Universität Hamburg
DER FORSCHUNG | DER LEHRE | DER BILDUNG

Policy Preference at Central Banks: Quantifying Monetary Policy Signals using Keyword Topic Models

Sami Diaf

Policy Preference at Central Banks: Quantifying Monetary Policy Signals using Keyword Topic Models

Sami Diaf, University of Hamburg

Policy Preference at Central Banks: Quantifying Monetary Policy Signals using Keyword Topic Models

Sami Diaf*

Abstract

This work analyzes central banking information flow and proposes a novel strategy to estimate individual-level preferences, toward monetary policy objectives, by quantifying the narratives within its different communication channels for the case of the United States. While most of the text-as-data literature related to central banking used unsupervised topic models to quantify narrative signals, I propose a semi-supervised, keyword-based approach built upon groups of words linked to monetary objectives in order to get a coherent, dynamic estimation of topics' prevalence, whose scores could determine individual policy preferences for inflation and unemployment rates. The corpus of Federal Reserve governors' speeches (1996-2020) identified three non-keyword topics matching financial stability, financial innovation and the banking regulation, whose dynamics follow the chairman's tenure, considered as informative policy signals toward financial markets. Governors' preferences toward monetary policy objectives were better estimated using FOMC transcripts (1994-2016) whose narratives strictly match monetary policy practices and help ranking members on a partisanship scale, with a spectrum linked to the members' educational background. Though released with a five-year delay, the FOMC transcripts, as a proxy of internal communicaton, offer a better picture of the partisanship prevailing within monetary policy committees in the United States, that cannot be learned from Governors' addresses, but remain unable to capture non-conventional, but not less important topics.

Credits

1 Introduction

Narrative economics has gained the interest of researchers in both economics and linguistics as a considerable amount of documents has been released and made public, allowing to test hypotheses with the help of a variety of tools and techniques applied to text data. Monetary policy, as a pillar of the economic landscape, remains an important field of application

---

*Universität Hamburg, Faculty of Business, Economics and Social Sciences, Department of Socioeconomics. Welckerstr. 8, 20354 Hamburg. Email: sami.diaf@uni-hamburg.de

where narratives help understanding central banking practices, enhance their predictability and gauge their potential impact on financial markets (Blinder et al., 2008).

The seminal paper of Shiller (2017) confirmed this shift and drove the interest of researchers to explore more economic corpora in order to extract relevant information and use them as a complement to existing economic data. Such directions have been previously, at different levels, implemented for the case of monetary policy where the literature targeted qualitative aspects of central banking communication, that is the released text documents related to central banks' scope, by running a variety of techniques borrowed from statistics and machine learning fields, with a distinctive line of research that specializes on financial markets responses to this communication (Gentzkow et al., 2019).

The 1990s marked a turnaround in monetary policy practices with the gradual adoption of transparency in central banking policies, instead of secrecy that was prevailing for a long time as stated by Blinder et al. (2008), considering that independent central banks should be more accountable. This effort came as an answer to earlier public misunderstanding of decisions made by monetary committees and their potential negative impacts on the economy (Goodfriend, 1986). Hence, the availability of monetary committees' statements and internal meetings constitutes a reliable source to embark in this line of research, although several contributions revealed a certain consensus or cacophony among central bankers that clearly emerged from these corpora, as a noise altering its informative power (Vissing-Jorgensen, 2019).

Today, central banking communication is seen as an informative channel of the monetary policy and a powerful tool for its forward guidance, although the use of unconventional instruments brought challenges about the effectiveness of communication at the European Central Bank (ECB) as well as at the FED, as reported by Whelan (2018), who highlighted communication issues related to modern central banking and cited examples of quantitative easing and forward guidance on policy rates.

The abundant literature related to central bank corpora demonstrated a keen interest on extracting narratives for storytelling and building indices as to define a hawkish/dovish scale of central bankers, based on different assumptions (Baerg and Lowe, 2020) that usually combine topic models and econometric inferences.

Noticeable is that central banking corpora are embedded with characteristics, or *stylized facts*, making the use of traditional text analysis tools biased, as for consensus among members (Meade, 2005) and ambiguity, whose occurrence in the speeches may be seen as an adopted communication strategy (Baerg, 2020), rendering the application of specific sentiment analysis and usual bag-of-word methods questionable, because messages tend to be neutral in tonality with less informative power in comparison with other corpora. Further individual characteristics of central bankers were found, in the case of the United States, to have a potential impact on dissenting votes at monetary policy meetings (Lähner, 2018).

While modern monetary policy practices around the world deal with specific objectives assigned to central banks, empirical works overlooked this feature and did not tailor the applications to take into account the importance of policy goals in the narratives as for unemployment

and inflation rates. Moreover, the used methods to study central banking corpora mostly belong to the bag-of-word family and are seen as naive applications, regarding the complexity and the specifications required when the discourse is ambiguous, not easily readable and understand by the public (Haldane and McMahon, 2018). The dominant technology used by researchers in automated content analysis has been probabilistic topic models, particularly latent Dirichlet allocation (LDA), which helps uncovering groups of words occurring together known as topics (Blei et al., 2003). Such heuristic methods usually fail to deliver coherent topic structures and were criticized for their sensitivity to starting values, inability to explore sequential corpora (Boyd-Graber et al., 2014), often requiring post-hoc adjustments of the learned topics (Eshima et al., 2020).

