ISSN 1936-5330

Research Working Papers

Text Sentiment about Monetary Policy

Hie Joo Ahn, Thomas Cook, Taeyoung Doh,
Elias Kastritis, and Jesse Wedewer

November 2025
RWP 25-18
https://doi.org/10.18651/RWP2025-18

FEDERAL RESERVE BANK OF KANSAS CITY

Text Sentiment about Monetary Policy*

Hie Joo Ahn† Thomas Cook‡ Taeyoung Doh§ Elias Kastritis¶ Jesse Wedewer ‖

November 25, 2025

Abstract

This paper uses text data from FOMC meeting transcripts to estimate the reference levels of full employment, inflation, and financial conditions perceived by voting members, and to uncover time variation in the Taylor rule parameters. We construct topic dictionaries on economic slack, inflation, and financial markets, and infer reference levels from members' sentiment using a state-space model. The estimated employment reference level indicates that FOMC voting members generally perceived the labor market as tighter than implied by the CBO's estimates between the mid-1980s and early 2000s, whereas the two measures align closely during the Great Recession and its subsequent recovery. The perceived inflation target varies widely in the 1970s and 1980s, trends downward in the 1990s, and stabilizes slightly below two percent thereafter. The estimated Taylor rule exhibits shifting policy weights over time—stronger emphasis on inflation stabilization before the mid-1990s, greater responsiveness to employment deviations thereafter, and renewed emphasis on the inflation trend following the Great Recession—while interest-rate smoothing remains substantial throughout.

JEL classification: C32, E43, E52, E58

Keywords: Monetary policy, Textual analysis, State space model, Taylor rule.

*The earlier version was circulated under the title *"Quantifying Monetary Policy Stance based on Text."* We thank Cooper Howes and the KAEA virtual seminar participants for helpful feedback. Jaclyn Lee provided excellent research assistance. The views expressed in this paper are solely the responsibility of the authors and should not be interpreted as reflecting the views of the Board of Governors , the Federal Reserve Bank of Kansas City, the Federal Reserve System or of anyone else associated with the Federal Reserve System.

†Corresponding author. Federal Reserve Board of Governors, 20th Street and Constitution Avenue NW, Washington, DC 20551, U.S.A. Email: econ.hjahn@gmail.com

‡Federal Reserve Bank of Kansas City. Email: Thomas.Cook@kc.frb.org

§Federal Reserve Bank of Kansas City. Email: taeyoung.doh@kc.frb.org

¶Federal Reserve Board of Governors. Email: elias.kastritis@yale.edu

‖Duke University. Email: jesse.wedewer@duke.edu

"I haven't much doubt in my mind that it's appropriate in substance to take the risk of more softness in the economy in the short run than one might ideally like in order to capitalize on the anti-inflationary momentum to the extent it exists." — *Chair Volcker, FOMC meeting transcript, July 7, 1981*

"I for one would need to see either a decline in the unemployment rate below its recent range or an acceleration in core inflation measures to justify a tightening. ... I wonder if it would not be useful to think of NAIRU more as a range than as a point–say, 5-1/2 to 6 percent. If the unemployment rate remains within this range, then there is no case for intervening." — *Governor Meyer, FOMC meeting transcript, July 3, 1996.*

"... after a year with unemployment well below most current estimates of its natural rate, it is disappointing that we are once again explaining away an unanticipated softening in inflation ... This pattern suggests the possibility of downside risk to longer-term inflation expectations and, therefore, to our ability to achieve our symmetric inflation goal on a sustained basis." — *Chair Powell, FOMC meeting transcript, May 1, 2019.*

1 Introduction

The Federal Reserve has operated under the dual mandate—maximum sustainable employment and price stability—since 1977. Reflecting these goals, the Taylor rule posits that the central bank has a target level of full employment and inflation, and sets the policy interest rate to minimize deviations of actual outcomes from these targets (e.g., Taylor [1993]; Bernanke [2015]). The rule also typically incorporates lagged interest rates to capture interest rate smoothing, reflecting the committee's notion of reducing surprises and uncertainty in financial markets. As the above quotes from FOMC members illustrate, policy preferences and reference level of mandated outcomes have evolved, suggesting that both input and reaction coefficients to the Taylor rule might have changed too over time.

However, the key components of the Taylor rule are not separately identified, particularly when the level of full employment and the long-run inflation trend vary over time, alongside changes in the relative weight on the dual mandate and the degree of interest rate smoothing. This identification issue arises because, in the Taylor rule, the policy interest rate is typically expressed as the sum of the responses to the deviation of employment from full employment and the deviation of inflation from its target. The degree of response to each factor—that is, the central bank's preference—is captured by the weight assigned to each component, multiplied by the respective gaps between employment or inflation and their targets.

Another challenge in identifying the Taylor rule is that the inflation target was formally announced only in 2012. It is unclear what the implicit inflation target was prior to 2012, particularly between the

1970s and 1990s when the inflation trend moved down significantly. Another critical factor is that FOMC has given significant focus on underlying inflation rather than its transitory and volatile variations, and has aimed to stabilize the persistent component of inflation with preemptive monetary policy. In this sense, it is unclear whether inflation trend is the object to be stabilized or is itself a target or a goal to achieve with monetary policy. Similarly, changes in interest-rate smoothing can also be confounded with changes in monetary policy targets. For example, FOMC maintains a low interest rate despite significant improvements in labor market conditions, because they estimate a rise in the level of full employment, for instance, due to the increased supply of workers—not because they are adjusting the policy rate more gradually. This example implies that one needs additional information to bear to distinguish the key components of Taylor rule.[1]

This paper estimates key components of the Taylor rule and their variations using text data from FOMC meeting transcripts. We use all publicly available transcripts from 1976 to 2019 (as of the time of this writing). We measure sentiment regarding the labor market, inflation, and financial conditions, interpreting greater net negativity expressed by FOMC participants as signaling deviations of economic conditions from their perceived reference levels—thereby uncovering the evolving reference levels of employment, inflation, and financial conditions. Incorporating the time-varying reference estimates in to the Taylor rule, we recover changes in the relative weights on the dual mandate—monetary policy preference—and the degree of interest-rate smoothing.

To extract information on monetary policy preferences from FOMC meeting transcripts, we first construct word dictionaries corresponding to *economic activity*, *inflation*, and *financial market conditions*. This process combines computational methods applied to the corpus of FOMC meeting transcripts with close human reading and review of words compiled through algorithmic text analysis. Specifically, we identify the 800 most frequent unigrams (single words) and 800 most frequent n-grams (two- to four-word phrases) across the corpus. The threshold of the top 800 terms was chosen to exclude words appearing in less than 1 percent of the total text, which are generally deemed too rare to be informative. These terms are then systematically and manually assessed to determine their relevance to one of three topics:

[1] Previous studies of the Taylor rule often use external measures—such as the CBO's natural rate of unemployment as a proxy for full employment and a 2% inflation target—even for periods before the FOMC formally adopted an explicit inflation target in 2012 (e.g., Chung et al. [2012]; Erceg and Levin [2014]; Rudebusch and Williams [2016]). However, these assumptions may not reflect the targets actually perceived by FOMC participants. The FOMC did not publicly announce an inflation target before 2012 and has never announced the level of full employment. While statistical trend estimates of macroeconomic variables are sometimes used as proxies, there is no clear basis for treating them as the benchmarks guiding monetary policy decisions.

the economic activity including labor market conditions, inflation, or financial conditions. By using n-grams, we recover the contextual usage when words span multiple topics. For example, the word "risks" is classified based on context: "inflation risk" is assigned to the inflation category, while "default risk" falls under the financial conditions category.

Based on this novel topic dictionary, we classify each utterance (sentence) into one of the topics. After the topic classification, we compute net negative sentiment of the utterance by applying pre-existing economic sentiment dictionaries to the utterance. For this, we use a bag-of-words approach that represents each utterance as a bundle of words. We proceed in two steps. The algorithm first identifies topical words in each utterance using the topic dictionary, then classifies the sentence under the topic with the highest count of topical words. Second, we apply the sentiment dictionary from Loughran and McDonald [2011] to count words expressing positive and negative sentiment within each utterance. We refer to these counts as the positive and negative sentiment scores, respectively. Net negativity is computed by aggregating sentiment scores within each topic for every meeting. We find that net-negative sentiment scores related to the economic activity, inflation, and financial conditions comove with corresponding macroeconomic indicators.

With the constructed net negative scores by topic, we infer FOMC members' perceived reference levels for employment, inflation, and financial conditions within a state space model. The identification of implicit reference levels is based on three assumptions. First, changes in the net negative score of a given topic (e.g, labor market) signals changes in the gap between the corresponding macroeconomic indicator (e.g., employment-to-population ratio) and its reference level (e.g., employment-to-population ratio at full employment). Second, these reference levels evolve smoothly over time. Third, deviations of employment, inflation, and financial conditions from their respective reference levels are overall stationary processes.

