Sentiment Analysis in Macroeconomics

Alessia Paccagnini
University College Dublin & CAMA

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Who Am I?

My name is Alessia Paccagnini and I am an Associate Professor at the University College Dublin and a research associate at the CAMA.

- My Website
- My Research
- Google Scholar
- X or Twitter
- LinkedIn

Road Map of the Lecture

- What is the **Sentiment Analysis**?
- Why is the **Sentiment Analysis in Macroeconomics**?
- Simple example in Python
- **Example in my research agenda:** Federal Reserve Chair Communication Sentiments and Target Rate Discovery

Sentiment Analysis

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Sentiment Analysis

Sentiment analysis also known as opinion mining, is a subfield of Natural Language Processing (NLP) that involves identifying and extracting subjective information from text. It aims to determine the sentiment expressed in a piece of text, which can be categorized as positive, negative, or neutral. Sentiment analysis is widely used to understand the emotional tone behind words and phrases, providing insights into public opinion, brand perception, and customer satisfaction.

Key Components:

- **Subjectivity Analysis:** Determines whether a text is subjective or objective.
- **Polarity Analysis:** Identifies the sentiment orientation (positive, negative, neutral).
- **Aspect-Based Sentiment Analysis:** Examines sentiments towards specific aspects or features within the text.

Sentiment Analysis

Methods:

- **Lexicon-Based Approaches:** These methods rely on a predefined list of words associated with positive or negative sentiments. The overall sentiment of a text is calculated based on the occurrence and intensity of these words.
- **Machine Learning Approaches:** These methods use algorithms like Naive Bayes, Support Vector Machines, and Deep Learning to classify text based on labeled training data.
- **Hybrid Approaches:** Combining lexicon-based and machine learning methods to improve accuracy and handle context-specific nuances.

Sentiment Analysis in Economics

Sentiment analysis in economics can be applied to various sources of data, including:

- **News articles:** to predict stock market movements.
- **Social media posts:** to gauge public sentiment about economic policies.
- **Financial reports:** to analyze the tone of corporate earnings calls.
- **Consumer reviews:** to assess consumer confidence and spending behavior.

Sentiment Analysis in Macroeconomics

Key Areas of relevance:

- **Financial Markets:** Sentiment analysis helps in predicting stock market movements, identifying market sentiment, and understanding investor behavior. Positive or negative sentiments can drive buying or selling decisions, affecting stock prices and market trends.

- **Consumer Behaviour:** By analyzing sentiments expressed in social media, reviews, and surveys, economists can gauge consumer confidence and spending patterns. This information is valuable for forecasting demand and planning marketing strategies.

Sentiment Analysis in Macroeconomics

Key Areas of relevance:

- **Policy Making:** Sentiment analysis of public opinion on economic policies can guide policymakers in making informed decisions. Understanding public sentiment helps in assessing the potential impact and acceptance of policy measures.
- **Economic Forecasting:** Integrating sentiment analysis with traditional economic indicators improves the accuracy of economic forecasts. Sentiment data provides early signals of economic turning points, such as recessions or recoveries.

Examples

- **Consumer Confidence Index (CCI):** The CCI measures the overall confidence of consumers in the economy. High consumer confidence typically leads to increased spending and investment, while low confidence can result in reduced consumption and economic slowdown. Sentiment analysis of news articles, social media, and surveys contributes to understanding and predicting changes in consumer confidence.

- **Stock Market Indices:** Stock markets are highly sensitive to news, rumors, and investor sentiments. Positive sentiments about a company or the economy can lead to stock price increases, while negative sentiments can trigger sell-offs and market declines. Sentiment analysis helps investors and analysts to interpret market reactions and make informed trading decisions.

Examples

- **Economic Policy Uncertainty (EPU) Index:** The EPU index measures the uncertainty in economic policies based on news articles and reports. High uncertainty can lead to reduced investment and economic growth. Sentiment analysis helps in quantifying the level of uncertainty and its potential impact on the economy.
- **Business Cycle Analysis:** Sentiment analysis aids in identifying the phases of the business cycle (expansion, peak, contraction, trough) by analyzing economic reports, corporate earnings calls, and other textual data. Positive sentiments are often associated with expansion phases, while negative sentiments indicate contractions
- **Central Bank Communications:** Statements and reports from central banks, such as the Federal Reserve, significantly influence economic expectations and financial markets. Sentiment analysis of these communications helps in understanding the central bank's stance on monetary policy, interest rates, and economic outlook, guiding investors and policymakers in their decisions.

Some references

- EPU project and other sentiment analysis indicators
- More than Words: Twitter Chatter and Financial Market Sentiment
- Professor Stephen Hansen GitHub
- Dr. Klodiana Istrefi Webpage
- Sentiment Analysis of Economic Text: A Lexicon-based Approach
- Lexicon-based Sentiment Analysis for Economic and Financial Applications in R by Dr. Luca Barbaglia
- Example of Sentiment Analysis in Python
- Eurovision Lyrics in Python

Central Bank Communication

Project joint with Juan Arismendi-Zambrano (University College Dublin) and Emmanuel Kypraios (Maynooth University)

Federal Reserve Chair Communication Sentiments' Heterogeneity, Personal Characteristics, and their Impact on Uncertainty and Target Rate Discovery

We estimate the personal communication risk-premium profile of the U.S. Federal Reserve (Fed) Chair by measuring a new dataset of the sentiment revealed by their public statements during their tenure. We analyze the impact of such Fed communications' sentiment risk on the uncertainty of the monetary policy, and the market price discovery process of interest rates, in the aftermath of the Federal Open Market Committee (FOMC) meetings. After controlling for the evolving state of the economy surrounding the meetings, we find that there is a significant statistical and economic difference in the communications' sentiment that is heterogeneous across Chairs, depending on their personal traits. The sentiment in the Chairs' communications plays a role in moderating the potential surprises in the Fed announcements, and it can be effectively used as a tool for controlling and measuring monetary policy shocks.