To the best of my knowledge, there was no published work that quantified central banking narratives, at the individual level, toward monetary policy objectives and the existing literature described attempts to either rank central bankers on an ideological scale based on hybrid approaches (Baerg and Lowe, 2020; Shapiro and Wilson, 2019) or using external corpora from newspaper and magazines (Istrefi, 2017) that are often embedded with information bias. This work proposes a novel strategy to explore central bankers' partisanship and preferences through quantifying monetary narratives in the United States by uncovering policy signals using the corpus of governors' speeches (1996-2020) and FOMC transcripts (1994-2016). I argue that both corpora offer a complete picture of the duality internal/external central banking communication as speeches have an external narrative purpose while transcripts, although available on a five-year delay, help understanding the inner debate between members and hence, their ideological preferences.

I adopt a semi-supervised approach, namely Keyword-Assisted Topic Model (KeyATM), implemented by Eshima et al. (2020), so that each monetary policy objective will be assigned a number of keywords that enhance the resulting topics' coherence, even if it remains a bag-of-word method. This strategy is convenient to estimate dynamic preferences of central bankers' and track the emphasize they gave during their tenures, to easily quantify their preferences with respect of the prevailing economic conjuncture and internal debates. Unlike usual topic models, keywords are set as an attention mechanism, and not as a weighting scheme, that builds meaningful groups of words matching the hypotheses to be tested. In other terms, keywords indicate the topic model which direction to take without biasing the sampling process, yielding robust topic scores that could be used to estimate stable, ideal points toward monetary policy objectives.

Results of KeyATM were used to estimate inflation and unemployment preferences for each governor in both corpora (FED speeches and FOMC transcripts) to make an effective comparison of the estimates, using an asymmetric loss function adopted by Shapiro and Wilson (2019), and investigate potential partisanship among members at the internal and external communication levels. The resulting topic prevalence scores were used to estimate unbiased FED governors' inflation and unemployment preferences or *ideal points* that proved to be more scattered at the FED level, rather than at FOMC meetings, with a particular consensus of long-term members around the chairman during Greenspan and Bernanke tenure (Lähner, 2018), in addition of highlighting an overall preference gap for unemployment at 6%.

The analysis of governors' speeches confirm the dominance of unemployment and inflation

topics during the periods (1996-2006) and (2012-2020) respectively, with a high variability over time and across members, depending on the prevailing economic conjuncture and the chairman's mandate, while interest rate topic was debated with force during and after the 2008 financial turmoil. Moreover, non-keyword topics were found to match second level, but not less important topics as for financial stability, financial innovation and the banking regulation, whose occurrences are linked to the 2007-2008 financial crisis. FOMC transcripts provide a more accurate estimates of individual objective preferences compared to the speeches, because of the inner debate structure that differentiates members.

The paper is organized as follows: the introduction will be followed by section 2 that gives a literature overview about central banking communication and topic models, and section 3 gives details about the estimation and results.

2 Related Literature

2.1 Central Banking Communication

Woodford (2005) cited three types of intertwined signals contained in central banking communication: macro signals about the outlook, policy signals about the potential policy path and public signals directed to private agents to coordinate when prices are strategic complements and agents seek to coordinate. Blinder et al. (2008) noticed the relatively high impact of short-run central banking communication (official statements, reports and minutes) on financial markets, which tends to create news, while a better central banking communication helps reducing noise.

Noticeable is that most of the central banking communication literature targeted, with the help of automated text analysis tools (Gentzkow et al., 2019), the impact of text releases on financial markets or the predictability of interest rates (Hubert, 2017) with an explicit focus on qualitative communication produced by central banks, aimed to achieve policy objectives (manage expectations) by what Blinder et al. (2008) qualified as *creating news* and *reducing noise*. Other attempts (Haldane and McMahon, 2018) measured readability of central banking publications using linguistic complexity metrics and found a relatively higher public accessibility than political speeches and suggested the use of more innovative channels to reach a higher audience.

For the case of the United States, the Congress assigned the Federal Reserve the objective to conduct the monetary policy to support the goals of maximum employment, stable prices, and moderate long-term interest rates (Federal Reserve, 2020). The secrecy around central banks (Goodfriend, 1986) was a trademark practice until the adoption of a transparency guidance aimed at reaching a wider audience and reduce economic uncertainty.

FOMC transcripts were scrutinized with modern text mining tools to find informative patterns (Hansen et al., 2017) that might explain several longstanding facts about its inner functioning, or to confirm ideological stances between members (McGregor, 1996) and voting preferences were identified by Havrilesky and Gildea (1991) as stemming from three potential sources: training background/career experience, state-of-the-economy measures and partisanship measures.

Attempts to estimate policy preferences among central bankers used mostly voting data of policy rate, as for Eijffinger et al. (2013) who constructed a hawkish-dovish scale for five east-European central bankers or Hix et al. (2010) for the Bank of England's Monetary Policy Committee (MPC). Bennani et al. (2019) examined European Central Bank's ad-hoc communication and constructed an informative index to predict future monetary policy movements. In a similar way, Andersson et al. (2006) found the published speeches at *Riksbank* to be an important determinant for long-term interest rates, than inflation reports, while Lähner (2018) studied dissenting voting behavior of FOMC members and concluded that the decision of releasing FOMC transcripts to the public in 1993 had a significant impact on voting habits, with long-serving members not inclined to cast negative votes, in comparison with new members.

In discerning central bankers' intonation to assigned goals and objectives, Masayuki and Yosuke (2019) compared corpora of two Bank of Japan governors and found one governor's strategy as *delphic*, with semantic ambiguity. Istrefi (2017) constructed an index to rank FOMC members in hawkish-dovish scale, based on human reading of 20,000 narrative records in US newspapers from 1960 until 2015 and concluded that 70% of FOMC members exhibited policy preferences in both directions, while the remaining are considered as swingers. Shapiro and Wilson (2019) gauged negative sentiment indices in the FOMC corpus to estimate a central bank objective function that found a lower implicit inflation target (1.5) than the commonly-assumed value (2).