We find that the estimated reference level of employment—measured with the employment-to-population (EPOP, henceforth) ratio at full employment——broadly aligns with the trend EPOP ratio from the Congressional Budget Office (CBO) albeit some notable differences. The estimated level of full employment indicates that FOMC voting members generally perceived the labor market as tighter than implied by the CBO's estimates between the mid-1980s and early 2000s, whereas the two measures align closely during the Great Recession and its subsequent recovery. In addition, the perceived reference level of inflation varies noticeably in the 1970s and 1980s, trends downward in the 1990s, and stabilizes slightly below two percent thereafter. The reference level of inflation generally aligns with the multivariate core trend (MCT) inflation from the Federal Reserve Bank of New York but is noticeably lower than the MCT during the Volcker dis-inflationary period of 1979-1982. This observation suggests that FOMC members thought that some of persistently high inflation could be brought down by policy. Nonetheless, the overall alignment between the two inflation estimates suggests that the reference inflation level perceived by FOMC members is closely tied to the inflation trend that excludes its transitory components.

We recover the relative weights on the dual mandate and the degree of interest rate smoothing in the Taylor rule based on our estimates of reference levels of employment and inflation. We include not only the employment and inflation deviations relative to their reference levels but also the reference levels themselves, to assess the extent to which both factors influence changes in the policy rate. We also include a lag of the policy interest rate to capture the gradualism of monetary policy. Since our primary interest lies in the evolution of the Taylor rule over time, we estimate the model using rolling regressions with a 60-quarter window.

We find that the FOMC responds to deviations of employment and inflation from their respective reference levels, along with the underlying inflation trend, when setting the policy interest rate. This finding is consistent with Chair Volcker's remark during the 1981 FOMC meeting that *"the hardest part of the battle is ... affecting the underlying rate of inflation,"* as well as with the FOMC members' recurring emphasis on resource utilization, inflation trends, and stable inflation expectations noted in public communications and press conferences.[2]

Importantly, the relative emphasis on the dual mandate changes over time. We find that the committee places similar but somewhat larger emphasis on the inflation trend relative to the deviation of employment from its reference level from the 1970s through the mid-1990s, but assigns a significantly greater weight to the full-employment objective starting in the mid-1990s. This shift reflects the declining inflation and the flattening of the Phillips curve during the 1980s and the first half of the 1990s. During the Great Recession and the period at the zero lower bound, however, the focus shifts back toward the inflation trend. This change reflects the increased importance of forward guidance in an environment of heightened deflation risk and persistently low inflation, which led policymakers to place greater emphasis on the persistent component of inflation.

Finally, the degree of gradualism remains sizable and increases further following the Great Recession.

[2]For example, Chair Bernanke stated that "the committee continues to anticipate that economic conditions, including low rates of resource utilization, subdued inflation trends, and stable inflation expectations, are likely to warrant exceptionally low levels for the federal funds rate for an extended period" at the FOMC press conference on April 27, 2011.

A notable observation is that gradualism is a persistent feature throughout the 1976–2019 period except for the Volcker era of the late 1970s when Volcker argued that an unexpected policy shock would be more effective in altering market expectations than a gradual approach. As inflation stabilized, gradualism increased from the mid-1990s and rose further in the mid-2000s as forward guidance became an important policy tool. All told, our empirical analysis highlights evolving preferences in the monetary policy rule that reflect structural changes in the macroeconomy.

We further measure the FOMC's attention to each topic by the share of words devoted to that topic during each meeting. This measure also indicates that the FOMC's attention to economic topics shifts over time in response to changing macroeconomic conditions. Notably, the share of words related to the economic activity increases between 1990 and 2005, aligning with the greater weight placed on the full-employment mandate during this period. Another important pattern is that the share of words concerning financial conditions rises during economic recessions and often exceeds that for labor and inflation. This observation reflects heightened attention to forward-looking indicators and the assessment of business-cycle turning points. This finding is consistent with Ahn et al. [2025], who show that the FOMC discusses overall macroeconomic conditions more extensively in meetings than is conveyed in post-meeting FOMC statements.

This paper contributes to the literature on the central bank's decision making process based upon text data (e.g., Apel and Grimaldi [2014], Istrefi [2019], Doh et al. [2025], Doh et al. [2022], Shapiro and Wilson [2022], Carreras et al. [2025]). Our paper is closest to Shapiro and Wilson [2022] in that both studies attempt to reveal the FOMC's inflation target based on text data from the FOMC meeting transcripts, but is distinguished from Shapiro and Wilson [2022] in the following ways. First, we construct topic dictionaries to distinguish sentiments by topic, while Shapiro and Wilson's focus is the inflation target only. We find that the counter-cyclicality of the net negative sentiment measured by Shapiro and Wilson [2022] primarily reflects changes in sentiments regarding economic activity and financial market conditions, rather than sentiment about inflation itself. They isolate the inflation-related net negativity by the portion of the net negative measure explained by realized inflation data while controlling impacts of labor market, economic activity, and financial market conditions. In contrast, we directly identify distinct underlying target levels for employment, inflation, and financial conditions from text-sentiment data.[3] Second, unlike Shapiro

[3] Nonetheless, the estimated inflation trend for the sample period of Shapiro and Wilson [2022] is close to Shapiro and Wilson's estimate. The average reference level of inflation during 2000-2011 from our estimates is 1.67 percent little different from 1.69 percent Shapiro and Wilson

and Wilson [2022] who focus only on the static inflation target, we estimate the reference levels of full employment, inflation and financial conditions at each point in time based on a state space model and sentiment of each topic. Last, we further explore the evolution of monetary policy preference and the degree of gradualism in Taylor rule, not considered by Shapiro and Wilson [2022].

This paper also contributes to the literature on Taylor rule, the central bank's preference, and the gradualism in monetary policy. Many studies and commentaries on monetary policy assume that the structural parameters in Taylor rule—those capturing relative weights on the dual mandates and the degree of interest-rate smoothing—are constant. In particular, it is frequently assumed that the FOMC puts equal weights on the dual mandates (e.g.,Taylor [1993], Bernanke [2015]). Recent empirical evidence suggests time-variation in the FOMC's preference and in the gradualism of monetary policy (e.g., Owyang and Ramey [2004], Ilbas [2012] and Givens [2012], Lakdawala [2016], and Duffee [2025]). However, estimating changes in the preference parameters of the Taylor rule is inherently challenging, as shifts in these parameters — including the one capturing the degree of interest rate smoothing—can be confounded with changes in the target variables without additional identifying assumptions. We address this issue by leveraging topic-specific sentiment expressed in the FOMC meeting transcripts.

The remainder of the paper is organized into six sections. Section 2 describes the construction of topic-specific sentiment measures from the FOMC transcripts. Section 3 presents the resulting word counts and net-negative sentiment indices by topic. Section 4 outlines the state-space models used to estimate the FOMC's target variables and reports the estimation results. Section 5 investigates the FOMC's preferences and gradualism in monetary policy through the lens of the Taylor rule and provides corroborating remarks of the FOMC members. Section 6 concludes.

2 Measuring the FOMC's sentiment by topic

Using publicly available transcripts of FOMC meetings held between 1976 and 2019 (a total of 366 meetings), we measure the FOMC's sentiment on three topics—economic activity, inflation, and financial conditions. Section 2.1 describes the construction of the text data. Section 2.2 details the development of the topic dictionary used to classify words in the transcripts by topic and explains how we compute sentiment scores based on a two-dimensional (topic and sentiment) classification. Section 2.3 describes in detail the design and implementation of three custom algorithms of varying complexity used in the cleaning of the corpus and the topic classification stages.

2.1 Text Data Construction

We follow the approach of Shapiro and Wilson [2022] to transform the FOMC transcripts into text data suitable for our analysis. The PDF files of the transcripts were programmatically retrieved from the website of Federal Reserve Board in a single scrape.[4]

We convert the FOMC transcripts to text data based on the following procedure. First, using punctuation, we identify each sentence. We then assign a speaker to each sentence to keep track of who utters each sentence. In this way, a sentence paired with a speaker is a unique observation for the meeting.

Second, we drop sentences that contain fewer than five words, while also dropping stand-alone sentences. Stand-alone sentences are defined as sentences that are preceded and followed by sentences of different speakers. Following Shapiro and Wilson [2022], we define a set of consecutive sentences to be a remark.

Third, we exclude sentences from our sentiment measure that do not pertain to economic conditions, particularly for considerations of code efficiency. This cleaning step is a nontrivial issue as small talk, procedural explanations or formalities, and even jokes are preserved in these transcripts. In order to do this, we use the Oxford Dictionary of Economics (ODE), containing economic terms, in addition to the terms that constitute our topic dictionaries to exclude remarks that do not contain at least a single economics term from the ODE or the topic dictionaries.

Finally, we exclude all sentences from speakers who are not voting members at the time of an FOMC meeting. [5] As we are primarily interested in measuring the sentiments and preferences of the FOMC that are directly relevant to the conduct of monetary policy, we focus on remarks made by voting members for the sentiment assessment.[6] However, to evaluate the relative emphasis on these topics, we consider remarks made by all meeting participants and compute the share of relevant words out of the total words spoken during each meeting.

[4] `https://www.federalreserve.gov/monetarypolicy/fomc_historical_year.htm`

[5] Unlike our approach, Shapiro and Wilson [2022] include remarks made by the non-voting members at FOMC meetings and speeches made by the committee members outside of the FOMC meetings in their analysis.

