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# What's that Noise? Analysing Sentiment-based Variation in Central Bank Communication

# What's that noise? Analysing sentiment-based variation in central bank communication.

*By* Bernd Hayo*†‡ and Johannes Zahner†‡§

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*To which degree can variation in sentiment-based indicators of central bank communication be attributed to changes in macroeconomic, financial, and monetary variables; idiosyncratic speaker effects; sentiment persistence; and random 'noise'? Using the Loughran and McDonald (2011) dictionary on a text corpus containing more than 10,000 speeches and press statements, we construct sentiment-based indicators for the ECB and the Fed. An analysis of variance (ANOVA) shows that sentiment is strongly persistent and influenced by speaker-specific effects. With about 80% of the variation in sentiment being due to noise, our findings cast doubt on the reliability of conclusions based on variation in dictionary-based indicators.*

*JEL: C55, E58, E61, Z13*
*Keywords: Sentiment index, monetary policy, central banks, Loughran and McDonald (2011) dictionary, information content of sentiment indices*

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## 1. Introduction

These days, both academics and practitioners study central bank communication (Blinder et al., 2008), and since language is multidimensional, a new strand of literature has emerged that is concerned with reducing this dimensionality. Most prominent are so-called dictionary approaches, based on counting predetermined words or terms (e.g., Loughran & McDonald, 2011, henceforth LM). This approach makes strong assumptions about the meaning of specific words that were selected a priori. Misspecification can cause severe noise in dictionary-based indices, as demonstrated here by the following sentence, in which we have underlined positive and negative terms as provided by the widely used LM dictionary.

> *'...the level of permanent job loss, as a fraction of the labor force, was considerably smaller than during the Great Recession.'*[1]

Note that the technical term 'job loss' has no negative connotation here and 'great' in 'Great Recession' is meant as an adjective.

Moreover, central bankers may be deliberately obtuse, as Alan Greenspan pointed out when he said: *'I know you think you understand what you thought I said but I'm not sure you realize that what you heard is not what I meant'*.[2]

We study the core factors typically thought to explain sentiment-based variation in central bank communication: changes in macroeconomic, financial, and monetary variables; idiosyncratic speaker effects; sentiment persistence; and random 'noise'. Our findings, based on an analysis of variance (ANOVA), show that about 80% of the variation in sentiment is due to noise, which raises questions about the index's reliability as an indicator.

## 2. Motivation

The main objectives of central bank communication are to guide inflation expectations, provide accountability, and build trust (Blinder et al., 2008; 2022). In this context, communication 'noise' is an ongoing concern in both the public and academic spheres. For instance, current ECB President Christine Lagarde's communication has been criticised as 'cumbersome' and 'convoluted'.[3]

[1] Jerome Powell (2021): www.federalreserve.gov/newsevents/speech/powell20210210a.html
[2] www.independent.co.uk/news/people/profiles/alan-greenspan-the-buck-starts-here-595789.html
[3] www.reuters.com/business/lagardes-communication-revolution-falls-short-hype-analysts-2021-07-22

Following the literature (e.g., Tillmann & Walter, 2019; Baranowski et al., 2021a; Bohl et al., 2022), we operationalise central bank communication at time $t$ as:

$$S_t = \beta_1 S_{t-1} + \beta_2 X_t + \beta_3 F_t + \beta_4 Y + \epsilon_t \tag{1}$$

where the sentiment indicator $S_t$ is our quantitative communication indicator derived from the LM dictionary and defined as follows:

$$S_t = \frac{\#positive\ terms_t - \#negative\ terms_t}{\#positive\ terms_t + \#negative\ terms_t} \tag{2}$$

Higher values of $S_t$ suggest that central bank language contains a more positive tone and vice versa. Variation in $S_t$ is caused by five factors: (i) macroeconomic variables ($X_t$), (ii) financial and monetary variables ($F_t$), (iii) speaker differences ($Y$), (iv) persistence in sentiment, and (v) unexpected shocks or 'noise'. An implication of Eq. (1) is that once influences (i) to (iii) are controlled for, the coefficient on $S_{t-1}$ should be close to 1. Thus:

> Hypothesis: Most of the variation in the sentiment index is explained by macroeconomic factors, financial and monetary conditions, and speaker characteristics.