Hartmann and Smets (2018) used topic models to investigate the prevailing topics in speeches of ECB Board members during the period 1999–2017, while Edison and Carcel (2020) used a similar approach to study topics' evolution related to FOMC statements during the period 2003-2012 and suggested to identify topic priorities within the corpus. In a similar methodology, Baerg and Lowe (2020) proposed a strategy combining topic models and document scaling to estimate a policy preference, built upon the Taylor rule, based on a FOMC meeting transcripts (2005-2008) that permitted to rank its members on a hawkish-dovish scale, similar to McGregor (1996) who identified *partisan ideology* and *partisan loyalty* as two sources fueling governors' voting behavior at the FOMC meetings, conditional to a controlled state of the economy.

2.2 Loss function

Shapiro and Wilson (2019) adopted an asymmetric loss function between inflation gap and the loss to estimate inflation preferences (inflation target) at the Federal Reserve, requiring a non-linear estimation on a linear specification of the loss function.

$$\alpha_{it} = \delta_1(\pi_t - \pi_t^\star) \times \mathbb{1}[\pi_t > \pi_t^\star] + \delta_2(\pi_t - \pi_t^\star) \times \mathbb{1}[\pi_t \leq \pi_t^\star] + \mathbf{X}_t\Lambda + \epsilon_{it} \tag{1}$$

where X_t is a vector if non-inflation variables, α_{ij} is the inflation topic score estimated with a topic model for the speaker i at the time t and $\pi^\star$ is the inflation preference to be estimated, along δ_1 and δ_2 using a grid search approach which tests all possible values from 0 to 3 (with a stepsize of 0.1) and selects the one that minimizes the sum of squared residuals (SSR) using an ordinary least squares estimation (Shapiro and Wilson, 2019).

2.3   Topic Models

Most of text-as-data applications in social sciences use automated content analysis (Gentzkow et al., 2019), namely the latent Dirichlet allocation (LDA) developed by Blei et al. (2003), to extract features and use them as explanatory variables for further inferences. LDA is an unsupervised, mixed-membership Bayesian model that learns latent features constituted of words, called topics, assuming documents being mixtures of topics, which are in their turn mixtures of words drawn from a Dirichlet distribution. Despite several limitations, LDA remains the go-to algorithms when dealing with text data, although it often requires post-hoc adjustments (Eshima et al., 2020). Several other extensions were later proposed to deal with specific cases (Boyd-Graber et al., 2014) as to consider sequences, hierarchies and sentiments in the corpus.

Wilson and Chew (2010) improved the precision of LDA models by adopting a weighting scheme for terms, preventing highly frequent words from dominating the resulting topics and Eshima et al. (2020) generalized the concept of keyword topic models, first established by Jagarlamudi et al. (2012) based upon seeded LDA (Lu et al., 2011), where groups of words are set as labels to highlight the interest of the study (keyword topics) along with other topics (non-keyword topics) that could be learned together. This strategy, knowns as KeyATM, differs from the standard post-hoc topic transformations that might alter the scientific objectivity (Eshima et al., 2020), and was found to outperform existing topic models used so far in practice. Moreover, the designed KeyATM incorporates covariates and models time trends, which helps tailoring the results and confront them with metadata.

The base KeyATM assumes D documents in the corpus, each document having total of N_d words, where w_{di} represents the ith word appearing in the document d. A total of K topics will be learned and $\tilde{K}$ represents the number of keyword topics ($\tilde{K} \leq K$), where each keyword topic k has L_k keywords.

The data generation process, as represented in Figure 1, first draws for each word i in document d, a latent topic variable $z_{di} \in \{1, ..., K\}$ from the topic distribution of the document: $z_{di} \sim Categorical(\theta_d)$ where θ_d is a K-dimension vector of topic probabilities whose elements sum to one.

If the sampled topic is one of the non-keyword topics, then we draw $w_{di}|z_{di} \sim Categorical(\phi_k)$, with ϕ_k is a V-dimension vector of word probabilities whose elements sum to one.

In case of a sampled topic is a keyword topic, a Bernoulli random variable s_{di} is drawn with success probability π_k for word i in document d. If this variable is equal to 1, then word w_{di} is drawn from the set of keywords for the topic based on probability vector $\tilde{\phi}_k$. In contrast, if s_{di} is equal to 0, then we sample the word from the standard topic-word distribution of the topic ϕ_k.

For sufficiently large data, it was shown that the choice of hyperparameter priors does not matter (Eshima et al., 2020), except for the prior of π_k whose values controls the influence of keywords which is assumed to follow a probability distribution Beta(1,1). Hence, the authors consider base KeyATM model as a mixture of two distributions: one for positive probabilities for keywords only, and one with positive probabilities for all words. The inference is
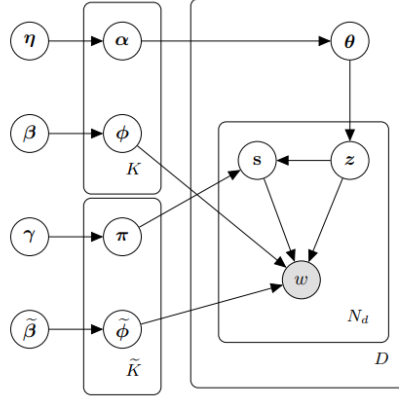
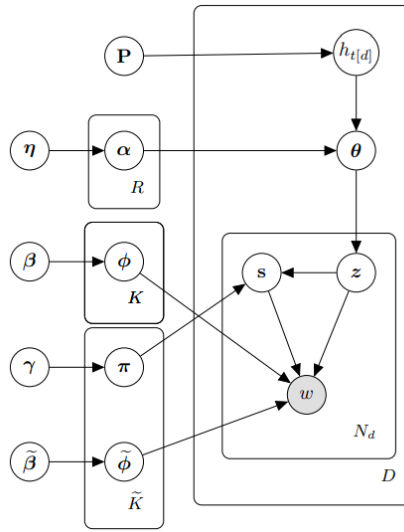Figure 1: Graphical Model of the base KeyATM (Eshima et al., 2020).