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JEL classification: G12, G14, G18, G21, G28, G41.

Keywords: Federal Reserve, Monetary Policy, Communications, Federal Funds Rate, Machine Learning

Monetary Policy and Chairs of the Federal Reserve

Motivation

- A recent line of research in macroeconomic and finance is developing about **official communications and the information's sentiment**.
- Bernanke & Reinhart (2004) analysed the Federal Reserve low rates monetary policy effects over short-term periods. They emphasised the importance of the communication process during the application of the low-rate policy.
- Nevertheless, the function of the institution's document is to communicate to the market the intentions of the Federal Reserve regarding monetary policy.

Federal Reserve (Central Bank's) Communications

- One of the most important tools that the Federal Reserve use for controlling monetary policy, is the Federal Funds Target Rate (FFTR).
- Federal Reserve documents, such as press releases, are processed before their delivery for having a standardised document in terms of the expressions used and adopted by the institution.
- The document with the most concise information that the Federal Reserve produces and that the market uses as a first source to understand the present and the future of the FFTR and the monetary policy, is the **FOMC statement**.

Federal Open Market Committee (FOMC)

Figure 1: An example of a Federal Open Market Committee Meeting

Federal Reserve (Central Bank's) Communications

- Other important documents in the communication of the Federal Reserve are **the official statements of the Chair**, the most important person on the Board.
- These statements are generally testimonies before Committees of the U.S. Senate and the U.S. House of Representatives – such as the Committee on Banking, Housing and Urban Affairs or the Energy and Commerce Committee – and before private institutions.
- FRC statements might serve to detect sentiment, as they are a more personalized version of the communications than the FOMC statements.

Federal Reserve (Central Bank's) Communications

- Failing to disseminate information about future changes generates a risk premium that is negative for the markets.
- Then, the Federal Reserve should conduct not only a consistent monetary policy, but it should inform the market in an adequate and prompt manner, and this has to be done within a thin balance between the amount of information:
  - too much information can generate confusion
  - not sufficient information can generate uncertainty

  both with negative consequences on interest rates and prices

Cochrane and Piazzesi (2002) The Fed and Interest Rates – A High-Frequency Identification

- An important feature of the change of the Federal Fund Target Rate, its that it affects the short term interest rate (risk-free).
- The change of the target rate is probably the economic policy scheduled event with wider impact in financial markets: it affects the risk-free rate and consequently the cost of capital in all valuations.
- Cochrane & Piazzesi (2002) identified the **unexpected jump of Federal Reserve announcements**, using high-frequency data.

Cochrane and Piazzesi (2002) The Fed and Interest Rates – A High-Frequency Identification

Figure 2: Interest rates (One-month Eurodollar) and Federal Funds target rate in 2001. Changes outside regular Federal Open Market Committee meetings are marked with an asterisk (*).

Contribution

- **What we do:** We propose a **textual sentiment profile** of the different Federal Reserve Chairmen and we study its impact into the volatility of the interest rates.
- **How we do:** We use machine learning tool - **Naïve Bayes classifier** - to create a sentiment indicator using a novel dataset from January 1971 to December 2015 and we assess the effects of communications on monetary policy.
- **What we expect:** a more 'emotional' Chair should increase the volatility of the interest rates.

Contribution

- The **information sentiment data** is constructed in the following way:
- We take all the speeches (press releases) of the Chairmen of the Federal Reserve from Arthur Burns to Janet Yellen. This is done to have the larger possible dataset to compare as we have the FR decisions over interest rates variables only up to the 1970s.
- Then we process the speeches using a Naïve Bayes classifier software (Machine Learning) (Pang et al., 2002 and Pang & Lee, 2004 and 2005), trained with a movie review database used in several studies (used in +100 publications). This will give us an index of the sentiment of the speech.

Finally, we can test if the sentiment of the speech is economic significant in terms of the interest rate risk premium.

Research Questions

- *Are the sentiments of the statements by the Chairs of the Federal Reserve different in tone?*
- *Can a single personal communication have a significant influence on the monetary policy process?*

Road Map

- Literature Review
- Communication's Sentiment Index
- Data Description
- Main Results
- Concluding Remarks

Literature Review

- Diverse studies have developed theoretical and practical models for conducting monetary policy (Bernanke et al., 1999; Bernanke & Gertler, 2000; Clarida et al., 2000; Bernanke & Gertler, 2001; Myatt & Wallace, 2014).
- Some empirical studies examine the impact of monetary policy communications at a **high-frequency level** (daily and intra-daily) for the Federal Reserve (Cochrane & Piazzesi, 2002; Gurkaynak et al., 2005), for the European Central Bank (ECB) (Rosa & Verga, 2008 and Picault & Renault, 2017) and non-monetary news in central bank communication (Cieslak and Schrimpf, 2019).
- Ehrmann & Fratzscher (2007) compare this impact of the monetary policy communications **across different Central Banks.**
- Granziera, Larswen, and Meggiorini (2022) use text analysis to study the impact of speeches of FOMC members and regional Fed presidents on inflation expectations.