[6] We also include all committee members, including nonvoting participants, in the broader data construction. As documented in the appendix, the fractions of words and the net negative sentiment by topic are largely similar to those based solely on voting members.

2.2 Dictionary Construction and Measurement of Sentiment by Topic

2.2.1 Dictionary Construction

This section discusses the net-negative sentiment by topic expressed by each FOMC member. We first construct a topic dictionary and then introduce an algorithm that classifies words by both topic and sentiment.

In constructing the dictionary for each topic, we combine human reading of the transcripts with computer-assisted enrichment. Using computer assistance, we identify frequently used words and phrases across the entire corpus, upon which human judgment is applied to determine the topic relevance of those terms. The authors then examine these words to ensure accurate classification and appropriate contextual interpretation.

The dictionary classifies words recorded in the transcripts into three topics: *economic activity*, *inflation*, and *financial conditions*. Note that the dictionary for economic activity encompasses terms related to labor markets as well as real economic activities such as production, consumption, and investment. We include financial conditions alongside the other two topics because financial market developments are an important and recurring subject in FOMC meetings.

The dictionary is constructed in three main steps:

1. **Step 1:** We identify the 800 most frequent unigrams (single words) and the 800 most frequent n-grams (from two- to four-word phrases) across the corpus. These terms are then systematically and manually assessed for their relevance to one of the three topics: labor markets, inflation, or financial conditions. The threshold of the top 800 terms was chosen to exclude words appearing in less than 1 percent of the total text, which are generally deemed too rare to be informative, notwithstanding remarks below.

2. **Step 2:** We incorporate additional human reading, screened by the authors, to avoid missing episodic words relevant to monetary policy (e.g., *furlough*). These words, while infrequent and unlikely to meet the one-percent threshold, are nevertheless important for discussions of monetary policy decisions and can typify topics.

3. **Step 3:** We further verify the contextual usage of words when they span multiple topics. For example, the term "risks" is classified based on context: "inflation risk" is assigned to the inflation

category, while “default risk” is classified under financial conditions. Similarly, international terms are categorized based on the context in which they are discussed—for instance, “oil” and “import prices” are classified under inflation, while “foreign currency” and “foreign reserves” fall under financial conditions, as they typically relate to financial market developments. Finally, the labor and inflation categories share four terms—“Phillips curve,” “income,” “wage,” and “wages.” Excluding these overlapping terms from either category does not materially affect the results.

Our final dictionary contains 415 terms in total: 130 related to economic activity, 61 about inflation, and 224 about financial conditions. Note that the economic activity dictionary encompasses words related to the labor market, production, and spending. The finance dictionary also includes terms pertaining to international finance, as discussions of international finance are typically intertwined with broader financial topics.[7] Importantly, words that are relevant to multiple topics are included in each corresponding dictionary to fully capture their contextual significance. For example, the words “compensation, income, Phillips curve, salary, utilization, wage, and wages” are included in both economic activity and inflation. Similarly, the words “home sales and profit margin” arise in both economic activity and finance discussions, while “commodity” appears in discussions related to both inflation and finance.

The dictionary includes both single words (unigrams) such as “inflation” and more complex compound terms (n-grams) such as “employment cost index.” Importantly, compound terms are distinguished from their constituent single-word terms that might also be unigrams so as to avoid double counting; they are furthermore distinguished from shorter compound terms in the dictionary that could be contained within them. For example, within the economic activity dictionary, the term “labor force participation rate” does not trigger additional matches for “labor force participation,” “labor force,” or “labor,” even though these terms also appear in the dictionary.

Notably, the number of words related to the labor market and inflation is smaller than that for financial conditions. This likely reflects the use of a narrower set of standardized terms—such as “unemployment rate” and “inflation”—in discussions of these topics, with little variation in terminology over time. In contrast, the financial-conditions category is roughly three times larger, reflecting the broader range of financial assets, evolving market structures, and the expansion of monetary policy tools over the sample period.

[7] In the meeting transcripts, GDP and GNP occasionally appear in lowercase form as “gdp” and “gnp.” These lowercase variants are also captured by our topic dictionaries.

Table 1: DICTIONARY TERMS BY TOPIC

Topic	Number	Dictionary Terms (Single and Compound)
Activity	130	aggregate demand, agricultural, auto, business confidence, business cycle, business fixed investment, business sector, businesses, capacity, capacity utilization, capital spending, construction, consumer confidence, consumer spending, consumption, current account, economic activity, economic growth, equipment, exports, GDI, GDP, GNP, gross domestic income, gross domestic product, home sales, housing starts, income, industrial, industrial production, inventories, inventory, light vehicle, manufacturing, materials, motor vehicle, motor vehicles, output, output gap, potential growth, potential output, private domestic final purchases, production, profit margins, real activity, residential, resource utilization, retail, retail sales, sales, sentiment, single family homes, single family housing, single family starts, slack, spending, tax, trade, trading partners, utilization, vacancy, investment, investments, housing, compensation, job, payrolls, unemployment, labor, hour, employment, NAIRU, hiring, payroll employment, layoffs, JOLTS, discharges, payroll, productivity, UI, labor force participation rate, openings, Manpower, labor markets, skilled, workers, ur, employees, labor market, hours, participation rate, participation, tightness, Turnover, Beveridge, worker, skills, Employers, placements, salary, employers, initial claims, jobs, labor force, labor force participation, manpower, natural rate, Phillips curve, turnover, unemployment rate, wage, wages, claims, nonfarm, help-wanted, employed, overtime, Humphrey-Hawkins, laid, laid-off, workweek, jobless, fill, rehiring, hire, furloughs, furloughed, rehired, natural, tight
Inflation	61	accelerating, average hourly earnings, commodity, compensation, consumer prices, core, core prices, cost, cost pressures, costs, cushion, deceleration, deflate, deflation, deflationary, deflators, deflator, disinflation, disinflate, employment cost index, energy, expectations, gasoline, gravitational, gravitational constant, house price, house prices, hyperinflation, import prices, income, inflation, inflation expectations, inflation risk, inflationary, inflate, input, oil, owners equivalent rent, PCE, PCE inflation, PCE price, PCE prices, Phillips curve, pressure, pressures, price indexes, price setting, price stability, price-level, prices indexes, profit margin, salary, unit labor costs, upward pressure, upward pressures, utilization, wage, wages, West Texas intermediate, west Texas intermediate, WTI
Finance	224	ABS, AMFL, AMLF, amortization, arbitrage, asset, asset class, assets, balance sheet, balance sheets, bank, banking, bankruptcies, bankruptcy, banks, basis, BOJ, bond, bonds, borrowers, borrowing, capital, capital inflows, capital market, capital markets, capital outflows, cash, CDO, CDOs, CDS, CDS collateral, checkable, collateral, collateralized, commercial paper, commodities, commodity, conforming, contagion, corporate, corporates, counterparties, counterparty, CP, CPFF, credibility, credit, credit markets, credit spreads, currencies, currency, dealer, dealers, debt, debt-service, debts, default risk, deleveraging, delinquencies, delinquency, delinquincies, denomination, deposit, deposits, depreciation, derivatives, discount rate, disintermediation, dollar-denominated, Dow, easing, ECB, effective lower bound, equities, equity, equity markets, euro, exchange, exchange rate, fed funds, federal funds rate, financial, financial flows, financing, five-year, fixed income, foreign currency, foreign exchange, foreign exchange reserves, foreign-currency, funding, future markets, futures markets, GSE, hedge fund, hedge funds, hedging, home sales, illiquid, instruments, issuance, leading, lending, leveraged, liability, LIBOR, liquid, liquidity, loan, loans, M0, M1, M2, M3, manipulation, market operations, maturities, maturity, maturity extension, MB, MBS, MMIFF, monetary, monetary aggregates, monetary base, monetary growth, money, money market, money market funds, money markets, monoline, monolines, Moody's, mortgage, mortgage-backed, mutual, mutual fund, mutual funds, Nasdaq, noncommercial, note, notes, NPLs, OIS, operations, origination, originations, originators, outflows, overdue, P-E, PE, pesos, portfolio, portfolios, precautionary, premiums, price-earnings, profit margins, quantitative easing, real estate, real rate, refinance, refinancing, refinancings, repatriation, repayment, repo, reserve, reserves, reverse repo, reverse repurchase, risk, risk appetite, risk appetites, risk premiums, risks, rrp, RRP, S&P, S&P500, securities, securitization, securitizations, securitize, securitized, self-insurance, shareholders, short term rates, SOMA, speculators, spread, spreads, sterling, stock, subprime, subprime mortgage, swap, swaps, TALF, ten-year, term premium, term premiums, thirty-year, TIPS, tranches, Treasuries, treasury, Treasury, Treasury bills, unwinding, unwound, velocity, VIX, volatility, won, yen, yield spreads, yields.