Figure 2: Graphical Model of the dynamic KeyATM (Eshima et al., 2020).

performed via collapsed Gibbs sampling algorithm, as provided by the paper (Eshima et al., 2020).

The dynamic version of KeyATM (Eshima et al., 2020), as pictured in Figure 2, was found to yield more stable topic proportions than the Structural Topic Model (STM) implemented by Roberts et al. (2013), as it encompasses a Hidden Markov Model (HMM) structure that defines T latent states ($h_{1:T}$) for the period of study, allowing the generative mechanism of topic probabilities of documents θ_d to evolve over time, via a forward-and-backward sampling procedure for $h_{1:T}$.

3 Data and Results

3.1 Federal Reserve governors' speeches

Federal Reserve governors' speeches were scraped from the Federal Reserve website, comprising 1,488 speeches from January 1996 to December 2020, pre-processed to remove numbers, symbols, stopwords, as well as lemmatization, using *spaCy* (Honnibal et al., 2020) English

language model. Rare words whose frequencies are less than 3 were excluded from the corpus, in order to reduce the size of the document-term matrix. A time variable was created to gather all speeches given between two FOMC meetings, serving as a period variable for the dynamic KeyATM inference.

I chose three groups of keyword related to the monetary policy objectives in the United States, as stated by the Congress, displayed in Table 1: *inflation*, *interest rate* and *unemployment* topics and three non-keyword topics that capture other word structures in the corpus[1]. Figure 3 displays the proportions of the chosen keywords, from a total of 15,557 words in the cleaned corpus.

Keyword Topic	Words
Inflation	inflation, rate, price, targeting, target.
Interest rate	interest, rate, borrowing, lending borrower, lender, mortgage.
Unemployment	unemployment, rate, employment, job, labor.

Table 1: Keywords used to label monetary policy goals for both corpora.
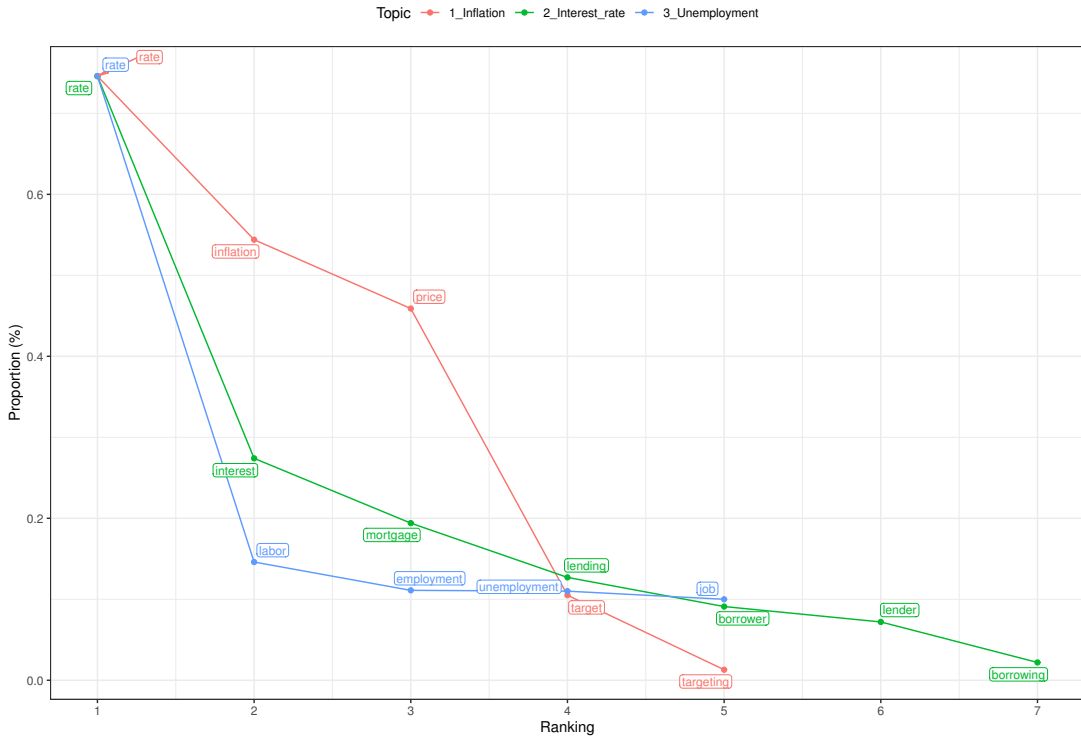

Figure 3: Proportion of keywords in the governors' speeches corpus.

Dynamic version of KeyATM was applied using the standard hyperparametrization provided by Eshima et al. (2020)[2], considering two discrete latent states for time periods and setting the number of iterations to 5,000.

---

[1]Increasing the number of non-keyword topic might assign keywords to non-keyword topics.

[2]Default parameters: $\gamma_1 = \gamma_2 = 1$, $\beta = 0.01$, $\tilde{\beta} = 0.1$, $\mu = 0$, $\sigma = 1$. A half of the samples will be discarded as burn-in.