There are three limitations to our analysis: First, a low signal-to-noise ratio may still be informative. Second, the constraining nature of dictionaries prevents us from separating noise due to the communication itself from noise due to the measurement of communication. Third, we are unable to separate speaker effects from writer effects.

## 3. Data

To derive $S_t$, we use Baumgärtner & Zahner's (2021) text corpus of speeches and press conferences. To ensure reasonable representativeness, we restrict our analysis to central banks having at least 250 speeches and speakers who have made more than one speech.[4] This yields the following subsamples:

a) Speeches by all (30) central banks (n = 10,871)

[4] Using a higher number of speeches for speakers does not change the text corpus much, e.g., > 5 speeches: 10,867 observations; > 10 speeches: 10,278 observations.

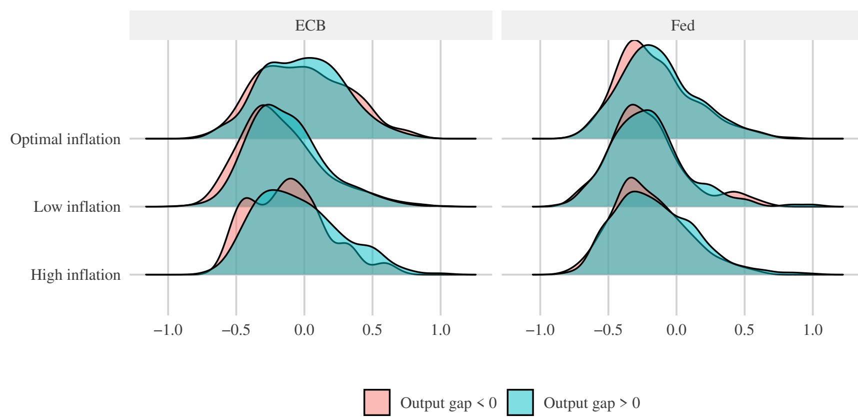
b) Speeches and press conferences by the Fed (n = 1,844; n = 49)

c) Speeches and press conferences by the ECB (n = 2,078; n = 246)

In a first step, we study the relationship between $S_t$ and factors (i) to (iv) from Section 2 above in a bivariate and descriptive way.

Most of the literature ties changes in sentiment to changes in underlying macroeconomic fundamentals derived from the respective central bank mandates, such as the inflation rate and indicators for real activity (e.g. Baranowski et al., 2021a), implying co-movement between tone and macroeconomic conditions. Figure 1 compares the variation in sentiment for the Fed, the ECB, and the national Eurosystem central banks in different macroeconomic states. Despite some variation in sentiment across macroeconomic states, overall, macroeconomic development has little impact on $S_t$.

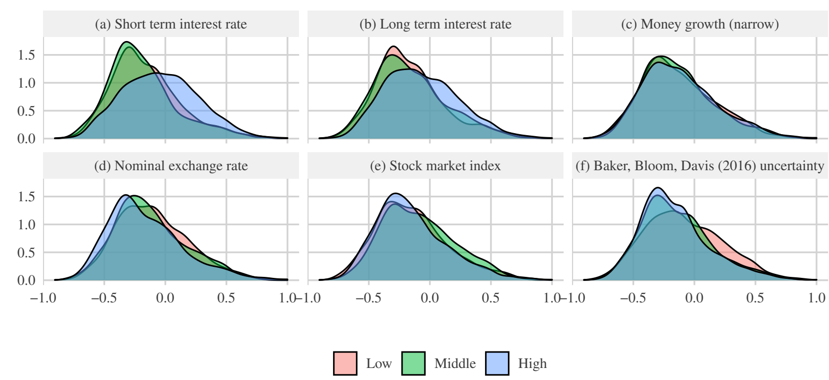
Figure 1 : Variation in central bank sentiment across different macroeconomic states




*Notes:* Subsamples b) and c) are used. Target inflation is defined as a CPI inflation rate between 1.5 and 2.5%; low and high inflation are below and above, respectively. The output gap is the cyclical component of HP-filtered real GDP.