2.2.2 Sentiment Assessment by Topic

For sentiment assessment, we use the "*automated search and count*" approach to estimate the net negativity sentiment by topic. This approach requires a pre-defined dictionary for the word categorization. The algorithm uses a simple mapping: if a given word in a text is found in the dictionary on a certain topic (or sentiment), it is taken to convey the particular topic (or sentiment). Once words in a text are classified accordingly, the frequency counts of the classified words are computed at the desired level of observation to categorize the text into a group presenting a certain topic (or sentiment).We use the Loughran and McDonald [2011] (hereafter, the LM dictionary) and classify words in a text into the categories of sentiment—positivity and negativity.[8]

For sentiment classification, it is important to account for negation (e.g., "not") that precedes a sentiment word. Because a negator can reverse the overall sentiment of a sentence, our algorithm is designed to detect whether a negator appears before a sentiment word and, if so, to flip the direction of the sentiment accordingly.

To jointly assess sentiment by topic, we develop a two-dimensional classification algorithm that applies the automated search-and-count approach to both topic and sentiment classification. The algorithm operates as follows. Suppose we measure the sentiment on the economic activity topic for speaker i in meeting month τ. We classify a sentence as belonging to the economic activity topic based on the number of activity-related terms appearing in our dictionary at the sentence level. If this count is nonzero and greater than the corresponding counts of inflation- or finance-related terms found in their respective dictionaries, the sentence is classified as pertaining to the economic activity topic.

Next, aggregating all sentences on the economic activity topic for speaker i in month τ, we compute the total number of words, $W^e_{i\tau}$, and the numbers of negative and positive words based on the LM dictionary, denoted by $N^e_{i\tau}$ and $P^e_{i\tau}$, respectively. Using the same procedure, we estimate sentiments for inflation and financial conditions, yielding analogous counts of total words on inflation, $W^\pi_{i\tau}$ ($W^f_{i\tau}$), and the corresponding numbers of positive and negative terms, $N^\pi_{i\tau}$ and $P^\pi_{i\tau}$ ($N^f_{i\tau}$ and $P^f_{i\tau}$), respectively.

[8] The LM dictionary is tailored to contexts in which economics and finance are discussed. The dictionary has 355 terms that are associated with positive sentiment and 2,356 terms that are associated with negative sentiment. Sentences containing negators—words that express negation such as "not"—that immediately preceded sentiment words are dropped from analysis. However, there are not that many such observations, and hence this procedure does not meaningfully alter the estimated sentiments.

Using these counts, we define the measures of net negativity as follows.

$$\begin{aligned} x_{i\tau}^{e} &= \frac{(N_{i\tau}^{e} - P_{i\tau}^{e})}{W_{i\tau}^{e}} \\ x_{i\tau}^{\pi} &= \frac{(N_{i\tau}^{\pi} - P_{i\tau}^{\pi})}{W_{i\tau}^{\pi}} \\ x_{i\tau}^{f} &= \frac{(N_{i\tau}^{f} - P_{i\tau}^{f})}{W_{i\tau}^{f}} \end{aligned}$$

Following Shapiro and Wilson [2022], we regress $x_{i\tau}^{j}$, for j=e,π, and f on time and speaker fixed effects. We control for speaker fixed effects in order to take idiosyncratic speaking styles into account. We then use the estimated time fixed effects of meeting month τ as the measure of sentiment on topic j of voting members in the meeting month, which we denote by S_{τ}^{j} for j=e,π, and f. The level of the time-fixed effect in March 1976 is normalized to be 0.

2.3 Custom Algorithms

Three custom algorithms were developed to facilitate specific cleaning steps for the corpus or topic classification steps of utterances within the cleaned corpus. In the construction of the corpus, a filtering step was implemented using the Oxford Dictionary of Economics in conjunction with the various topic dictionaries in order to assess the basic relevance of observations, with an eye towards better performance downstream by eliminating irrelevant observations before conducting the more involved topic classification later on. One algorithm, `DetectOxford`, simply scanned each observation of the corpus for the presence of a unigram from the ODE and topic dictionaries list and, if there was no presence, for an n-gram. The failure to detect either presence resulted in that observation being dropped for failing to meet a basic relevance criterion.

Regarding the sentiment measures of net positivity or negativity, a separate algorithm, `CountWords`, was deployed in light of the fact that only unigrams are present in either sentiment dictionary, considerably simplifying the counting procedure. The algorithm scanned each utterance and returned the counts of the number of occurrences of positive (negative) sentiment unigrams, for the given sentiment dictionaries while also avoiding double-counting unigrams that could contain other unigrams (e.g., “positive” and “positively”).

Finally, the topic classification algorithm, `CountDictWords`, was more involved, reflecting the fact that great care was needed to prevent double-counting of terms so as to avoid systematic bias. For each utterance in the cleaned corpus, the utterance was first scanned for the presence of the largest n-grams in the supplied topic dictionary (e.g., "labor force participation rate" for the labor dictionary), all of whose instances were counted and then deleted from subsequent scans of that utterance if detected. Such a deletion removed the possibility of double-counting smaller nested n-grams (e.g., "labor force participation") or unigrams (e.g., "labor") in subsequent scans of the same utterance while also leaving unaffected the presence of those same smaller n-grams (unigrams) elsewhere in the utterance. Accordingly, once the scan of all n-grams was completed for a given utterance, only thereafter were unigrams scanned for and counted if present. Even within the scan for unigrams, care was taken to avoid the double-counting of unigrams that could contain other smaller unigrams (e.g., "bank" and "banking") due to morphological inflections. Finally, for a given utterance and topic dictionary, the algorithm returned the final total (non-unique) count of all such detected terms from the topic dictionary.

3 Sentiment and Weight by Topic

This section discusses the constructed sentiment scores by topic in Section 3.1 and topic weights in Section 3.2.

3.1 Sentiment Index by Topic

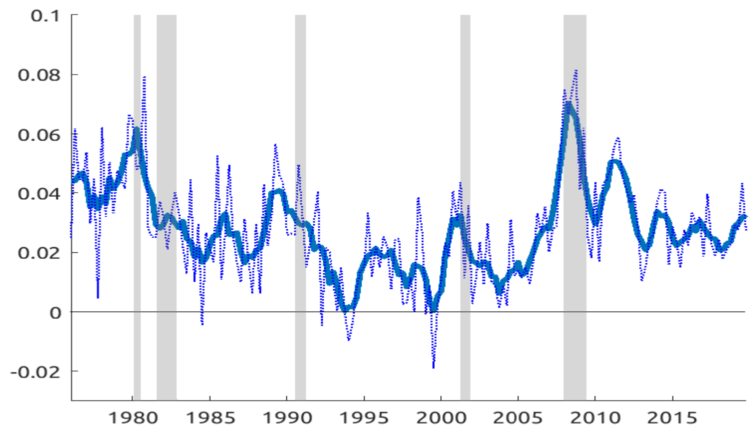
Figure 1 displays the net negative sentiment index on economic activity (Panel A), inflation (Panel B), and financial conditions (Panel C) together with the centered five-quarter moving average to smooth out the noise in the raw sentiment estimates.[9] The raw estimates are available at the meeting level, but we aggregate them to a quarterly frequency to analyze their time series properties and compare with cyclical macroeconomic indicators. Let S_t^e, S_t^π, and S_t^f denote the smoothed sentiment indices for economic activity, inflation, and finance, respectively.

Figure 2 plots the smoothed index of each topic together with the corresponding macroeconomic indicator. Panel A plots S_t^e with the negative EPOP gap which is defined as the difference between the EPOP

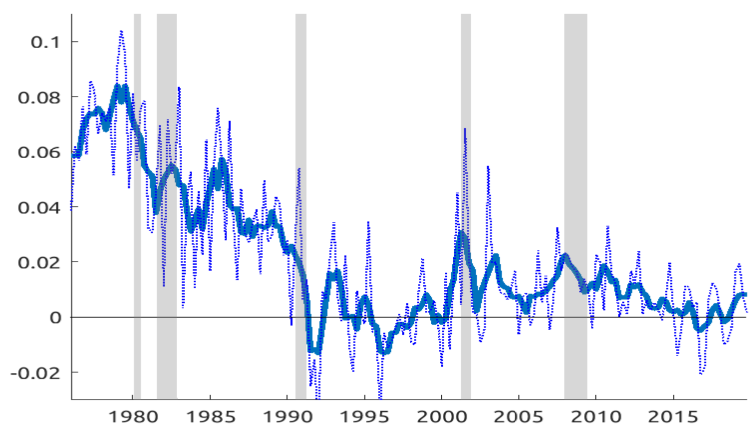
[9] Using the centered three-quarter moving average does not change the result. Once we expand the sample to all meeting participants, the raw sentiment series become less noisier. Shapiro and Wilson [2022] also plot the centered 11-month moving averages of raw data, when they report their constructed sentiment indexes. Notably, the smoothed sentiment indexes on economic activity and inflation are similar to the estimates that are documented in the appendix of Shapiro and Wilson [2022]. This observation suggests that the dictionary that Shapiro and Wilson [2022] use to classify words by topic is fairly effective in accurately categorizing words actually spoken during the FOMC meetings.