Inflation	Interest rate	Unemployment	nk topic 1	nk topic 2	nk topic 3
policy	community	rate ✓	country	bank	financial
inflation ✓	mortgage ✓	price [1]	economy	risk	market
rate ✓	federal	year	market	banking	bank
monetary	loan	growth	economic	will	risk
federal	reserve	increase	united	capital	crisis
reserve	business	percent	states	management	asset
bank	credit	will	world	financial	credit
text	consumer	market	one	institution	liquidity
economic	financial	economy	u.s	regulatory	firm
return	small	rise	trade	basel	reserve
central	payment	high	government	process	system
price ✓	lending ✓	economic	financial	organization	federal
long	income	productivity	system	change	capital
interest [2]	return	recent	international	market	institution
term	development	low	exchange	information	fund
fomc	work	labor ✓	foreign	system	large
economy	service	decline	technology	firm	stability
see	text	long	global	new	term
target ✓	borrower ✓	demand	new	business	return
expectation	housing	business	many	practice	stress

Table 2: Top 20 words of KeyATM for governors' speeches (keywords have ticks and numbers in brackets indicates keywords of specified topics).
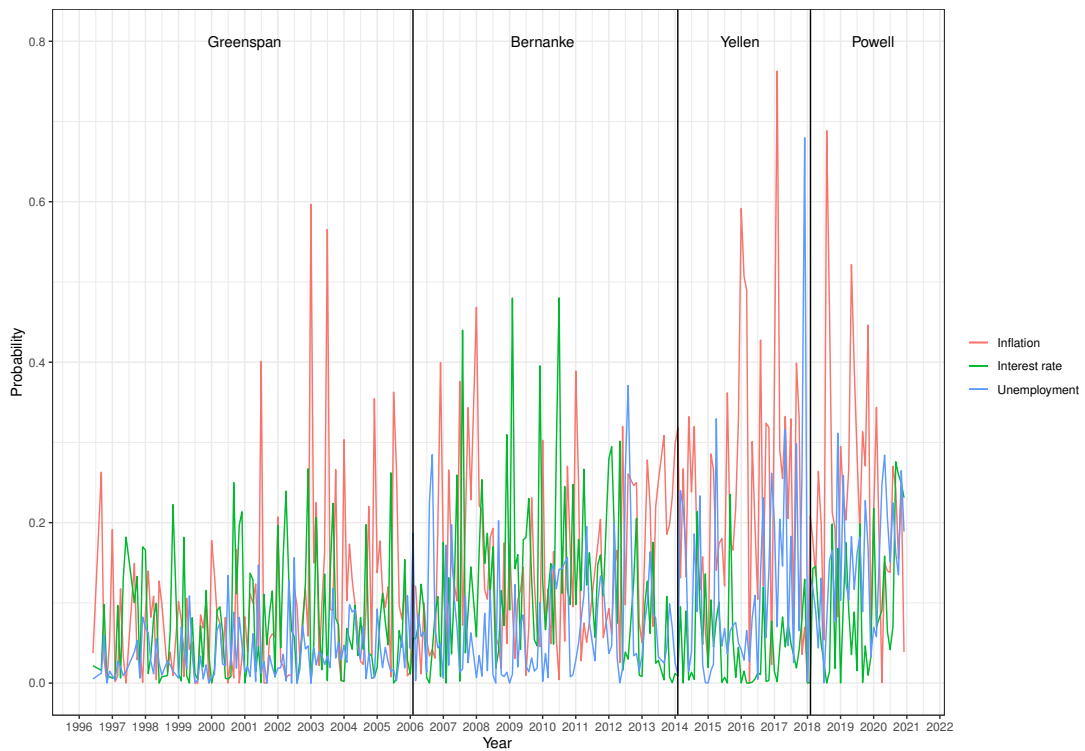

Figure 4: Evolution of keyword topic scores (monthly averaged) in the FED speeches.

Table 2 shows top 20 words in keyword topics, where the word *rate*, although initially included in all keyword topics, seems to match inflation and unemployment topics rather than
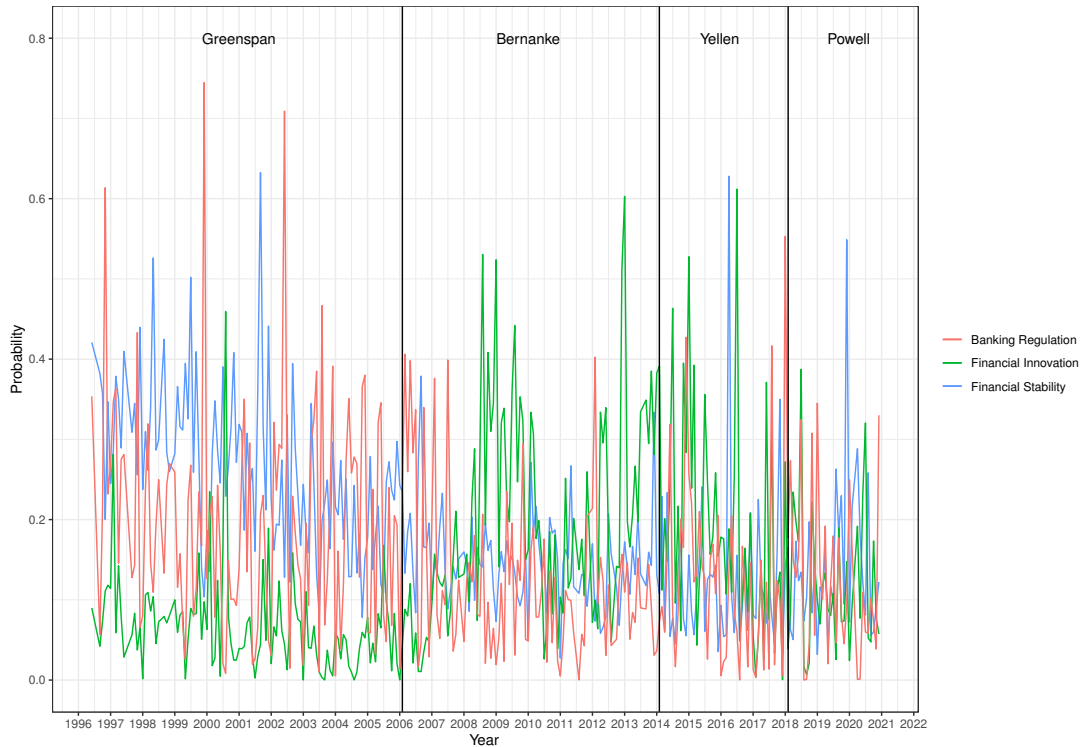
Figure 5: Evolution of non-keyword topic scores (monthly averaged) in the FED speeches.

