significant and has a counter intuitive (negative) value when including market expectations of monetary policy. The predictive ability of the ECB tone shock is similar to that in the baseline model: the BN tone shock is helpful for predicting ECB rate decisions at $t+1$, whereas the PR tone shock is more useful for predicting ECB rate decisions at $t+2$. These findings show that the predictive ability of the ECB tone shock is robust to the horizon of the macroeconomic forecasts used in the Taylor rule.

5.3 Alternative expectations of future monetary policy

Table 1 shows that the ECB tone shock computed with the BN and PR dictionaries provides additional information about future ECB policy decisions beyond that provided by the term structure of market rates. To test whether this result is robust to an alternative proxy of market expectations of monetary policy, we replace the term structure of market rates in eq. (7) with the interest rate forecasts collected by Reuters. Eq. (7) becomes:

$$dR_{t+n} = \beta_i \dot{i}_t + \beta_\pi E_t \pi_{t+k} + \beta_y E_t y_{t+k} + \beta_{\varepsilon, dic} \varepsilon_{tone_{t,dic}} + \beta_i^E E_t \dot{i}_{t+z} + \epsilon_{t+n}; \quad (10)$$

where $E_t \dot{i}_{t+z}$ reflects market expectations of the ECB policy rate one quarter ahead ($z=3$ months). Table A9 in the Appendix shows the estimated results of eq. (10) for 2000M02-2018M04. Interestingly, when we include the interest rate forecasts of market participants in the specification, we find that the tone shock still provides additional information for predicting ECB monetary policy decisions when using the BN dictionary only.

5.4 Controlling for negation patterns in the BN dictionary

We control for negation patterns when measuring the ECB tone shock with the BN dictionary.¹⁷ Specifically, we replace negation words such as: “no”, “never”, “neither”,

¹⁶We do not consider forecasts corresponding to four-quarters ahead since the number of individual forecasters submitting forecasts for this horizon is low.

¹⁷We do not consider negations when using the PR since it is already taking into account when building the dictionary.

“hardly”, “less”, “nothing”, “nowhere”, and “none” with “not”. Second, we search for and count phrases such as “not strongly” as the negation of the BN hawkish keyword “strong*ⁿ”. Finally, we measure the ECB tone as:

$$tone_{t,BN}^n = \frac{(\#haw_{t,BN} + \#dov_{t,BN}^n) - (\#dov_{t,BN} + \#haw_{t,BN}^n)}{\#haw_{t,BN} + \#haw_{t,BN}^n + \#dov_{t,BN} + \#dov_{t,BN}^n}; \quad (11)$$

where $\#haw_{t,BN}$ and $\#dov_{t,BN}$ reflect hawkish and dovish words (without negation), whereas $\#haw_{t,BN}^n$ and $\#dov_{t,BN}^n$ denote the negation of hawkish and dovish words, respectively. Hence, we treat negated hawkish words as dovish entries, whereas negated dovish words are considered as hawkish ones.

Next, we orthogonalise the ECB tone measure with negation patterns following a procedure similar to that described in Section 2 - eq. (3).¹⁸ The resulting residual is considered as the ECB tone shock with negation patterns that is orthogonal to past, current, and future economic conditions. Finally, we re-estimate eq. (7) replacing $\varepsilon_{tone_{t,BN}}$ with the ECB tone shock with negation patterns, $\varepsilon_{tone_{t,BN}}^n$. The left-hand side variable as well as remaining variables on the right-hand remain similar. Table A10 in the Appendix shows the estimated results for 2000M02-2018M04.

The results suggest that the ECB tone shock with negation patterns is positively and significantly related to future ECB monetary policy decisions. When the tone is measured with the BN dictionary, the ECB tone shock helps predict the rate decision at $t + 1$.

5.5 Alternative normalization of the ECB tone when using the BN dictionary

Since the findings in Table 1 might be sensitive to the normalization of the tone measure when using the BN dictionary, eq. (1), we specify a different normalization to test the robustness of the results.¹⁹ The alternative tone measure is:

$$tone_{t,BN}^{word} = \frac{\#haw_{t,BN} - \#dov_{t,BN}}{\#words_t}; \quad (12)$$

where $\#haw_{t,BN}$ ($\#dov_{t,BN}$) reflects the number of hawkish (dovish) words in the Introductory Statements and $\#words_t$ is the total number of words. Hence, instead of considering the sum of the hawkish and dovish words in the denominator, as in eq. (1), we consider the total number of words. Once the alternative BN tone is measured, we compute the corresponding tone shock by re-estimating eq. (3). As a final step, we assess

¹⁸To save space, the estimation results are available upon request.