Figure 1: SENTIMENT ON ACTIVITY, INFLATION AND FINANCIAL CONDITIONS

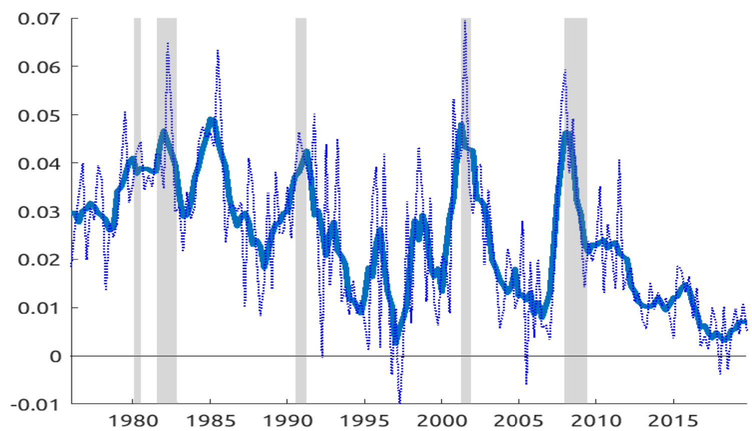
Panel A: Activity (S_t^e)



Panel B: Inflation (S_t^π)



Panel C: Financial Conditions (S_t^f)

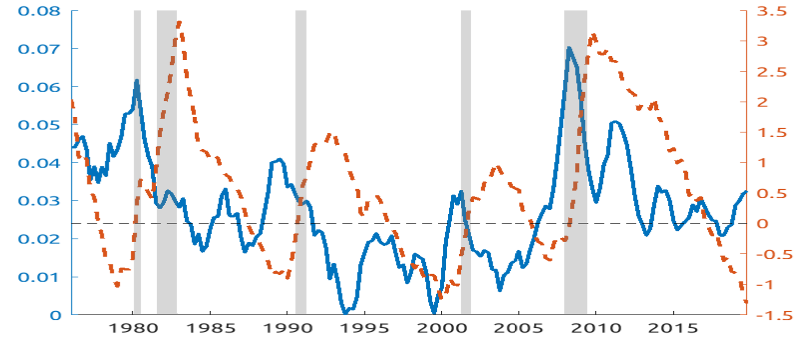


Note to figure: The dotted blue line shows the raw sentiment estimate, while the solid line represents the smoothed estimate. Shaded areas indicate NBER-defined recessions.

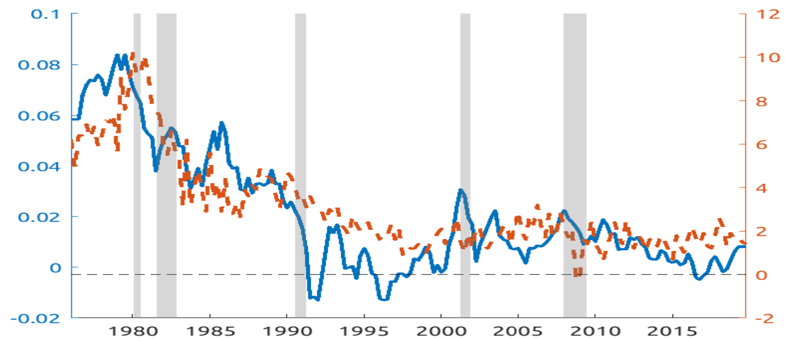
Source: Authors' calculation.

Figure 2: SENTIMENT INDICES AND THE RELEVANT MACROECONOMIC VARIABLE

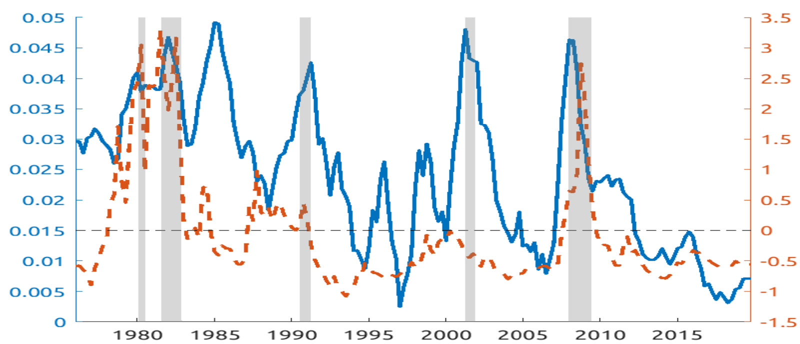
Panel A: S_t^e and Negative EPOP gap (%)



Panel B: S_t^{π} and Core PCEPI inflation (%)



Panel C: S_t^f and Chicago Fed's Financial Conditions Index



Note to figure: The solid line represents the smoothed sentiment index, while the dashed red line shows the corresponding macroeconomic indicator. The left axis refers to the sentiment index, and the right axis to the macroeconomic indicator. The negative EPOP gap is defined as the trend EPOP ratio minus the actual EPOP ratio, where the trend EPOP ratio is from Congressional Budget Office. Shaded areas indicate NBER-defined recessions.

Source: Authors' calculation.

ratio and CBO's trend EPOP ratio. The labor index and the negative EPOP gap are positively correlated with the Pearson correlation coefficient of 0.43 with a standard error of 0.14. We compare the sentiment of economic activity with the EPOP ratio, because employment and overall labor market conditions are closely associated with each other, as suggested by the Okun's law.[10]

Panel B plots S_t^{π} together with 4-quarter core PCEPI inflation. Both S_t^{π} and core PCEPI inflation show a clear downtrend from 1980 through the mid 1990s, and then stays largely flat after 2000. This observation suggests that S_t^{π} is likely to capture the deviation of inflation from its trend, not the trend component. In line with the conjecture, the Pearson correlation coefficient between the two series is 0.80 with a standard error of 0.05. This observation suggests that FOMC members view inflation more negatively when the data indicate a persistent upward trend.

Panel C exhibits S_t^{f} together with Chicago Fed's national financial conditions index. Note that the Financial Conditions Index rises (falls) when financial conditions tighten (loosen). The finance sentiment index is closely correlated with movements in Chicago Fed's index. One difference is the high net negative sentiment observed in the early 2000s, when the dot-com bubble burst and the NASDAQ stock price index plunged sharply but the financial conditions index shows a rather subdued rise during this period. Other than this, the two indicators are overall aligned with the Pearson correlation of 0.50 with a standard error of 0.01.

In summary, the relationship between the text-based sentiment index and the corresponding economic indicators suggests that the sentiment index may provide information about the target levels of employment, inflation, and financial conditions that FOMC members have in mind at each point in time.

3.2 Topic Weights

To assess the relative interest in each topic, we compute the fraction of words spoken by all meeting participants. We consider remarks made by all meeting participants, because discussions provided by the non-voting members and the staff represent the views of the FOMC and also affect the voting members' decisions.Using total word counts for each topic (W_τ^e, W_τ^π , and W_t^τ), we compute the fraction of words

[10]For robustness checks, we consider focusing only on the labor market topic. The overall sentiment of labor market is similar to that of economic activity, but the sentiment index is observed with greater noises, because fewer sentences are classified as labor-topic sentences.

spoken by all meeting participants on each topic as follows:

$$f_t^e = \frac{W_t^e}{W_t^e + W_t^\pi + W_t^f} \tag{3.1}$$

$$f_t^\pi = \frac{W_t^\pi}{W_t^e + W_t^\pi + W_t^f} \tag{3.2}$$

$$f_t^f = \frac{W_t^f}{W_t^e + W_t^\pi + W_t^f}. \tag{3.3}$$

Figure 3 shows the estimated topic fractions aggregated at a quarterly frequency. On average, finance-related words are used more frequently than those related to economic activity or inflation. This prominence reflects the wide range of assets the committee monitors and underscores the close connection between financial market discussions and the implementation of monetary policy tools. Moreover, the committee often discusses uncertainty and risks surrounding monetary policy in the context of asset prices and financial market volatility—topics that may not be prominently featured in formal policy announcements or statements. The fraction of finance-related words is especially high during the 1970s and 1980s, reflecting extensive discussions of monetary aggregates under the monetary targeting regimes of that period.

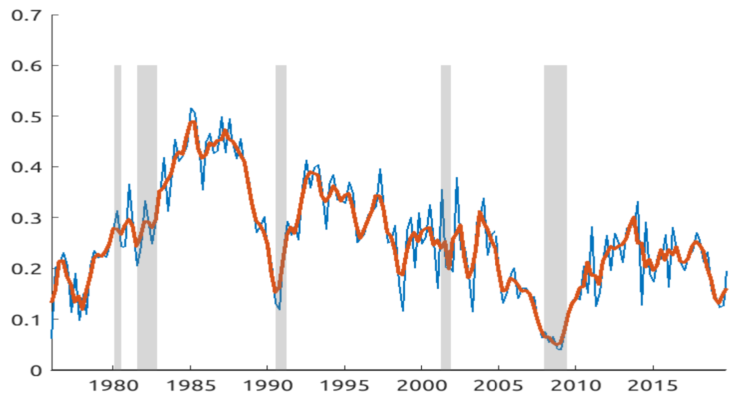
It is important to note that topic word fractions vary over time. The fraction devoted to financial discussions increases during economic downturns (Panel C), suggesting that the FOMC members place greater emphasis on financial market signals when assessing the cyclical state of the economy or identifying turning points in the business cycle. The share of inflation-related words also rises in the 2000s, prior to the Great Recession, reflecting the run-up in oil prices. Finally, discussions on economic activity increase markedly from 1990 through the eve of the Great Recession. This heightened focus on economic activity reflects both the stabilization of inflation and the weakening of the Phillips curve, which made labor market conditions more central to the committee's assessment of economic slack.