Figure 2 examines the sentiment distribution across various financial and monetary variables, such as interest rates and money growth (e.g. Baranowski et al., 2021b) and political uncertainty (e.g., Tillmann & Walter, 2019). Although certain variables exhibit notable patterns (e.g., example interest rates), there does not appear to be a relationship between sentiment and these variables.

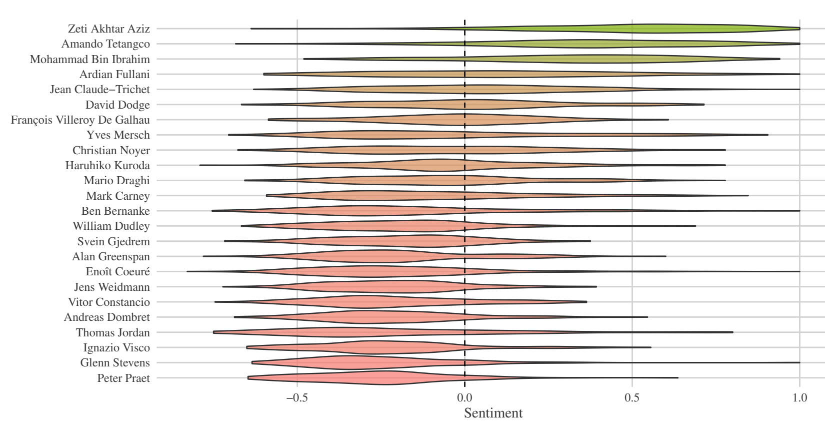
Figure 2 : Variation in central bank sentiment across different financial and monetary conditions




*Notes:* Subsamples b) and c) are used. The values of each financial variable are ordered from low to high into three bins of equal size.

Figure 3 shows the average positivity/negativity of central bankers with at least 100 speeches as sentiment densities. Here, the variance in average sentiment is statistically significant and economically relevant (Table A1 of the Appendix). Hence, omitting speaker-specific effects from tone analysis, as, for instance, in Bohl et al. (2022), may lead to biased estimates.

Figure 3 : Variation in central bank sentiment across different financial and monetary conditions

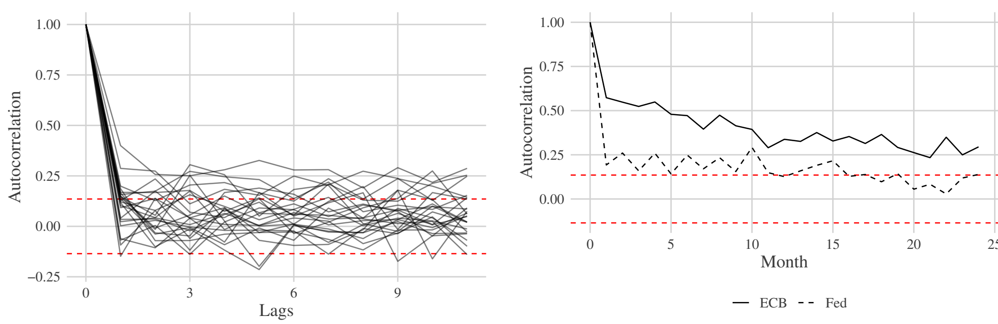



*Notes:* Subsamples b) and c) are used. The values of each financial variable are ordered from low to high into three bins of equal size.