¹⁹The alternative normalization described in this section applies only to the tone measured with the BN dictionary because the procedure is not applicable to “n-grams”-based PR tone

the predictive ability of the alternative tone shock for ECB policy decisions using eq. (7). Table A11 in the Appendix shows the estimated results of eq. (7) when including the alternative tone shock for 2000M02-2018M04.

Regarding the coefficients of the macroeconomic and financial variables (β_π , β_y and β_{term}), Table A11 presents results similar to those of the baseline model: the GDP growth forecasts and the term structure of market rates are useful for predicting ECB rate movements, whereas this is not the case for inflation forecasts. We also find the same results for the coefficient related to the ECB tone shock, $\beta_{\varepsilon_{BN}}$: The BN tone shock helps predict the ECB rate at $t + 1$.

5.6 Robustness tests

We consider several robustness tests to assess the relevance of our main findings. First, we estimate eq. (7) using the sample period 2000M02-2014M06 given that the main refinancing rate was set to 0.05% in June 2014. Second, we apply likelihood-ratio tests to check for symmetry restriction between hawkish and dovish tone shocks. The aim is to assess whether differentiating between different tone shocks provides better predictions of ECB monetary policy decisions. We highlight the different impacts of hawkish and dovish tone shocks by adding an interaction term, $DP_t \cdot \varepsilon_{tone_{t,dic}}$, which captures the hawkish tone shock only.²⁰ Third, we include the lagged dependent variable in eq. (7) to account for persistent increases, no changes, or decreases in addition to the level of the interest rate. Finally, we control for omitted variable bias by including a shock based on the KOF Monetary Policy Communicator in the second-stage regression, i.e. eq. (7).²¹

The results are qualitatively and quantitatively similar to those of the baseline model (see Table A12 in the Appendix); that is, the ECB tone shock is positively and significantly related to future ECB monetary policy decisions in all specifications, in particular when using the BN dictionary. Finally, the results of the likelihood ratio tests do not indicate a significant asymmetric relationship between hawkish and dovish tone shocks and future ECB interest rate changes.

²⁰ DP_t is a dummy variable equal to one when $\varepsilon_{tone_{t,dic}} > 0$ and zero otherwise.

²¹The KOF Monetary Policy Communicator can be downloaded at <https://kof.ethz.ch/en/forecasts-and-indicators/indicators/kof-monetary-policy-communicator.html>. The first-stage regression is similar to that applied to the ECB tone computed with the BN and PR dictionaries; that is, we orthogonalise the KOF indicator on past, current, and future economic conditions.

6 Conclusion

This paper offers original contributions to the literature on ECB communication, especially its informativeness about future monetary policy decisions and its quantification as tone. Using a bag-of-words approach and different dictionaries on the ECB’s Introductory Statements, we derive several tone measures that reflect the degree of hawkishness and dovishness in these statements. We then orthogonalise each tone measure on the latest macroeconomic and financial data available to market participants, and consider the residual from this regression as tone shock. Finally, we assess the informativeness of the tone shock for future ECB monetary policy decisions.

We find that the tone shock helps predict ECB policy decisions even when controlling for (i) market expectations of monetary policy, (ii) negation patterns when computing the tone measure, and (iii) the ECB’s GC inter-meeting communication. Furthermore, several extensions show that the predictive ability of the tone shock is robust to (i) the normalization of the tone measure, (ii) alternative market expectations of monetary policy, and (iii) the horizon of the macroeconomic variables used in the Taylor monetary policy rule. However, we find that the horizon of predictive ability of the tone shock is sensitive to the dictionary used to compute the tone measures. Finally, the announcement of the unconventional policy measures do not provide additional insights to market participants about future ECB rate movements. These results highlight an additional channel through which ECB communication improves monetary policy predictability, suggesting that the ECB may communicate private information about exogenous shocks to output and inflation through its Introductory Statements.