4 Estimates of the Reference Levels

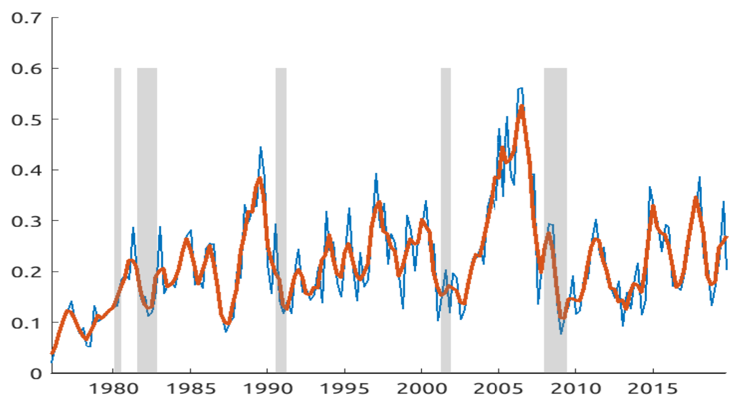
This section presents a state-space model for estimating the target levels of employment, inflation, and financial conditions. Section 4.1 describes the model, Section 4.2 discusses the estimation results.

Figure 3: Fraction of words by topic (Voting Members, 1976:Q1-2019:Q4)

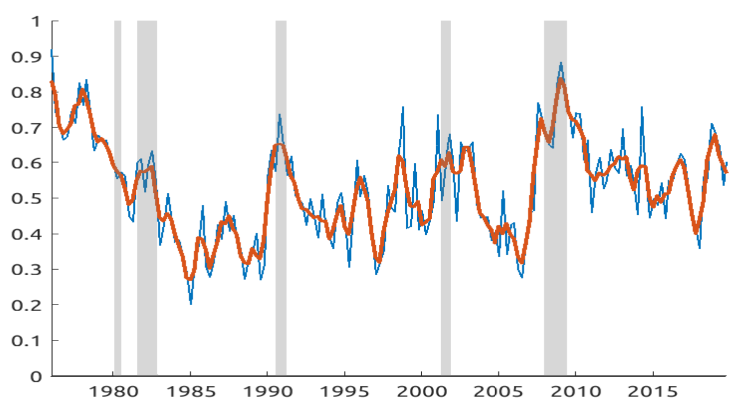
Panel A: Economic Activity (f_t^e)



Panel B: Inflation (f_t^π)



Panel C: Financial Conditions (f_t^f)



Note to figure: The thin blue lines represent the raw topic fractions, while the thicker red lines show the centered three-quarter moving averages. Shaded areas indicate NBER-defined recessions.
Source: Authors' calculation.

4.1 Model

The state-space model links six unobserved components to six observed data series. We begin with the trend-cycle decomposition of the EPOP ratio (e_t), four-quarter core PCEPI inflation (π_t), and Chicago Fed's national index of financial conditions (f_t), where each series consists of a trend, a cyclical or transitory component, and an innovation term. The trend component is interpreted as the reference level of the respective series.

The state equations are specified as follows:

$$e_t = e_t^* + g_t^e + r_t^e \tag{4.1}$$

$$\pi_t = \pi_t^* + g_t^\pi + r_t^\pi \tag{4.2}$$

$$f_t = f_t^* + g_t^f + r_t^f, \tag{4.3}$$

where e_t^*, π_t^*, and f_t^* denote the trend components; g_t^e, g_t^π, and g_t^f denote the cyclical components; and r_t^e, r_t^π, and r_t^f represent measurement errors in the EPOP ratio, the core PCEPI inflation, and the financial conditions index, respectively.

Next, we related the sentiment indices to the cyclical components as follows. We assume that the sentiment index of each topic reflects where the corresponding indicator is located relative to its trend. Specifically, the measurement equations of the three sentiment indices are written as follows:

$$S_t^e = c_e + b_e g_t^e + r_{s,t}^e \tag{4.4}$$

$$S_t^\pi = c_\pi + b_\pi g_t^\pi + r_{s,t}^\pi \tag{4.5}$$

$$S_t^f = c_f + b_f g_t^f + r_{s,t}^f, \tag{4.6}$$

where S_t^e, S_t^π, and S_t^f denote the sentiment indices for the labor market, inflation, and financial conditions, respectively; c_e, c_π, and c_f are constants; and $r_{s,t}^e$, $r_{s,t}^\pi$, and $r_{s,t}^f$ represent measurement errors in the sentiment indices. We assume that the cyclical component of the EPOP ratio is negatively related to S_t^e, with coefficient $b_e < 0$. The transitory component of inflation, g_t^π, is positively related to S_t^π with coefficient $b_\pi > 0$, and the cyclical component of financial conditions, g_t^f, is positively related to S_t^f with coefficient $b_f > 0$.

We assume that the six measurement errors have zero mean and are mutually independent, with a diagonal covariance matrix denoted by $\mathbf{R}$. Denoting the vector of measurement errors, $\boldsymbol{r}_t = [r_t^e, r_t^\pi, r_t^f, r_{s,t}^e, r_{s,t}^\pi, r_{s,t}^f]'$, the vector of measurement errors is assumed to be normally distributed as follows:

$$\boldsymbol{r}_t \sim N(\mathbf{0}, \mathbf{R}),$$

$$\mathbf{R} = \begin{bmatrix} R_e & 0 & 0 & 0 & 0 & 0 \\ 0 & R_\pi & 0 & 0 & 0 & 0 \\ 0 & 0 & R_f & 0 & 0 & 0 \\ 0 & 0 & 0 & R_{se} & 0 & 0 \\ 0 & 0 & 0 & 0 & R_{s\pi} & 0 \\ 0 & 0 & 0 & 0 & 0 & R_{sf} \end{bmatrix}.$$

Next, we turn to the state equation for the six latent states. First, we model the trend component of the EPOP ratio evolves according to an integrated random walk, because the trend growth of the EPOP ratio changes over time.[11]

$$\triangle e_t^* = \triangle e_{t-1}^* + \epsilon_t^{e*}, \tag{4.7}$$

In this equation, ϵ_t^{e*} is an innovation to changes in e_t^*. The above equation is rewritten as

$$e_t^* = 2e_{t-1}^* - e_{t-2}^* + \epsilon_t^{e*}. \tag{4.8}$$

We assume that the trend components of inflation and the financial conditions index follow a random walk. This assumption for inflation is consistent with previous studies (e.g., Stock and Watson, 2016), while the assumption for the financial conditions index reflects the absence of a prominent trend in that series. The inflation trend is expressed as:

$$\pi_t^* = \pi_{t-1}^* + \epsilon_t^{\pi*}, \tag{4.9}$$

[11] Changes in the trend EPOP ratio is mainly driven by changes in the LFPR trend.

where $\epsilon_t^{\pi*}$ is an innovation term to π_t^*. Likewise, the trend component of f_t is written as:

$$f_t^* = f_{t-1}^* + \epsilon_t^{f*}, \tag{4.10}$$

where ϵ_t^{f*} is an innovation term to f_t^*.

The cyclical components are assumed to evolve according to an AR(2) process as follows:

$$\begin{aligned} g_t^e &= \rho_1^e g_{t-1}^e + \rho_2^e g_{t-e}^e + \epsilon_t^e \\ g_t^\pi &= \rho_1^\pi g_{t-1}^\pi + \rho_2^\pi g_{t-e}^\pi + \epsilon_t^\pi \\ g_t^f &= \rho_1^f g_{t-1}^f + \rho_2^f g_{t-e}^f + \epsilon_t^f, \end{aligned}$$

where ϵ_t^e, ϵ_t^π, and ϵ_t^f denote the innovations to the cyclical components of the employment-to-population ratio, inflation, and financial conditions, respectively.[12]

Let $\boldsymbol{\epsilon}_t$ denote the vector of innovations of six latent variables, $\boldsymbol{\epsilon}_t = [\epsilon_t^{e*}, \epsilon_t^{\pi*}, \epsilon_t^{f*}, \epsilon_t^e, \epsilon_t^\pi, \epsilon_t^f]'$. This vector is assumed to be drawn from a normal distribution with mean zero and covariance matrix $\mathbf{Q}$. We assume that the innovations are uncorrelated with each other, and hence $\mathbf{Q}$ is a (6×6) diagonal matrix.

$$\boldsymbol{\epsilon}_t \sim N(\mathbf{0}, \mathbf{Q}),$$

$$\mathbf{Q} = \begin{bmatrix} Q_e & 0 & 0 & 0 & 0 & 0 \\ 0 & Q_\pi & 0 & 0 & 0 & 0 \\ 0 & 0 & Q_f & 0 & 0 & 0 \\ 0 & 0 & 0 & Q_{e*} & 0 & 0 \\ 0 & 0 & 0 & 0 & Q_{\pi*} & 0 \\ 0 & 0 & 0 & 0 & 0 & Q_{f*} \end{bmatrix}.$$

We impose several parameter restrictions on the state equation to alleviate the well-known numerical challenges associated with trend-cycle decomposition. First, we require that the sum of the AR(2) coefficients for each variable does not exceed 0.95, ensuring stationarity of the cyclical components. In addition, for the cyclical component of the EPOP ratio, we assume that g_t^e follows an AR(2) process with $\rho_1^e > 1$ and

[12] This assumption of AR(2) process for the cyclical component is widely adopted in the literature of trend-cycle decomposition. We also considered a more generalized VAR(2) process and found that all the off-diagonal terms were not statistically different from 0 at the 10% level.