Figure 4 highlights the persistence of sentiment at the institutional level and at the speaker level.[5] The sentiment autocorrelation functions show strong evidence of first-order autocorrelation with a coefficient equal to or close to unity, which suggests that using $S_t$ in time-based regressions may create nonstationarity issues. At the speaker level, sentiment autocorrelation appears to be mainly restricted to the first lag, whereas there is significant autocorrelation for 12 to 24 months at the institutional level. The ECB exhibits the longest significant lag order and the Fed the shortest, with the other central banks in between.

Figure 4 : Sentiment ACF plot

(a) Speaker (b) Institutional level




*Notes:* Subsample a) is used in panel (a) and Subsamples b) and c) are used in panel (b). Panel (a) is based on speakers with more than 100 speeches. Panel (b) is based on the monthly average of the respective institution.

## 4. Multivariate ANOVA

Next, we employ a multivariate ANOVA to study the relative contribution of macroeconomic and financial and monetary variables in explaining variation in $S_t$ (Table 1). The results are presented in Table 2.

The last row in Table 2 suggests notable variation in $S_t$, particularly for speeches; a variance of 0.08 corresponds to an absolute average deviation in sentiment between two randomly selected speeches of approximately 0.3 index points (∼15% of $S_t$).[6] Most of the explained variation stems from speaker-specific effects (8%-11%) and persistence (3%-15%), whereas, generally, changes in macroeconomic

[5] The PACF plots do not find such long significant lags. Results are available upon request.

[6] We assume $S_t$ to be normally distributed. Example for the Fed: $MAE_{Fed} = 1.13 \times \sqrt{Var(S_t)} = 0.32$

Table 1: Explanatory variables

| | |
|---|---|
| Macroeconomic variables | $\Delta$consumer prices, $\Delta$GDP (cyclical component of HP-Filter), unemployment rate |
| Financial variables | Nominal effective dollar-euro-exchange rate, national, stock market index, $\Delta$broad money base, $\Delta$narrow money base, overnight-interbank-rate, 3-month-interbank rate, long-term-interest rate, Baker et al. (2016): national policy news uncertainty index, three component index |
| Lagged Sentiment | $S_{t-1}$ with $t \in \{\text{speaker, month, quarter}\}$ |

*Note:* All variables are available upon request

and financial variables have tiny explanatory power. Exceptions are financial and monetary variables (∼1%) in the case of the Fed—driven by variation in the exchange rate—and macroeconomic variables, specifically ΔGDP and the unemployment rate, in the case of the ECB (∼5%).[7]

Table 2: ANOVA main results

| | Dependent Variable: Sentiment $S_t$ | | | | |
|---|---|---|---|---|---|
| | | Speeches | | Press conferences | |
| | All | Fed | ECB | Fed | ECB |
| Sentiment lags | 8.4%*** | 3.5%*** | 2.5%*** | 15.0%* | 8.5%*** |
| Speaker-specific effects | 9.5%*** | 7.9%*** | 11.2%*** | | |
| Macroeconomic variables | | 0.1% | 0.2% | 2.5% | 4.9%** |
| Financial/monetary variables | | 1.1%*** | 1.1% | 17.9%* | 3.4% |
| Country-specific effects | 0.06%* | | | | |
| Residual | 82.0% | 87.3% | 85.1% | 64.5% | 83.2% |
| N | 10,529 | 1,785 | 2,058 | 48 | 244 |
| Var(y) | 0.08 | 0.08 | 0.08 | 0.01 | 0.03 |

*Note:* Subsamples a), b), and c) are used. *, **, and *** indicate significance at a 10%, 5%, and 1% level, respectively.

[7]Note that these findings raise doubts about the general validity of the reported influence of central bank mandates on central bankers' tone (see Bohl et al., 2022).