Appendix

Figure A4: Absolute frequency of hawkish and dovish words using the BN dictionary

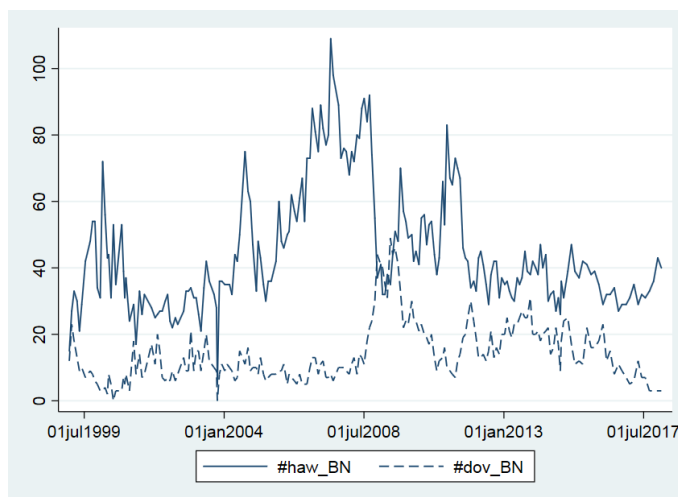


Figure A5: Hawkish and dovish probabilities using the PR dictionary

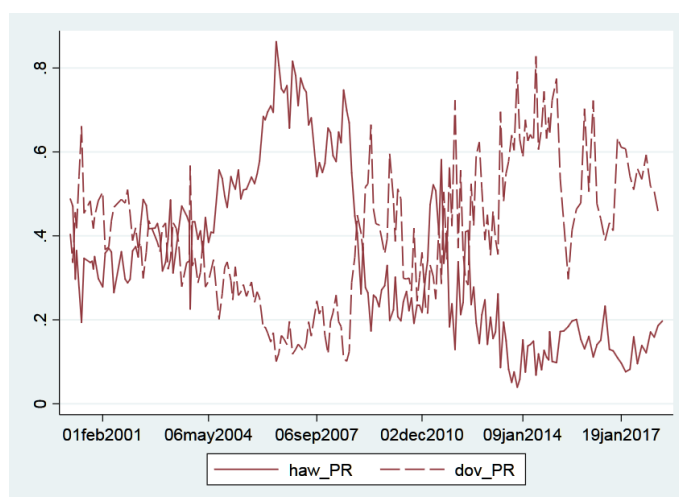


Table A1: Reuters individual data characteristics

Variable	Horizon	Mean	S.D.	Min	Max	Contributors(Min-Max)
i_t	1 Q	1.68	1.48	-0.45	5.25	20-94
	2 Q	1.70	1.50	-0.45	5.50	20-94
	4 Q	1.75	1.47	-0.45	5.50	19-92
π_t	1 Q	1.63	0.90	-1.20	4.30	15-57
	2 Q	1.61	0.74	-1.90	4.20	15-55
	4 Q	1.61	0.45	-1.90	3.40	17-51
y_t	1 Q	1.21	1.45	-6.00	4.20	16-53
	2 Q	1.32	1.28	-5.70	4.30	16-53
	4 Q	1.61	0.87	-3.00	4.30	11-49

Table A2: Summary statistics

Variable	Mean	Min	Max	S.D.
$tone_{t,BN}$	0.52	-0.17	1	0.25
$tone_{t,PR}$	-0.05	-0.76	0.76	0.35
$\varepsilon_{tone_{t,BN}}$	0	-0.46	0.51	0.12
$\varepsilon_{tone_{t,PR}}$	0	-0.52	0.46	0.16
π_t	1.75	-0.7	4.1	0.93
y_t	1.08	-4.85	3.72	1.72
$Stoxx$	8.07	7.57	8.60	0.22
EPU_t	4.85	3.86	6.07	0.44
$tone_{t,LM}$	0.06	-0.79	0.61	0.24
$tone_{t,ABG}$	0.25	-1	1	0.68
$\varepsilon_{tone_{t,LM}}$	0	-0.89	0.51	0.17
$\varepsilon_{tone_{t,ABG}}$	0	-1.63	1.50	0.57
$tone_{t,BN}^n$	0.51	-0.17	1	0.24
$\varepsilon_{tone_{t,BN}}^n$	0	-0.46	0.52	0.13
$tone_{t,BN}^{word}$	0.04	-0.01	0.11	0.02
$\varepsilon_{tone_{t,BN}}^{word}$	0.00	-0.03	0.06	0.01