Literature Review

Two important strands of the literature about monetary policy and sentiment analysis are:

- the study of the **measurement of sentiment in the media and in communications** and its effect on macroeconomics and stock markets (Tetlock, 2007; Tetlock et al., 2008; Loughran McDonald, 2011; Hansen, McMahon, and Tong, 2019; Benchimol, Kazinnik, and Saadon, 2021; Masciandaro, Romelli, and Rubera, 2021; Gardner, Scotti, and Vega, 2021, Gorodnichenko, Pham, and Talavera, 2022, and Gnan et al., 2022 among others).
- the study about the **personal characteristics of the FOMC board members effects** on FFTR estimation as done by Bordo and Istrefi (2018) by using a Taylor rule and by using textual sentiment of the FOMC board members developed by Istrefi (2019).

Definition of Sentiment

- We use a well-defined sentiment analysis framework developed by Pang et al. (2002) (+6000 citations) and extended by Pang & Lee (2004 and 2005), that is based in sentiment **polarity** studies.
- This methodology and sentiment database (Polarity 2.0, and 3.0) it's trained using a Naïve Bayes classifier, and with a database of 2000 movie reviews.
- The Naïve Bayes training method consists of the estimation of the Prior probability $P(f_i|c)$ given that:

$$P_{NB}(c|d) = \frac{P(c)\left(\prod_{i=1}^{m} P(f_i|c)^{n_i(d)}\right)}{P(d)} \tag{1}$$

where d is the document, f_i for $i = 1, 2, 3$ are the set of defined features, and $n_i(d)$ the number of times f_i occurs in the document. Each document d will be represented by $d = (n_1(d), \ldots, n_3(d))$.

Definition of Sentiment

- We are measuring primitive emotions effects that the markets might perceive from the official communication.
- The sentiment variable of the printed documents is defined with three possible values:
  - **Positive**, the set of expressions in the official communication produces a positive emotion in the reader,
  - **Negative**, the set of expressions will produce the opposite feeling, and
  - **Neutral**, the sentiment of the document has a mixed of emotions, and it cannot be concluded the actual polarity of the document.

FOMC and FRC Statements

Table I
Federal Reserve Communications

The table shows a description of the two communications' documents analyzed, the FOMC and Fed Chair statements. Panel A shows the FOMC statements. The period for the Panel A sample is from February 01, 1994 to December 31, 2015 (first FOMC statement was made available to the public since January 01, 1994). Meetings are scheduled events, while telephone conferences are unscheduled. FOMC statements are released immediately after finishing the meeting/telephone conference, with the exception of 4 statements issued outside normal trading hourse due to the 2007/2008 financial crisis: August 17, 2007, January 22, 2008, March 11, 2008, and October 8, 2008. Panel B shows the Fed Chair statements statistics. Two sub-panels are presented, one with document statistics per type of document, and other sub-panel with per Chair statistics. The period for the Panel B sample is from January 01, 1971 to December 31, 2015. The Average days before the FFTR change is calculated with a sub-sample: only the last Fed Chair statement issued before an FFTR is included ($N = 244$ statements). The standard error of the average is between parentheses.

Panel A: FOMC Statements

	Number	(%)	Average Number of Words	Average Days Between Statements
FOMC Statements	164	100.00%	374.35	51.22
			(18.59)	(4.18)
Meeting	153	93.29%	384.64	54.93
			(19.49)	(4.38)
Telephone Conference	11	6.71%	231.18	586.50
			(38.33)	(235.38)

Panel B: Fed Chair Statements

	Number	(%)	Average Number of Words	Average Days Between Statements	Average Days Before FFTR Change ($N = 244$)
Fed Chair Statements	1134	100.00%	2870.50	14.77	16.64
			(58.40)	(0.49)	(1.04)
Per Type of Document					
Testimony before the House of Representatives	231	20.37%	2979.97	72.63	71.05
			(178.22)	(5.26)	(4.69)
Testimony before the Senate	196	17.28%	3005.53	84.17	83.48
			(176.04)	(6.43)	(5.21)
Testimony before a Joint Committee	76	6.70%	2705.08	222.99	152.05
			(358.41)	(18.75)	(9.89)
Remarks before an Institution	579	51.06%	2017.47	28.85	42.50
			(61.82)	(1.54)	(2.85)
Other (Press Briefing, Dedication, Interview)	52	4.59%	2292.08	317.55	295.64
			(289.03)	(45.05)	(14.91)
Per Chair					
Arthur Burns	146	12.87%	2951.19	20.12	18.06
			(118.95)	(1.60)	(1.88)
George W. Miller	50	4.41%	3018.54	10.14	12.95
			(157.26)	(1.64)	(3.28)
Paul Volcker	168	14.81%	3589.70	17.22	20.08
			(254.32)	(1.48)	(2.68)
Alan Greenspan	505	44.53%	2748.61	13.24	15.22
			(78.67)	(0.66)	(1.57)
Ben Bernanke	233	20.55%	2616.06	12.45	9.54
			(87.65)	(0.87)	(1.38)
Janet Yellen	32	2.82%	2442.41	21.29	13.00
			(303.74)	(4.04)	(0.00)