interest rate topic. Inflation topic exhibits strong ties to classic central banking policy and top words suggest a preference for long-term outlooks, while unemployment topic is linked to economic indicators (growth, productivity) and the real sector (investment, demand, price). Interest rate topic is close to retail banking and housing sector. Non-keyword topics[3] (Table 3) exhibit interesting structures, that could be identified as: financial stability (nk topic 3), financial innovation (nk topic 1) and banking regulation (nk topic 2).

Figures 4 and 5 show the monthly averages of the topics scores, respectively for keyword and non-keyword topics. Inflation topic (Figure 4) was the hot topic in earlier speeches until the beginning of the financial crisis (end-2007) while the interest rate gained the attention of Federal Reserve members in the aftermath of the crisis until the second round of the Quantitative Easing program (end-2012), which marked a clear dominance of inflation in the subsequent speeches. Figure 5 shows the financial innovation and banking regulation were the most non-keyword topics contained in the pre-2007 period, which marked a growing concern about the financial stability, but just second to financial innovation. By tenure, financial innovation and unemployment were dominant during Greenspan's time (1996-2006), while the mandate of Bernanke coincided with the financial crisis and debated mostly the interest rate and financial stability. Inflation attracted the attention of Federal Reserve members during the tenure of Yellen and continues to dominate the overall topics. Recent development, related to the Covid-19 pandemic, shows a resurgence of interest rate and financial stability topics in the speeches.

---

[3]nk for non-keyword

3.2 FOMC Transcripts

FOMC transcripts that occured after the public release decision (1993) were scraped from the Federal Reserve website, selecting all documents from 1994 until 2016, comprising 250 meeting and conference-call transcripts, pre-processed to remove numbers, symbols, stopwords, as well as lemmatization, in a similar fashion as for FED speeches. For the rest of the analysis, individual contributions within each meeting were gathered into a single document for each member, so to build informative documents for the KeyATM estimation.

Table 3 show high consistency of keywords topics with the selected keywords, while non-keywords are not as informative as in the governors' speeches, given that FOMC transcripts are by essence dialogues/debates between members around specific points, rather than structured texts given as addresses.

Inflation	Interest rate	Unemployment	nk topic 1	nk topic 2	nk topic 3
rate ✓	bank	unemployment ✓	think	chairman	chairman
inflation ✓	market	rate ✓	go	greenspan	bernanke
growth	credit	policy	say	president	president
price ✓	financial	will	will	will	will
forecast	interest ✓	labor ✓	one	move	thank
risk	rate ✓	chair	get	governor	think
year	mortgage ✓	committee	just	go	go
economy	asset	market	mr	yes	governor
policy	loan	economic	make	question	let
market	will	percent	us	one	question
high	capital	year	now	get	inflation [1]
percent	fund	time	market	issue	comment
will	business	yellen	point	know	meeting
increase	treasury	purchase	good	number	just
see	new	thank	way	meeting	like
low	large	job ✓	much	point	issue
point	balance	inflation [1]	thing	change	discussion
demand	institution	employment ✓	want	inventory	take
term	liquidity	september	really	significant	make
last	debt	statement	see	look	okay

Table 3: Top 20 words of KeyATM for FOMC transcripts (keywords have ticks and numbers in brackets indicates keywords of specified topics).

3.3 Individual preferences estimates

Topic scores, as results of KeyATM, were used to estimate governors' preferences for inflation and unemployment for both corpora[4]. The idea is to link the inflation topic score drawn from KeyATM with the prevailing inflation rate in the United States (lagged year-on-year monthly inflation rate). For each governor in both corpora, I estimated inflation preferences $\pi_i^\star$ using a rolling regression with grid search values ranging from 0 to 5 (increments by 0.1) and a vector of remaining keyword topic scores (unemployment and interest rate) as covariates,

---

[4]The analysis excluded governors who do not appear in both corpora, for the sake of comparability in terms of policy preferences.

then I selected the value of $\pi_i^\star$ for each governor that maximizes the godness of fit (R^2).

$$\alpha_{it} = \delta_1(\pi_{t-1} - \pi_i^\star) \times \mathbb{1}[\pi_{t-1} > \pi_i^\star] + \delta_2(\pi_{t-1} - \pi_i^\star) \times \mathbb{1}[\pi_{t-1} \leq \pi_i^\star] + \mathbf{X}_t\Lambda + \epsilon_{it} \qquad (2)$$

The same methodology applies to unemployment preferences $U^\star$ which use lagged monthly unemployment rates in the United States and a vector of remaining keyword topic scores (inflation and interest rate) as covariates. Results are given in Table 4 at governor and corpus levels.

Figure 6 offers an in-depth picture of partisanship among governors using the estimated inflation and unemployment preferences respectively from FED governors' speeches and FOMC transcripts. Preferences from FOMC transcripts seems to be homogeneous when compared to FED speeches, indicating similarities between governors that could be identified as small clusters, while preferences of FED speeches are scattered and cannot capture strong alignments. Particularly, the idea of consensus (Meade, 2005) appears to be prevailing at FOMC transcripts, independently from their voting and it is possible that the prevailing variability in FED speeches' preferences result from a kind of freedom endowed to governors' when giving their addresses.