With the exception of Fed press conferences, more than 80% of the variation in sentiment is attributed to unexplained variation. Since we control for the persistence in $S_t$, this unexplained variation is not due to a high degree of auto-correlation, but to a noisy underlying process. Even after controlling for changes in external circumstances and speaker-specific effects, the average distance between two speeches is 0.3 index points,[8] which implies that the coding distinction between a positively rated speech and negatively rated speech might just be the outcome of random noise. Thus, we reject our hypothesis.

We conduct several robustness checks to test our variable selection for the ANOVA outcome we: (i) use the sentiment index in log-differences, (ii) include additional variables, such as construction and labour costs, (iii) employ speeches by five Eurosystem central banks (Germany, France, Italy, the Netherlands, and Spain (n = 1,496)), and (iv) control for future interest rate decisions. Our results are unchanged (see Tables A2 and A3).

## 5. Conclusion

In this paper, we examine the degree to which variation in sentiment-based indicators of central bank communication can be attributed to (i) macroeconomic variables, (ii) financial and monetary variables, (iii) speaker differences, (iv) persistence in sentiment, and/or (v) unexpected shocks, that is, 'noise'.

Using the LM dictionary on a text corpus containing more than 10,000 speeches and press statements, we construct sentiment indicators for the ECB and the Fed. We discover that sentiment is strongly persistent over time and influenced by speaker-specific effects. It is not much influenced by a large set of macroeconomic, financial, or monetary variables.

Conducting a multivariate ANOVA, we find that about 20% of the variation in sentiment can be explained by factors (i) to (iv), whereas 'noise' explains about 80%. Our findings cast some doubt on the reliability of conclusions about the sentiment of central bank communication that are based on variations in dictionary-based sentiment indicators.

[8] $MAE_{Fed}|X, F, Y = 1.13 \times \sqrt{\epsilon} = 0.30$

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## Appendix

Table A1: Statistics underlying Figure 3

| | *Dependent variable:* |
|---|---|
| | Sentiment $S_t$ |
| Speaker | 36.6%$^{***}$ |
| Residual | 63.4% |
| N | 4,206 |

*Note:* Notes: Subsample a) is used. Speakers with more than 100 speeches.

Table A2: List of additional explanatory variables

| | |
|---|---|
| Macroeconomic variables | $\Delta$producer prices, $\Delta$car registrations, $\Delta$construction, $\Delta$consumer confidence, $\Delta$manufacturing, $\Delta$unit labour cost, $\Delta$exports |
| Financial/monetary variables | $\Delta$fixed capital formation, Share price index |
| Forward Guidance | Level and change of short term interest rate announced at next press-conference after the speech. |

*Note:* All variables are available upon request

Table A3: Robustness–ANOVA results

| | $log(\frac{S_t}{S_{t-1}})$ | | Sentiment $S_t$ | | | | |
|---|---|---|---|---|---|---|---|
| | Fed | ECB | Fed | ECB | EA Banks | Fed | ECB |
| Sentiment lags | 0.5% | 0.5% | 3.6%*** | 1.5%*** | 6.0%*** | 3.7%*** | 2.3%*** |
| Speaker-specific effects | 5.3%*** | 8.1%*** | 7.8%*** | 11.7%*** | 8.3%*** | 7.9%*** | 11.2%*** |
| Macroeconomic variables | 0.1% | 0.02% | 0.3% | 0.5% | 1.1% | 0.1% | 0.2% |
| Financial variables | 0.2%* | 0.1% | 1.2%** | 0.8% | 1.5% | 1.2%** | 1.3% |
| Forward Guidance | | | | | | 0.06% | 0.2%* |
| Residual | 93.8% | 91.3% | 87.2% | 85.5% | 83.0% | 87.0% | 84.9% |
| N | 10,529 | 1,785 | 1,785 | 1,984 | 1,173 | 1,777 | 2,061 |
| Var(y) | 0.04 | 0.04 | 0.08 | 0.08 | 0.06 | 0.08 | 0.08 |

*Note:* Subsamples a), b), and c) are used. *, **, and *** indicate significance at a 10%, 5%, and 1% level, respectively.