Table A3: First stage regression

Variable	$tone_{t,BN}$	$tone_{t,PR}$
α	-0.116 (0.662)	0.861 (0.870)
$\beta tone_{t-1,BN}$	0.467*** (0.0697)	
$\beta tone_{t-1,PR}$		0.732*** (0.0522)
$\gamma_{\pi,-1}$	-0.09** (0.04)	-0.0431 (0.052)
$\gamma_{\pi,0}$	0.051 (0.05)	0.0461 (0.0654)
$\gamma_{\pi,1}$	-0.02 (0.06)	-0.0317 (0.08)
$\gamma_{\pi,2}$	0.013*** (0.05)	0.0782 (0.06)
$\lambda_{GDP,-1}$	-0.009 (0.01)	0.0031 (0.02)
$\lambda_{GDP,0}$	0.045* (0.02)	-0.007 (0.02)
$\lambda_{GDP,1}$	-0.046 (0.03)	0.0378 (0.03)
$\lambda_{GDP,2}$	0.048 (0.03)	-0.033 (0.04)
$\eta_{Stoxx,t}$	0.095 (0.07)	-0.048 (0.097)
$\psi_{EPU,t}$	-0.1*** (0.03)	0.116*** (0.04)
$\theta_{MRR,t}$	-0.031** (0.01)	0.004 (0.015)
Obs.	199	199
R^2	0.74	0.79

Robust standard errors are shown in between brackets *, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table A4: First stage backward stepwise regression

Variable	$tone_{t,BN}$	$tone_{t,PR}$
α	0.702*** (0.15)	0.392*** (0.148)
$\beta tone_{t-1,BN}$	0.519*** (0.06)	
$\beta tone_{t-1,PR}$		0.743*** (0.0475)
$\gamma_{\pi,-1}$	-0.087*** (0.019)	
$\gamma_{\pi,2}$	0.154*** (0.02)	0.055*** (0.02)
$\lambda_{GDP,0}$	0.031*** (0.007)	
$\lambda_{GDP,1}$		
$\lambda_{GDP,2}$		
$\psi_{EPU,t}$	-0.111*** (0.02)	-0.102*** (0.03)
$\theta_{MRR,t}$	-0.025** (0.01)	
Obs.	199	199
R^2	0.74	0.79

Robust standard errors are shown in between brackets. ** and *** denote significance at the 5% and 1% levels, respectively

Table A5: Correlation matrix

Variable	$tone_{t,BN}$	$tone_{t,PR}$	$\varepsilon_{tone_{t,BN}}$	$\varepsilon_{tone_{t,PR}}$
$tone_{t,BN}$	1			
$tone_{t,PR}$	0.54***	1		
$\varepsilon_{tone_{t,BN}}$	0.51***	0.16**	1	
$\varepsilon_{tone_{t,PR}}$	0.13*	0.45***	0.18**	1

*, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table A6: LM tone shock (2000M02-2018M04)

Variable	dR_{t+1}			dR_{t+2}		
	(1)	(2)	(3)	(4)	(5)	(6)
β_i	-0.11 (0.17)	-0.09 (0.18)	0.36** (0.17)	-0.09 (0.17)	-0.07 (0.18)	0.31* (0.17)
β_π	0.24 (0.34)	0.17 (0.36)	-0.42 (0.42)	0.09 (0.34)	-0.02 (0.37)	-0.55 (0.42)
β_y	0.61*** (0.16)	0.6*** (0.16)	0.86*** (0.18)	0.5*** (0.14)	0.52*** (0.15)	0.71*** (0.17)
$\beta_{\varepsilon_{LM}}$		0.54 (0.96)	0.39 (1.16)		1.92** (0.85)	2.31** (1.01)
β_{term}			5.88*** (1.17)			4.85*** (1.14)
Pseudo- R^2	0.084	0.084	0.21	0.052	0.064	0.16
Accuracy	0.792	0.795	0.809	0.797	0.805	0.819
χ^2	17.86	17.98	47.12	13.94	17.02	29.66
Obs.	212	200	199	212	200	199

Robust standard errors are shown in between brackets. *, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table A7: ABG tone shock (2000M02-2018M04)