Word Count

Most Frequent Positive and Negative Words in the Statements

This table show the most sentiment' significant words extracted from the FOMC and FRC statements. FOMC statements' sample is from February 1, 1994 to December 31, 2015 (first FOMC statement was made available to the public since January 1994), and FRC statements sample is from January 01, 1971 to December 31, 2015. The words are extracted by cross-checking the words of every document with the Harvard IV (Tetlock et al., 2008) and Loughran and McDonald (2011) dictionaries and counting the repetitions. The cumulative percentage is relative to the total words recognized by the dictionary (conditional frequency). Positive and common extracted words from both dictionaries are highlighted in green, negative and common extracted words from both dictionaries are highlighted in red.

Panel A: Positive

FOMC Statements				Federal Reserve Statements			
Tetlock (Harvard IV)	Cumulative %	Loughran & McDonald	Cumulative %	Tetlock (Harvard IV)	Cumulative %	Loughran & McDonald	Cumulative %
STABILITY	7.62%	STABILITY	17.40%	IMPORTANT	1.33%	GREATER	3%
SUPPORT	12.86%	STABLE	24.63%	EVEN	2.64%	STABILITY	5%
MODERATE	17.83%	IMPROVED	31.12%	INTEREST	3.87%	BETTER	7%
FOSTER	22.61%	PROGRESS	37.32%	SIGNIFICANT	5.01%	STRONG	10%
HELP	26.81%	IMPROVEMENT	43.51%	CREDIT	6.13%	GOOD	12%
CONSISTENT	30.49%	EXCEPTIONALLY	49.56%	STABILITY	7.16%	ABLE	14%
PRODUCTIVITY	33.98%	STRONGER	54.28%	SUPPORT	8.17%	EFFECTIVE	15%
ACCOMMODATION	37.34%	IMPROVE	58.55%	LIKE	9.13%	BEST	17%
STABLE	40.50%	ATTAINMENT	62.39%	EXPERIENCE	10.04%	PROGRESS	19%
UTILIZATION	43.60%	GAINS	65.93%	VALUE	10.92%	GREAT	21%
INTEREST	46.58%	STRENGTHENS	68.88%	ABILITY	11.79%	OPPORTUNITY	23%
IMPROVEMENT	49.29%	STRENGTH	71.24%	HELP	12.66%	DESPITE	25%
CREDIT	51.94%	DESPITE	73.30%	KNOW	13.50%	GAINS	26%
OBJECTIVE	54.20%	STRENGTHEN	75.22%	ABLE	14.31%	IMPROVE	28%
ENSURE	56.27%	STRENGTHENING	77.14%	BEST	15.12%	IMPROVED	29%
APPROACH	58.27%	EFFECTIVE	79.06%	EFFECTIVE	15.92%	ACHIEVE	31%
EVEN	60.21%	STRONG	80.83%	MEET	16.67%	STABLE	32%
ASSET	62.14%	FAVORABLE	82.45%	OPPORTUNITY	17.41%	PLEASED	34%
IMPROVE	64.02%	IMPROVING	84.07%	CONSISTENT	18.14%	IMPROVEMENT	35%
ROBUST	65.70%	BEST	85.40%	PRODUCTIVITY	18.86%	OPPORTUNITIES	36%
UPSIDE	67.38%	STRENGTHENED	86.73%	SHARE	19.56%	SUCCESS	38%
ATTAINMENT	69.06%	IMPROVES	87.91%	HOME	20.25%	STRENGTH	39%
GENERATE	70.67%	STABILIZE	88.94%	APPROACH	20.91%	EFFICIENCY	40%
RETURN	72.22%	STABILIZING	89.97%	IMPROVE	21.56%	BENEFIT	41%
BLOOM	73.71%	CONFIDENT	91.00%	RETURN	22.20%	ENCOURAGING	42%
SIGNIFICANT	75.06%	ADVANCES	92.04%	IMPORTANCE	22.84%	IMPROVING	43%
MODEST	76.29%	ADVANCING	92.92%	ACHIEVE	23.47%	ACHIEVING	44%
COMPENSATION	77.39%	SMOOTH	93.81%	SAVINGS	24.09%	STRONGER	45%
EFFICACY	78.49%	BETTER	94.69%	STABLE	24.70%	SUCCESSFUL	46%
NORMAL	79.46%	ACHIEVED	95.28%	EQUITY	25.29%	IMPROVEMENTS	47%