$\rho_2^e < 0$, which generates a hump-shaped response—a common feature shown in cyclical indicators of real economic activities.[13]

Second, we assume that the variance of each trend component is smaller than that of its corresponding cyclical component, consistent with the definitions of trend and cycle. Specifically, we set Q_{e*} to be no greater than 80% of Q_e, ensuring that the variability of the trend component does not exceed that of the cyclical component. Similarly, we assume that $Q_{\pi*}$ is 50 percent or less of Q_π, referencing the multivariate core trend inflation (MCT) estimate from the Federal Reserve Bank of New York. Because there is no widely accepted trend estimate for the financial conditions index, we conservatively assume that Q_{f*} is at most 1.5 percent of Q_f, ensuring that the trend component of financial conditions exhibits less variability than its cyclical counterpart.

We estimate the model using maximum likelihood and infer the latent state variables via the Gaussian Kalman filter. The model includes a total of 30 parameters to estimate: six elements in $\boldsymbol{Q}$, six in $\boldsymbol{R}$, six in $\boldsymbol{F}$, six coefficients from the sentiment measurement equations, and six parameters in the initial state vector $\boldsymbol{\xi}_0$. To reduce the number of parameters, we assume $\boldsymbol{\xi}_0 = \boldsymbol{\xi}_{-1}$ and assign a large variance to the initial state vector to reflect uncertainty about its values. Appendix A.1 provides details about the calculation of standard errors and the confidence intervals of the latent variables.

4.2 Estimation Results

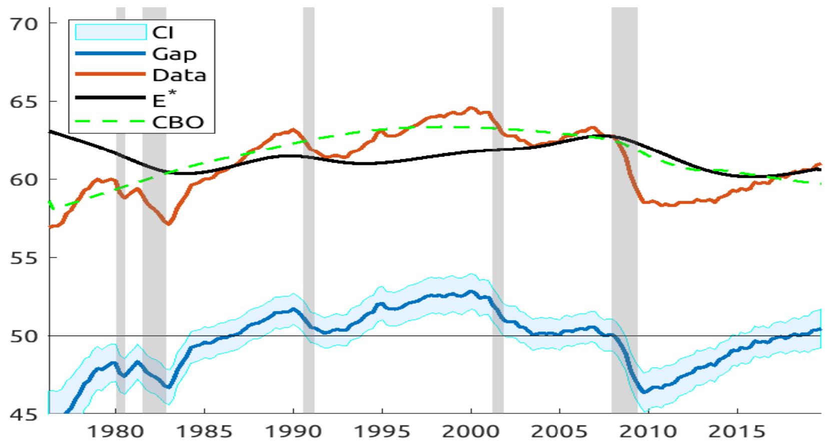
Table A.1 reports the parameter estimates. Panel A of Figure 4 displays the estimates of latent variables with text-sentiment data while Panel B shows estimates without text-sentiment data. We estimate the latent variables without the text sentiment measures to assess the extent to which the text sentiment measures help to identify the reference employment level. The black line is the text-based employment target (e_t^*), and the blue line is the cyclical component (g_t^e, denoted "Data"). The shaded area represents the 90% confidence intervals (denoted "CI"). The red line is the EPOP ratio (denoted "Data"), and the dashed green line is the CBO's trend EPOP ratio (denoted "CBO"). When we do not use text-sentiment data, the CI of the cyclical gap measure is much wider.

There are several notable observations. We find that the estimated reference level of employment—measured with the EPOP ratio at full employment—–broadly aligns with the trend EPOP ratio from the Congressional Budget Office (CBO) with some notable differences. The estimated level of full employment indicates that

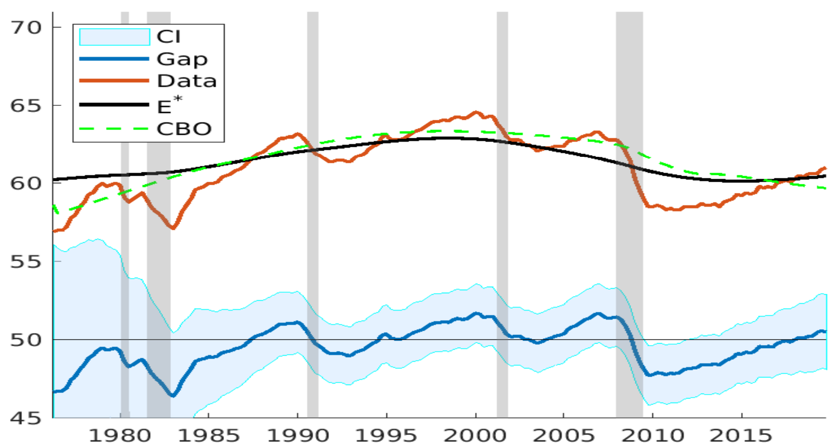
[13] See, for example, Chan et al. [2019] for more discussions.

Figure 4: Estimated Employment Measures (percent)

Panel A. Baseline Results with Text-Sentiment Data



Panel B. Estimation without Text-Sentiment Data

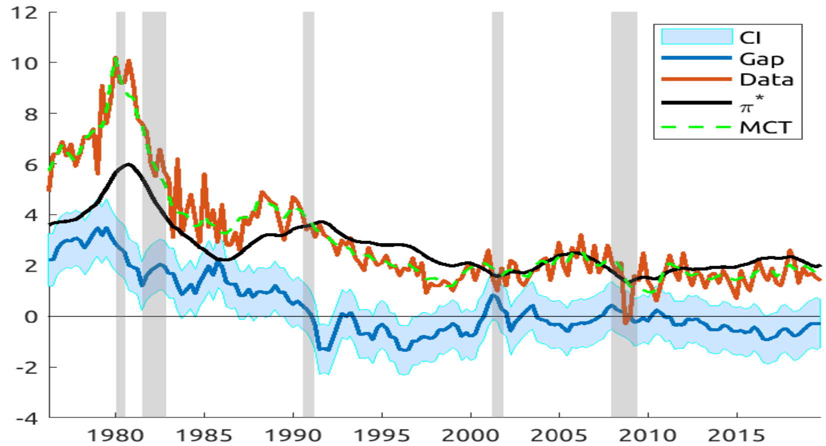


Note to figure: The black line represents $\hat{e}_t^*$, the blue line depicts $\hat{g}_t^e$, and the shaded area (CI) indicates the 90% confidence interval for $\hat{g}_t^e$. The dashed green line shows the CBO's trend EPOP ratio, and the red line is the EPOP ratio. The gap is normalized to have a mean of 50 for visibility.

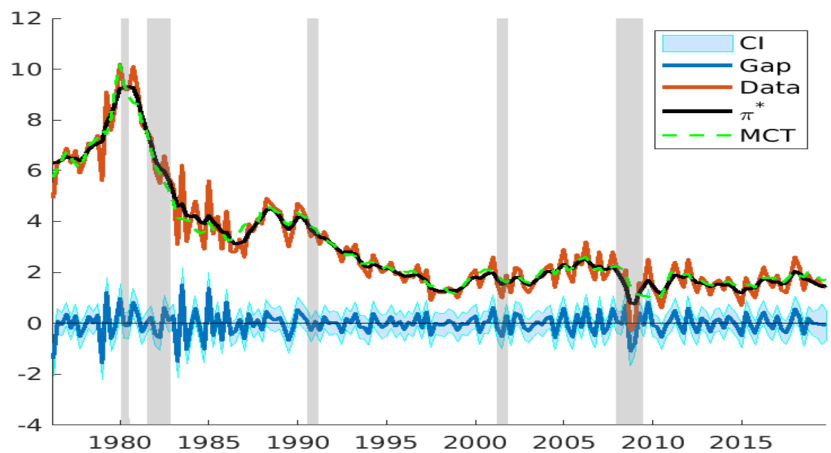
Source: Authors' calculation.

FOMC voting members generally perceived the labor market as tighter than implied by the CBO's estimates between themid-1980s and early 2000s. Meanwhile, the two measures show similar trajectories—both rise until 2000 and then decline, and also agree about the cyclical position in the labor market during the Great Recession and its subsequent recovery. It is notable that e_t^* signals a tighter labor market than the CBO's estimate during the 1980s and the 2010s like estimates without using text-sentiment data. Our finding suggests that FOMC members might have judged tigher labor market conditions than implied by the ex-post realized labor market data.