FOMC members' preferences are mostly comprised between 2% and 3.5% for inflation rate, and between 5% and 7% for unemployment rate, while FED speeches have relatively lower unemployment preferences (between 4% and 6%) and noticeable departure from the 2%-3% range for inflation rate. FED corpus tend to have lower unemployment preferences compared to FOMC.

Overall, there is a significant downward trend in the inflation preferences, at the same time an upward trend in unemployment preferences. This may indicate growing worries about the general price levels that were found to be more important, at the governor level, than unemployment numbers. Governors with a law studies background tend to favor low unemployment preferences, in comparison with others from an economic background which have higher inflation preferences, and recent FOMC members (tenures in the 2010s) tend to favor low inflation levels (around 1%), in comparison with former members.

Governor	$\pi^{\star}_{FED}$	$U^{\star}_{FED}$	$\pi^{\star}_{FOMC}$	$U^{\star}_{FOMC}$
Bernanke	1.1	6.4	3.2	5.3
Bies	2.1	4.4	3.4	6.0
Brainard	0.4	4.0	0.7	5.3
Duke	1.1	9.4	4.6	7.4
Ferguson	4.1	5.2	2.7	5.8
Fischer	2.1	5.3	0.7	5.1
Gramlich	2.6	5.7	3.3	4.8
Greenspan	1.8	5.4	2.1	6.0
Kelley	3.2	4.6	3.3	5.3
Kohn	4.5	6.4	3.0	7.2
Kroszner	3.4	4.8	4.1	6.0
Meyer	1.4	5.3	2.2	7.1
Mishkin	3.8	4.6	4.8	4.6
Olson	2.2	5.6	3.5	4.8
Phillips	2.9	4.8	2.2	5.8
Powell	0.3	4.9	0.7	6.6
Raskin	3.0	8.7	1.3	8.0
Rivlin	2.2	4.2	1.4	4.6
Stein	2.1	7.7	1.3	7.7
Tarullo	1.0	8.1	0.7	9.0
Warsh	2.0	5.3	2.4	6.4
Yellen	2.6	7.9	2.2	7.1

Table 4: Governors' inflation and unemployment preferences estimated using FED governors' speeches and FOMC transcripts.

Figure 6: Biplot of estimated inflation and unemployment individual preferences.

13

4 Conclusion

This works investigated central bank policy signals under narrative economics with the help of a keyword-based topic models, so to map individual monetary objectives of FED governors from topic scores learned through FED speeches and FOMC transcripts. Three keyword topics, concerning monetary objectives set by the Congress in the United States, seem to be dominant in both corpora, while non-keyword topics were found to be informative in FED speeches and concerning financial stability, financial innovation and banking supervision. Individual preferences on inflation and unemployment rates were found homogeneous in FOMC transcripts rather than FED speeches, confirming a potential consensus among the members probably due to the debate-structured meetings, while FED speeches yielded scattered preferences that may result from a freedom given to governors when writing their addresses at specific occasions. Individual characteristics, as for the educational background, could explain wide differences in the preferences estimates, where governors with a background in law tend to favor low level of unemployment, in contrast to tolerated higher inflation preferences for economic-educated governors. Finally, broad differences in individual estimates demonstrate heterogeneity in the used communication sources but confirms a potential shared consensus during FOMC meetings.

References

M. Andersson, H. Dillén, and P. Sellin. Monetary policy signaling and movements in the term structure of interest rates. *Journal of Monetary Economics*, 53(8):1815 – 1855, 2006. ISSN 0304-3932. doi: https://doi.org/10.1016/j.jmoneco.2006.06.002.

N. Baerg. *Crafting Consensus: Why Central Bankers Change their Speech and how Speech Changes the Economy*. Oxford University Press, 2020.

N. Baerg and W. Lowe. A textual taylor rule: estimating central bank preferences combining topic and scaling methods. *Political Science Research and Methods*, 8(1):106–122, 2020. doi: 10.1017/psrm.2018.31.

H. Bennani, N. Fanta, P. Gertler, and R. Horvath. Does central bank communication signal future monetary policy? the case of the ecb. Working paper, Institute of Economic Studies, Faculty of Social Sciences, Charles University in Prague, 2019. URL https://www.econstor.eu/bitstream/10419/203231/1/1666601551.pdf.

D. M. Blei, A. Y. Ng, and M. I. Jordan. Latent dirichlet allocation. *J. Mach. Learn. Res.*, 3 (null):993–1022, Mar. 2003. ISSN 1532-4435.

A. S. Blinder, M. Ehrmann, M. Fratzscher, J. De Haan, and D.-J. Jansen. Central bank communication and monetary policy: A survey of theory and evidence. Working Paper 13932, National Bureau of Economic Research, April 2008. URL http://www.nber.org/papers/w13932.

J. Boyd-Graber, D. Mimno, and D. Newman. Care and feeding of topic models: Problems, diagnostics, and improvements. In *Handbook of Mixed Membership Models and Their Applications*, CRC Handbooks of Modern Statistical Methods. CRC Press, 2014.

H. Edison and H. Carcel. Text data analysis using latent dirichlet allocation: an application to fomc transcripts. *Applied Economics Letters*, 0(0):1–5, 2020. doi: 10.1080/ 13504851.2020.1730748. URL `https://doi.org/10.1080/13504851.2020.1730748`.

S. Eijffinger, R. Mahieu, and L. Raes. Estimating the preferences of central bankers: An analysis of four voting records. Workingpaper, Economics, 2013. Pagination: 26.