Variable	dR_{t+1}			dR_{t+2}		
	(1)	(2)	(3)	(4)	(5)	(6)
β_i	-0.11 (0.17)	-0.11 (0.18)	0.34** (0.17)	-0.09 (0.17)	-0.08 (0.18)	0.29* (0.17)
β_π	0.24 (0.34)	0.22 (0.36)	-0.38 (0.42)	0.09 (0.34)	0.05 (0.36)	-0.49 (0.41)
β_y	0.61*** (0.16)	0.63*** (0.16)	0.88*** (0.19)	0.5*** (0.14)	0.5*** (0.15)	0.69*** (0.17)
$\beta_{\varepsilon_{ABG}}$		0.75** (0.32)	0.63* (0.35)		0.40 (0.33)	0.26 (0.34)
β_{term}			5.75*** (1.18)			4.77*** (1.13)
Pseudo- R^2	0.0844	0.104	0.224	0.0527	0.057	0.15
Accuracy	0.792	0.795	0.799	0.797	0.800	0.819
χ^2	17.86	22.27	47.85	13.94	15.05	30.2
Obs.	212	199	199	212	199	199

Robust standard errors are shown in between brackets. *, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table A8: Current-looking Taylor rule ($k=0$) (2000M02-2018M04)

BN tone shock						
Variable	dR_{t+1}			dR_{t+2}		
	(1)	(2)	(3)	(4)	(5)	(6)
β_i	0.15 (0.17)	0.14 (0.17)	0.52*** (0.15)	0.12 (0.17)	0.11 (0.17)	0.43*** (0.14)
β_π	-0.34 (0.26)	-0.33 (0.26)	-0.75** (0.30)	-0.31 (0.26)	-0.3 (0.26)	-0.67** (0.29)
β_y	0.28*** (0.08)	0.29*** (0.08)	0.51*** (0.11)	0.21*** (0.08)	0.21*** (0.08)	0.37*** (0.10)
$\beta_{\varepsilon_{BN}}$		2.97*** (1.21)	2.55** (1.28)		1.16 (1.51)	0.51 (1.36)
β_{term}			5.77*** (1.07)			4.82*** (1.03)
Pseudo- R^2	0.033	0.049	0.185	0.019	0.021	0.123
Accuracy	0.816	0.816	0.815	0.815	0.815	0.819
χ^2	11.80	25.33	39.22	7.45	10.18	29.71
Obs.	201	201	200	200	200	199

PR tone shock						
Variable	dR_{t+1}			dR_{t+2}		
	(7)	(8)	(9)	(10)	(11)	(12)
β_i	0.15 (0.17)	0.15 (0.17)	0.53*** (0.14)	0.12 (0.17)	0.11 (0.17)	0.45*** (0.15)
β_π	-0.34 (0.26)	-0.34 (0.26)	-0.77** (0.3)	-0.31 (0.26)	-0.29 (0.26)	-0.69** (0.29)
β_y	0.28*** (0.08)	0.28*** (0.08)	0.51*** (0.11)	0.21*** (0.08)	0.21*** (0.08)	0.38*** (0.1)
$\beta_{\varepsilon_{PR}}$		0.65 (1.04)	0.79 (1.21)		2.07* (1.24)	2.34* (1.28)
β_{term}			5.89*** (1.05)			5*** (1.06)
Pseudo- R^2	0.033	0.034	0.17	0.019	0.032	0.138
Accuracy	0.816	0.816	0.810	0.815	0.815	0.824
χ^2	11.8	12.97	46.8	7.45	11.22	29.84
Obs.	201	201	200	200	200	199

Robust standard errors are shown in between brackets. *, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table A9: Alternative market expectations of monetary policy (2000M02-2018M04)

Variable	BN tone shock		PR tone shock	
	dR_{t+1}	dR_{t+2}	dR_{t+1}	dR_{t+2}
β_i	-6.69*** (1.41)	-3.96*** (0.88)	-6.7*** (1.42)	-3.93*** (0.88)
β_π	0.23 (0.43)	-0.01 (0.38)	0.2 (0.42)	0.01 (0.4)
β_y	0.29 (0.20)	0.22 (0.16)	0.27 (0.2)	0.23 (0.16)
$\beta_{\varepsilon_{dic}}$	2.93* (1.52)	0.46 (1.74)	-0.22 (1.25)	1.87 (1.34)
β_{iE}	6.69*** (1.38)	3.97*** (0.81)	6.7*** (1.38)	3.92*** (0.8)
Pseudo- R^2	0.333	0.164	0.32	0.17
χ^2	35.57	45.11	37.02	44.62
Accuracy	0.835	0.835	0.835	0.835
Obs.	200	200	200	200