Word Count

Panel B: Negative

FOMC Statements				Federal Reserve Statements			
Tetlock (Harvard IV)	Cumulative %	Loughran & McDonald	Cumulative %	Tetlock (Harvard IV)	Cumulative %	Loughran & McDonald	Cumulative %
INFLATION	30.24%	UNEMPLOYMENT	7.39%	DIFFICULT	2.44%	DIFFICULT	1.35%
LOW	47.46%	DECLINE	11.96%	INFLATION	4.37%	PROBLEMS	2.65%
DECLINE	54.30%	SLOWED	15.81%	COST	6.21%	DECLINE	3.77%
STERN	59.60%	WEAK	19.65%	LOW	8.02%	PROBLEM	4.83%
EXCESS	63.13%	SLOW	22.90%	TURN	9.76%	CONCERN	5.85%
DECREASE	66.00%	DECLINES	26.14%	DECLINE	11.43%	LATE	6.84%
COST	68.65%	DIMINISHED	29.39%	FOREIGN	13.02%	CRITICAL	7.84%
RELUCTANT	70.64%	DEPRESSED	32.64%	PROBLEM	14.59%	CONCERNS	8.81%
TURN	72.63%	DOWNWARD	35.89%	COMPETITIVE	16.10%	UNEMPLOYMENT	9.69%
LIMIT	74.39%	DECLINED	38.85%	DEAL	17.41%	QUESTION	10.52%
UNDERMINE	76.16%	WEAKNESS	41.80%	COMPLEX	18.69%	SHARPLY	11.32%
EXECUTE	77.70%	IMBALANCES	44.61%	FORCE	19.84%	FORCE	12.12%
STRESS	79.25%	STRAINS	47.42%	RECESSION	20.98%	RECESSION	12.92%
ORDER	80.57%	CONCERNED	50.07%	AVOID	22.11%	DIFFICULTIES	13.71%
CRUDE	81.90%	EASING	52.44%	DEFICIT	23.23%	SERIOUS	14.49%
FOREIGN	83.00%	SLOWING	54.51%	ORDER	24.34%	DEFICIT	15.27%
ADVERSE	84.11%	UNDERUTILIZAT	56.43%	COMPETITION	25.43%	CRISIS	16.01%
ABATE	85.21%	SLOWER	58.35%	CRISIS	26.51%	DECLINED	16.73%
NEED	86.09%	LATE	59.97%	EXCESSIVE	27.56%	LOSSES	17.44%
FAIL	86.98%	PERSISTENTLY	61.60%	DOUBT	28.56%	EXCESSIVE	18.15%
TRAGIC	87.86%	DISRUPTIONS	63.07%	HARD	29.56%	DECLINES	18.86%
CRISIS	88.52%	CONCERN	64.55%	ADVERSE	30.54%	DOUBT	19.56%
TURMOIL	89.18%	DIMINISHING	65.88%	WAR	31.50%	QUESTIONS	20.25%
TEMPORARILY	89.85%	CONTRACTION	67.21%	SEVERE	32.44%	CHALLENGES	20.92%
OMIT	90.51%	RELUCTANT	68.54%	FAILURE	33.35%	ADVERSE	21.59%
SLUGGISH	91.17%	UNWELCOME	69.72%	LIMIT	34.25%	DEFICITS	22.26%
DEPENDENT	91.61%	WEAKENED	70.90%	EXCESS	35.14%	SLOW	22.93%
BIT	92.05%	DECLINING	72.08%	LOSS	36.00%	CONCERNED	23.57%
SPOT	92.49%	SHORTFALL	73.26%	SERVE	36.81%	SEVERE	24.21%
EROSION	92.94%	UNDERMINE	74.45%		37.61%	FAILURE	24.84%

Research Questions

- **Are the sentiments of the statements by the Chairs of the Federal Reserve different in tone?**
- *Can a single personal communication have a significant influence on the monetary policy process?*

Federal Reserve Communications Sentiment - FRC Statements

	Panel A: Communication's Sentiment Tone								
	Panel A.1: Proportion			Panel A.2: Average Word Count Per Doc					
	Naïve Bayes (NLTK) (%)			Tetlock (Harvard IV) (%)			Loughran & McDonald (%)		
	Neut	Pos	Neg	Neut	Pos	Neg	Neut	Pos	Neg
Before February 1994									
Arthur Burns	66.44	31.51	2.05	77.83	14.36	7.80	90.11	3.52	6.36
				(0.25)	(0.21)	(0.15)	(0.16)	(0.09)	(0.13)
George W. Miller	60.00	38.00	2.00	77.19	15.04	7.78	89.95	3.98	6.07
				(0.30)	(0.28)	(0.23)	(0.23)	(0.13)	(0.20)
Paul Volcker	28.57	68.45	2.98	76.68	15.29	8.03	89.62	3.69	6.70
				(0.21)	(0.16)	(0.12)	(0.15)	(0.07)	(0.12)
Alan Greenspan (I)	46.32	52.59	1.09	77.98	14.73	7.29	90.64	3.73	5.63
				(0.15)	(0.12)	(0.11)	(0.09)	(0.05)	(0.09)
After February 1994									
Alan Greenspan (II)	36.96	59.42	3.62	78.38	14.20	7.42	90.41	3.35	6.24
				(0.24)	(0.18)	(0.14)	(0.15)	(0.08)	(0.13)
Ben Bernanke	72.96	25.75	1.29	78.06	15.61	6.33	90.71	3.75	5.54
				(0.20)	(0.19)	(0.13)	(0.13)	(0.08)	(0.14)
Janeth Yellen	56.25	43.75	0.00	78.64	15.22	6.14	90.56	4.15	5.30
				(0.63)	(0.62)	(0.36)	(0.24)	(0.23)	(0.29)

Table 1: FRC Statements Sentiment.