S. Eshima, K. Imai, and T. Sasaki. Keyword assisted topic models. *ArXiv*, abs/2004.05964, 2020.

F. Federal Reserve. What economic goals does the federal reserve seek to achieve through its monetary policy? Technical report, National Bureau of Economic Research, 2020.

M. Gentzkow, B. Kelly, and M. Taddy. Text as data. *Journal of Economic Literature*, 57 (3):535–74, September 2019. doi: 10.1257/jel.20181020. URL `https://www.aeaweb.org/ articles?id=10.1257/jel.20181020`.

M. Goodfriend. Monetary mystique: Secrecy and central banking. *Journal of Monetary Economics*, 17(1):63–92, 1986.

A. Haldane and M. McMahon. Central bank communications and the general public. *AEA Papers and Proceedings*, 108:578–83, May 2018. doi: 10.1257/pandp.20181082. URL `https://www.aeaweb.org/articles?id=10.1257/pandp.20181082`.

S. Hansen, M. McMahon, and A. Prat. Transparency and Deliberation Within the FOMC: A Computational Linguistics Approach*. *The Quarterly Journal of Economics*, 133(2): 801–870, 10 2017. ISSN 0033-5533. doi: 10.1093/qje/qjx045. URL `https://doi.org/ 10.1093/qje/qjx045`.

P. Hartmann and F. Smets. The first twenty years of the European Central Bank: monetary policy. Working Paper Series 2219, European Central Bank, Dec. 2018. URL `https: //ideas.repec.org/p/ecb/ecbwps/20182219.html`.

T. Havrilesky and J. A. Gildea. The policy preferences of fomc members as revealed by dissenting votes: Comment. *Journal of Money, Credit and Banking*, 23(1):130–138, 1991. ISSN 00222879, 15384616. URL `http://www.jstor.org/stable/1992770`.

S. Hix, B. Høyland, and N. Vivyan. From doves to hawks: A spatial analysis of voting in the monetary policy committee of the bank of england. *European Journal of Political Research*, 49(6):731–758, 2010.

M. Honnibal, I. Montani, S. Van Landeghem, and A. Boyd. spaCy: Industrial-strength Natural Language Processing in Python, 2020. URL `https://doi.org/10.5281/ zenodo.1212303`.

P. Hubert. Qualitative and quantitative central bank communication and inflation expectations. *The B.E. Journal of Macroeconomics*, 17(1):20160024, 2017. doi: https: //doi.org/10.1515/bejm-2016-0024. URL `https://www.degruyter.com/view/journals/ bejm/17/1/article-20160024.xml`.

K. Istrefi. In fed watchers' eyes: Hawks, doves and monetary policy. Working Paper 725, Banque de France, 2017. URL `https://publications.banque-france.fr/en/fed-watchers-eyes-hawks-doves-and-monetary-policy`.

J. Jagarlamudi, H. Daumé, and R. Udupa. Incorporating lexical priors into topic models. In *EACL*, 2012.

B. Lu, M. Ott, C. Cardie, and B. K. Tsou. Multi-aspect sentiment analysis with topic models. In *2011 IEEE 11th International Conference on Data Mining Workshops*, pages 81–88, 2011.

T. Lähner. Inconsistent voting behaviour in the FOMC. *Applied Economics*, 50(14):1617–1643, Mar. 2018. ISSN 0003-6846. doi: 10.1080/00036846.2017.1368994. Routledge.

K. Masayuki and T. Yosuke. The Art of Central Bank Communication: A Topic Analysis on Words used by the Bank of Japan's Governors. Discussion papers 19038, Research Institute of Economy, Trade and Industry (RIETI), May 2019. URL https://ideas.repec.org/p/eti/dpaper/19038.html.

R. R. McGregor. Fomc voting behavior and electoral cycles: Partisan ideology and partisan loyalty. *Economics & Politics*, 8(1):17–32, 1996. doi: https://doi.org/10.1111/j.1468-0343.1996.tb00118.x.

E. E. Meade. The FOMC: preferences, voting, and consensus. *Review*, 87(Mar):93–101, 2005. URL https://ideas.repec.org/a/fip/fedlrv/y2005imarp93-101nv.87no.2,pt.1.html.

M. Roberts, B. Stewart, T. Dustin, and E. Airoldi. The structural topic model and applied social science. Neural Information Processing Society, 2013.

A. H. Shapiro and D. J. Wilson. Taking the Fed at its Word: A New Approach to Estimating Central Bank Objectives Using Text Analysis. Working Paper Series 2019-2, Federal Reserve Bank of San Francisco, Jan. 2019. URL https://ideas.repec.org/p/fip/fedfwp/2019-02.html.

R. J. Shiller. Narrative economics. Working Paper 23075, National Bureau of Economic Research, January 2017. URL http://www.nber.org/papers/w23075.

A. Vissing-Jorgensen. Central banking with many voices: The communications arms race. 2019. URL https://www.bcentral.cl/es/web/banco-central/contenido/-/detalle/xxiii-annual-conference-of-the-central-bank-of-chile-6/-/detalle/xxiii-annual-conference-of-the-central-bank-of-chile-6.

K. Whelan. Central banks communications and monetary policy. Report, European Parliament Committee, 2018. URL www.europarl.europa.eu/cmsdata/153224/WHELAN_Final.pdf.

A. T. Wilson and P. A. Chew. Term weighting schemes for latent dirichlet allocation. In *Human Language Technologies: The 2010 Annual Conference of the North American Chapter of the Association for Computational Linguistics*, HLT '10, page 465–473, USA, 2010. Association for Computational Linguistics. ISBN 1932432655.

M. Woodford. Central bank communication and policy effectiveness. Working Paper 11898, National Bureau of Economic Research, December 2005. URL http://www.nber.org/papers/w11898.