Robust standard errors are shown in between brackets. *, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table A10: ECB tone shock with negation patterns (BN dictionary) (2000M02-2018M04)

Variable	dR_{t+1}			dR_{t+2}		
	(1)	(2)	(3)	(4)	(5)	(6)
β_i	-0.11 (0.17)	-0.11 (0.18)	0.34** (0.17)	-0.09 (0.17)	-0.07 (0.18)	0.3* (0.17)
β_π	0.24 (0.34)	0.22 (0.38)	-0.37 (0.43)	0.09 (0.34)	0.04 (0.36)	-0.5 (0.41)
β_y	0.61*** (0.16)	0.62*** (0.16)	0.85*** (0.19)	0.5*** (0.14)	0.5*** (0.15)	0.69*** (0.17)
$\beta_{\varepsilon_{BN}^n}$		2.95*** (1.28)	1.99 (1.34)		0.85 (1.54)	-0.21 (1.43)
β_{term}			5.71*** (1.17)			4.87*** (1.14)
pseudo- R^2	0.08	0.1	0.21	0.05	0.05	0.14
Accuracy	0.792	0.805	0.809	0.797	0.805	0.814
χ^2	17.86	21.5	44.32	13.94	13.34	29.83
Obs.	212	200	199	212	200	199

Robust standard errors are shown in between brackets. *, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table A11: Alternative measure of the BN tone shock (2000M02-2018M04)

Variable	dR_{t+1}			dR_{t+2}		
	(1)	(2)	(3)	(4)	(5)	(6)
β_i	-0.11 (0.17)	-0.11 (0.19)	0.34* (0.17)	-0.09 (0.17)	-0.08 (0.18)	0.29* (0.17)
β_π	0.24 (0.34)	0.20 (0.38)	-0.38 (0.43)	0.09 (0.34)	0.03 (0.36)	-0.49 (0.41)
β_y	0.61*** (0.16)	0.64*** (0.17)	0.87*** (0.19)	0.50*** (0.14)	0.51*** (0.15)	0.69*** (0.17)
$\beta_{\varepsilon_{BN}}$		37.39** (15.40)	24.42* (18.00)		23.16 (20.02)	9.89 (17.04)
β_{term}			5.70*** (1.21)			4.75*** (1.15)
Pseudo- R^2	0.0844	0.105	0.220	0.0527	0.0589	0.149
Accuracy	0.792	0.805	0.809	0.797	0.810	0.824
χ^2	17.86	20.51	41.81	13.94	14.89	31.22
Obs.	212	200	199	212	200	199

Robust standard errors are shown in between brackets. *, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table A12: Robustness tests

Variable	BN tone shock		PR tone shock	
	dR_{t+1}	dR_{t+2}	dR_{t+1}	dR_{t+2}
Controlling for the effective lower bound				
$\beta_{\varepsilon,dic}$	3.33** (1.45)	1.44 (1.79)	0.89 (1.13)	2.46* (1.32)
Asymmetry (positive/negative tone shocks)				
$\beta_{\varepsilon,dic}$	4.94** (2.31)	0.82 (2.75)	2.72 (1.92)	1.52 (2.19)
$\beta_{\varepsilon,dic} \cdot DP_t$	-3.79 (3.71)	0.75 (4.6)	-4.57 (3.2)	1.61 (3.64)
$p(LR)$	0.307	0.87	0.154	0.66
Controlling for the lagged dependent variable				
$\beta_{\varepsilon,dic}$	2.23* (1.3)	-0.14 (1.60)	0.22 (1.16)	1.63 (1.25)
Controlling for the KOF indicator				
$\beta_{\varepsilon,dic}$	2.99** (1.34)	0.06 (1.69)	0.9 (1.26)	2.48* (1.3)

Robust standard errors are shown in between brackets. *, ** and *** denote significance at the 10%, 5%, and 1% levels, respectively. $p(LR)$ denote p-value of the likelihood-ratio test for symmetry restriction between positive and negative tone shocks.

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- We assess whether a tone shock helps predict ECB monetary policy decisions.
- We measure the tone of ECB's President introductory statements.
- We orthogonalize the tone measure on a set of variables to compute a tone shock.
- The ECB tone shock is significantly related to future ECB policy decisions.

Conflicts of Interest Statement

Manuscript title: Do the ECB's Introductory Statements Help Predict Monetary Policy? Evidence from a Tone Analysis

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