Research Questions

- *Are the sentiments of the statements by the Chairs of the Federal Reserve different in tone?*
- **Can a single personal communication have a significant influence on the monetary policy process?**

FRC Statements and FFTR Change

Figure 2. Interest rates (1-month Eurodollar – blue) and FFTR (red). The interest rates' sample is from January 01, 1971 to December 31, 2015. The graph is split by regions with the tenures of the different Fed Chairs.

Market Expectations

Figure 3: Market expectations over decisions of the FFTR by the FOMC.

FRC Statements and FFTR Change

- We define as the dependent variable in the Logit regression the **1-week jump lagged difference** between the FFTR on the day of the announcement (post-announcement) and the 1-month Eurodollar future observed one-week before the announcement, $f_{t-1}^{(1)}$:

$$J_t = \left| \frac{FFTR_t - f_{t-1}^{(1)}}{FFTR_t - FFTR_{t-1}} \right|. \tag{2}$$

FRC Statements and FFTR Change

(a) Sentiment (Neutral, Positive, Negative) and FFTR-1-Month Eurodollar ratio (J)

Figure 3. Jump surprise (J) ratio of difference between FFTR and the U.S. short-term interest rate (1-month Eurodollar) (in %) during the FFTR change announcement. Jump surprise (J) is calculated as in Equation (2). Sentiment is measured by the Naïve Bayes (NLTK) classifier. Jump surprises where the last Fed Chair statement was tagged as "Neutral" are in black, and when the last Fed Chair statement was tagged as "Non-neutral", it was tagged red for "Positive" ones, and blue for "Negative" ones. The data sample is from January 01, 1971 to December 31, 2015, and include $N = 244$ data points (FFTR changes occurred during the period).

Data

$$
\begin{aligned}
J_t &= \beta_0 + \beta_1 * MacroVariables_{t-1} + \beta_2 * FinancialVariables_{t-1} + \\
&\quad \beta_3 * PersonalCharacteristics_{t-1} + && (3) \\
&\quad \beta_4 + SentimentVariable_{t-1} + \varepsilon_t, && (4)
\end{aligned}
$$

- Jump surprise
- Macroeconomic Variables
- Financial Variables
- Personal Characteristics
- Fed Chair sentiment variable

The sample covers the period from January 1971 to December 2015.

FRC Statements: FFTR Change LOGIT Regression

Panel A: Jump Surprise J_t Regressed by Macroeconomic, Fed Chair Neutral Sentiment and Personal Characteristics

		Naïve Bayes		Harvard IV (Tetlock)		Loughran & McDonald	
Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Constant	-2.8***	-4.2***	-12.5***	-13.3**	-20.7***	-17.5**	-27.9***
	(0.9)	(1.2)	(3.2)	(5.2)	(6.3)	(8.7)	(10.0)
Macroeconomic							
Business Cycle	-0.3	-0.4	-0.0	-0.3	0.1	-0.4	-0.0
	(0.5)	(0.5)	(0.5)	(0.5)	(0.6)	(0.5)	(0.5)
Δ PCE	-31.6	-29.0	6.4	-3.2	25.4	-12.0	28.7
	(54.1)	(56.4)	(67.5)	(56.7)	(67.8)	(56.6)	(69.0)
Δ Industrial Production	-4.2	-2.1	-1.7	-1.7	-1.7	-2.3	-1.8
	(4.0)	(4.2)	(4.7)	(4.2)	(4.7)	(4.1)	(4.7)
Δ M1	-16.4	-20.7	-11.2	-7.8	0.1	-7.1	2.8
	(20.5)	(21.2)	(24.2)	(21.1)	(25.9)	(21.2)	(26.0)
Unemployment rate	0.5***	0.5***	0.7***	0.5***	0.8***	0.5***	0.8***
	(0.1)	(0.1)	(0.2)	(0.1)	(0.2)	(0.1)	(0.2)
Financial							
Δ SP500	-4.8**	-3.3	-2.3	-4.4*	-2.8	-3.8*	-2.4
	(2.2)	(2.4)	(2.6)	(2.3)	(2.6)	(2.3)	(2.6)
Baa10YT	-2.1	-1.4	-0.8	-1.6	-0.8	-1.3	-0.5
	(1.5)	(1.6)	(1.7)	(1.5)	(1.7)	(1.5)	(1.7)
Communications' Sentiment							
Fed Chair Statement Neutral Sentiment		1.7***	1.2**	12.6**	11.1*	15.7*	17.0*
		(0.5)	(0.6)	(6.2)	(6.7)	(9.2)	(9.9)
Fed Chair Statement Stance(H/D)		-0.0	-0.2	-0.1	-0.3	-0.0	-0.2
		(0.4)	(0.5)	(0.4)	(0.5)	(0.4)	(0.5)
Personal Characteristics							
Chair			0.3**		0.3**		0.3***
			(0.1)		(0.1)		(0.1)
Age			-0.1*		-0.0		-0.0
			(0.0)		(0.0)		(0.0)
Academic Background			0.5***		0.4***		0.5***
			(0.2)		(0.2)		(0.2)
N(weeks)	230	230	230	230	230	230	230
Deviance	275.76	255.08	233.61	260.65	235.06	261.98	234.85
Fit improvement	-	0.07	0.15	0.05	0.15	0.05	0.15

Table 2: The FFTR Change and the Fed Chair Statements' Sentiment.

FRC Statements: FFTR Change

			Panel C: Macroeconomic			
Constant	0.6	11.4***	18.4	1.7	-1.6*	-56.7***
	(0.7)	(3.5)	(16.0)	(1.3)	(0.8)	(7.7)
Macroeconomic						
Δ CPI	12.2	-372.7*	-669.0**	-12.5	-73.1	1315.0***
	(42.4)	(219.2)	(292.6)	(52.5)	(59.3)	(99.5)
Δ Industrial Production	-7.9**	-22.8***	-9.5	-6.1	2.1	-81.0
	(3.1)	(6.3)	(31.6)	(4.7)	(3.3)	(10.1)
Δ M1	-19.0	-624.2***	113.2	9.2	-11.3	-274.4
	(20.1)	(162.0)	(237.0)	(32.6)	(15.1)	(33.2)
Unemployment rate	0.1	-1.0**	-1.7	0.0	0.5	12.3
	(0.1)	(0.4)	(2.6)	(0.1)	(0.1)	(1.6)
Financial						
Δ SP500	-5.8***	-5.7	-9.9	-2.4	-1.8	16.4
	(1.6)	(5.5)	(5.1)	(2.1)	(1.3)	(7.2)
Baa10YT	-1.3	1.5	-1.2	-1.4	1.0	-2.0
	(1.2)	(6.1)	(2.7)	(0.9)	(1.3)	(2.6)
N(weeks)	230	55	19	58	84	13
R^2 (Adj)	0.05	0.32	0.47	0.08	0.22	0.99
			Panel D: Personal Characteristics			
Constant	-1.36					
	(3.10)					
Personal Characteristics						
Age	-0.08***					
	(0.02)					
Education Years	0.36***					
	(0.13)					
N(weeks)	230	BURNS	MILLER	VOLCKER	GREENSPAN	BERNANKE
R^2 (Adj)	0.20					
FULL PERIOD			Panel E: Sentiment			
Constant	0.53**	0.93	-0.18	0.84***	0.79***	1.53
	(0.39)	(0.81)	(0.53)	(0.21)	(0.19)	(2.16)
Fed Chair Statement Neutral Sentiment	1.71***	2.75**	2.28**	0.35	-0.00	1.40
	(0.39)	(1.20)	(0.91)	(0.48)	(0.34)	(2.82)
N(weeks)	230	55	19	58	84	13
R^2 (Adj)	0.08	0.08	0.23	-0.01	-0.01	-0.07
Constant	0.79**	1.74*	-2.36**	0.48	1.37***	0.35
	(0.32)	(0.91)	(1.00)	(0.45)	(0.27)	(3.09)
Fed Chair Statement Stance (H/D)	0.46	0.49	4.30***	0.47	-0.58**	1.80
	(0.30)	(0.78)	(1.24)	(0.42)	(0.26)	(2.49)
N(weeks)	230	55	19	58	84	13
R^2 (Adj)	0.01	-0.01	0.38	0.00	0.05	-0.04

FRC Statements' Sentiment and Implicit Probabilities

(a) Sentiment

Figure 4: Uncertainty of the FFTR changes expected by the market for the next FOMC meeting after a FRC Statement.

Uncertainty of the FFTR changes

(b) Burns

(c) Miller

(d) Volcker

(e) Greenspan

(f) Bernanke

(g) Yellen

Figure A4. Uncertainty of the FFTR changes expected by the market for the next FOMC meeting after a Fed Chair statement release and Neutral sentiment of the Fed Chair statement.

Takeaways

- **The communications' sentiment across Chairs of the FED differs significantly**, controlling for the economic conditions (i.e. business cycle, inflation, industrial production, unemployment rate, stock and credit market indices)
- **Chair sentiment is rooted in personal characteristics** (i.e. age and academic background)
- the sentiment has an **inverse effect** on the interest rate surprise
- **the surprise of the interest rate is reduced by the existence of positive/negative sentiment in the communications analyzed**, after FFTR change announcement.

Conclusions

- FRC Statement sentiment impact on monetary policy shocks has decreased over time, as the Federal Reserve has improved in the implementation of the monetary policy, including the communications mechanisms.
- The reduction of effects of the FRC statements sentiment is associated with greater effectiveness in the implementation of the monetary shock, by reducing the sentiment and increasing the "market uncertainty".
- **Our results provide a framework for the policymakers to understand the impact of communication tones on monetary policy.**

What's Next?

- Estimate the effects of the FRC Statement Sentiment on business cycle in VAR models.
- A future extension that it could be to measure the sentiment in other communications formats, such as video and audio of the FOMC meetings.

What's Next?

What is the additional informational content of monetary policy communication (verbal and non-verbal) as coming from the FOMC press conferences (opening remarks and the Q&A).

- **Verbal** (text) – the Fed Chair opening remarks (scripted), and Fed Chair answers to journalists' questions (unscripted), and,
- **Non-verbal** (face) – the Fed chair face emotions during the opening remarks, and while answering to journalists' questions (Curti and Kazinnik, 2022 and Alexopoulos, Han, Kryvtsov and Zhang, 2022).

Thanks for Your Attention!

Structural VAR

Figure 7. SVAR impulse response function. The structural-VAR (SVAR) considers the Jump surprise as the shock (instead of the FFTR), and analyze the effects of the macroeconomic variables (inflation - PCE, liquidity – M1, growth/industrial production – IndProd, and unemployment rate – UnemploymentRate), and the financial variables (stock market – SP500 and credit market – Baa). The periods (x-axis) are conditional on a FFTR change; then $t = 1, 2, \ldots, 20$ represents the next FFTR change decision. The data sample is from January 01, 1971 to December 31, 2015, and include $N = 230$ data points (FFTR weekly changes occurred during the period).

Structural VAR

Figure 8. SVAR historical decomposition The structural-VAR (SVAR) considers the Jump surprise as the shock (instead of the FFTR), and analyze the effects of the macroeconomic variables (inflation - PCE, liquidity – M1, growth/industrial production – IndProd, and unemployment rate – UnemploymentRate), and the financial variables (stock market – SP500 and credit market – Baa). The periods (x-axis) are conditional on a FFTR change; then $t = 1, 2, \ldots, 20$ represents the next FFTR change decision. The data sample is from January 01, 1971 to December 31, 2015, and include $N = 230$ data points (FFTR weekly changes occurred during the period).

Federal Reserve Communications Sentiment - FRC Statements

(a) Sentiment of a Fed Chair statement extract (Remarks) from June 05, 2007.

Figure 5: Federal Reserve Chair statement's sentiment example.

1-month Eurodollar Futures

- Consider,
  - 1-month Eurodollar future of the short term interest rate $f_t^{(1)}$,
  - Federal Funds Effective Rate $FFER_t$,
  - Federal Funds Target Rate $FFTR_t$, for $t = 1, \ldots, T$ the time in days.
- Assume that T represents the period during which the FOMC maintains the $FFTR_t$ without any change.
- By arbitrage conditions, if there is no expected change of the $FFTR$ for the next month, $T \geq 30$, and

$$\left(1 + \frac{f_1^{(1)}}{12}\right)^{1/12} = \left(1 + \frac{E\left(\sum_{t=1}^{T} \frac{FFER_t}{T}\right)}{12}\right)^{1/12} = \left(1 + \frac{FFTR_1}{12}\right)^{1/12},$$

that implies $f_1^{(1)} = \sum_{t=1}^{T} \frac{E(FFER_t)}{T} = FFTR_1$.

1-month Eurodollar Futures

- Nevertheless, decisions on the FFTR can appear before the regular scheduled FOMC meetings due to the economy or market conditions, and in that case $T \leq 30$. Then,

$$f_t^{(1)} = \mathbb{P}(T < 30)\left(\frac{T}{30}FFTR_t + \frac{30-T}{30}FFTR_{T+1}\right) + (1 - \mathbb{P}(T < 30))\,(FFTR_t)\,, \quad (5)$$

  for $t < T$.

- In Equation (5), we know at time $t = 1$, $f_1^{(1)}$ and $FFTR_1$. $\mathbb{P}(T < 30)$, T and $FFTR_{T+1}$ are unknown, but they can be estimated by considering the monetary policy in place.

1-month Eurodollar Futures and FOMC Meetings

- Setting an increasing/decreasing scale of policy shocks,

$$\begin{aligned} FFTR_{t+1} &= FFTR_t \pm \delta \\ &= FFTR_t + 12.5bp, 25bp, 37.5bp, 50bp, \ldots, \max(change)bp, \end{aligned} \quad (6)$$

  we can estimate the probability of every $FFTR_{T+1}$ change.

- Using this setup, define $\mathbb{P}_\delta(T < 30)$ as the probability of the change $\delta\ bp$ occurring in $T < 30$, then we will have N Equations similar to Equation (5), where N is the number of different FFTR changes (**?**):

$$\begin{aligned} f_t^{(1)} = \mathbb{P}_\delta(T < 30) \left(\frac{T}{30} FFTR_t + \frac{30 - T}{30} \left(FFTR_t + \delta \right) \right) + \\ \left(1 - \mathbb{P}_\delta(T < 30)\right) \left(FFTR_t \right). \end{aligned} \quad (7)$$

1-month Eurodollar Futures and FOMC Meetings

- Setting all the δ changes on average yield the expected change implicit in the 1-month Eurdollar future, the Equation (5) can be transformed into

$$f_t^{(1)} = (1/N) \sum_{\delta = \pm 12.5bp, \ldots, \pm \max(change)bp} \mathbb{P}_\delta(T < 30) \left(\frac{T}{30} FFTR_t + \frac{30 - T}{30} (FFTR_t + \delta) \right) + (1 - \mathbb{P}_\delta(T < 30)) \left(\frac{1}{T} FFTR_t \right), \quad (8)$$

3-month Eurodollar Futures

- Expectations of longer than 1-month maturity interest rates futures affect the probabilities of a FFTR change. The 3-month Eurodollar futures are included to balance those expectations:

$$f_t^{(3)} = \mathbb{P}_\delta(T < 90)\left(\frac{T}{90}FFTR_t + \frac{90-T}{90}\left(FFTR_t + \delta\right)\right) + \left(1 - \mathbb{P}_\delta(T < 90)\right)\left(FFTR_t\right). \quad (9)$$

Implicit probability of the FFTR changes

Figure 6: Implicit probability of the FFTR changes expected by the market for the next FOMC meeting .