Figure 5: ESTIMATED INFLATION MEASURES (PERCENT)
Panel A. Baseline Result with Text-Sentiment Data



Panel B. Estimation without Text-Sentiment Data



Note to figure: The black line represents $\hat{\pi}_t^*$, the blue line depicts $\hat{g}_t^{\pi}$, and the shaded area (CI) indicates the 90% confidence intervals of the estimated gap. The dashed green line is the multivariate core trend inflation from the Federal Reserve Bank of New York. The red line is four-quarter core PCE price inflation.
Source: Authors' calculation.

Figure 5 shows the estimate of π_t^* (black line) alongside four-quarter core PCE inflation (red line, denoted "Data") and the MCT estimate from the Federal Reserve Bank of New York (dashed green line, denoted "MCT"). Panel A displays the estimates with the text-sentiment measures and Panel B shows those without the text-based measures. Overall, the π_t^* estimate closely tracks both the MCT and the observed data, exhibiting a downward trend from 1980 to the mid-1990s and flattening thereafter. However, there are notable differences. Between 1976 and 1982 which includes the Volcker dis-inflationary period of 1979-1982, the π_t^* estimate is lower than both the MCT and the observed data—by about 1.25 percentage points—reflecting a somewhat persistent positive inflation gap ($\hat{g}_t^{\pi}$, blue line, denoted "Gap"). This gap estimate is primarily driven by a bit stronger negative inflation sentiment primarily driven by volatile oil prices during this time, suggesting that inflation levels were perceived to be above FOMC members' reference level. In the first half of the 1980s, the π_t^* estimate, the MCT, and core PCE inflation all declined in tandem, showing close alignment. Interestingly, if we exclude text-sentiment data in estimation, the reference level of inflation is nearly perfectly aligned with the MCT measure because we only extract information on the reference level of inflation only from the realized inflation data without using real-time assessment of FOMC members.

Overall the inflation gap estimates show volatile and transitory variations. Reflecting the period of stable inflation from the mid-1990s, variations in the estimated inflation gap stays largely subdued. As a result, core PCEPI inflation tracks the π_t^* estimate. Following the Great Recession—and particularly after 2012, when the explicit inflation target was announced—the average value of π_t^* is 1.8 percent, though it reaches 2 percent in some quarters.[14] This suggests that the 2 percent inflation target may serve more as an upper bound for the reference level of inflation implicitly held by FOMC members.

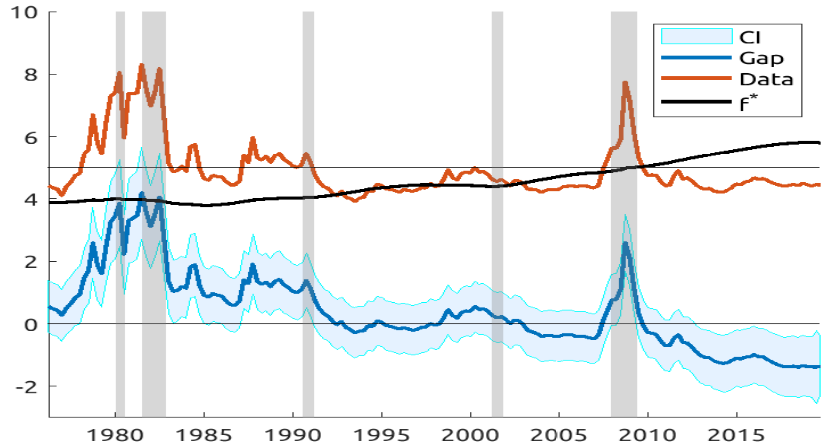
Figure 6 shows the estimate of f_t^* (black line) alongside the Chicago Fed's Financial Conditions Index (red line, denoted "Data"). Panel A displays the estimates with the text-sentiment measures and Panel B shows those without the text-based measures. The estimated financial gap, $\hat{g}_t^f$ (blue line, denoted "Gap")—which reflects sentiment regarding financial conditions—closely tracks cyclical variations in the data. The gap shows pronounced countercyclical variations during the 1980s recession and the Great Recession. Its countercyclical variations are somewhat subdued in 1998–1999, and between 2006 and 2008. In particular, the 1980s recession and the Great Recession coincide with episodes of financial distress: the early 1980s recession was triggered by the Federal Reserve's aggressive monetary tightening to curb high inflation and the 2006–2008 period marks the buildup to the global financial crisis driven by the collapse of the subprime mortgage market.

The estimate of f_t^* (black line) reflects underlying low-frequency financial conditions. It indicates tight financial conditions in the second half of the 1970s, reflecting monetary tightening aimed at combating inflation, and accommodative conditions in the early 1990s and again from the mid-1990s through the mid-2010s. This pattern aligns with the onset of loose monetary policy in mid-1994 in response to

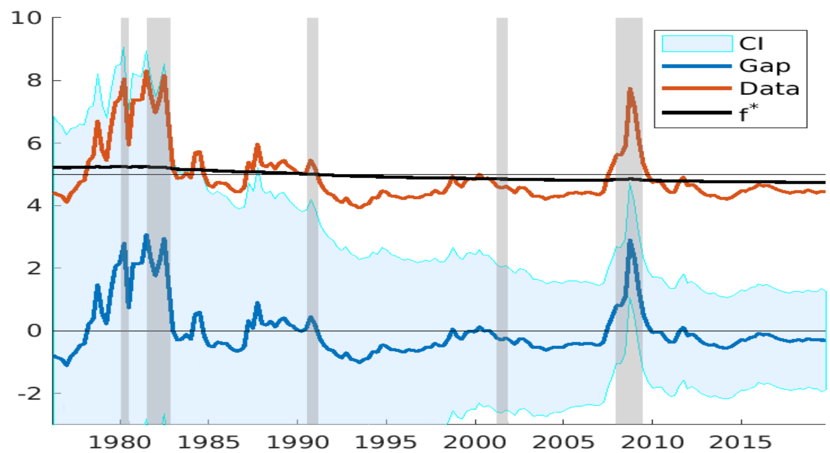
[14]This finding aligns with the finding of Shapiro and Wilson [2022]. During the same period, the average MCT estimate is 1.6 percent, slightly below the text-based trend estimate.

Figure 6: Estimated Financial Measures

Panel A. Baseline Results with Text-Sentiment Data



Panel B. Estimation without Text-Sentiment Data



Note to figure: The black line represents $\hat{f}_t^*$, the blue line depicts $\hat{g}_t^f$, and the shaded area (CI) indicates the 90% confidence intervals of the estimated gap. The red line depicts Chicago Fed's financial conditions index. Chicago Fed's index and $\hat{f}_t^*$ are normalized to have a mean of 5 for visibility.

Source: Authors' calculation.

declining inflation, the accommodative policy stance during the 2000s that contributed to the housing bubble, and the quantitative easing implemented after the Great Recession. Interestingly, when we do not use text-sentiment data in estimation, the reference level of financial market conditions is close to the average value of realized data, implying that financial market conditions have not been particularly loose relative to the trend throughout the 2010s.

5 Inference about Monetary Policy

We empirically explore the changing FOMC's preference and gradualism in Section 5.1 and corroborating evidence from remarks of the FOMC members in Section 5.2.

5.1 Estimation of FOMC's preference and gradualism

This section explores what our sentiment indices imply for the components of Taylor rule and their time variations.

Specifically, we examine the relative weights placed on the dual mandate and the degree of interest rate smoothing using our sentiment-based indices. In the standard Taylor rule, changes in the central bank's preferences—reflected in the relative emphasis on full employment versus inflation stabilization—are not separately identifiable from changes in the deviations of employment and inflation from FOMC's respective targets or perceived reference values. Moreover, since the goal of monetary policy is to stabilize the persistent component of inflation that reflects underlying demand conditions—rather than respond to transitory and volatile fluctuations—the FOMC has focused on underlying or trend inflation as a basis for preemptive policy actions and forward guidance, rather than treating the trend itself as the inflation target. Without an explicitly stated inflation target prior to 2012, it is particularly challenging to identify the time-varying preferences of monetary policymakers.

We address this identification issue by using our text-based estimates of trend and gap measures for employment and inflation. As an analytical framework, we take Coibion and Gorodnichenko [2012]'s Taylor rule model and include these text-based measures into the model as described below.[15]

$$i_t = \phi^e \hat{g}_t^e + \phi^\pi \hat{g}_t^\pi + \phi^{e(trend)} \hat{e}_t^* + \phi^{\pi(trend)} \hat{\pi}_t^* + \rho_i i_{t-1} + u_t. \tag{5.1}$$

The notation i_t denotes the shadow rate of Wu and Xia [2016]; the coefficients ϕ^e and ϕ^π represent the weights on the gap measures of employment and inflation, respectively, while $\phi^{e(\text{trend})}$ and $\phi^{\pi(\text{trend})}$ are the weights on the trend estimates of employment and inflation.[16] The coefficient ρ_i captures the degree of

[15] Coibion and Gorodnichenko [2012] use the target federal funds rate for i_t, the inflation forecast for $\tilde{\pi}_t$ and the forecast for the contemporaneous output gap for $\tilde{x}_t$. Instead of output, we use employment proxied by the EPOP ratio.

[16] The raw data for effective federal funds rate can be retrieved from "FEDFUNDS" of St. Louis' FRED. We use the effective federal funds rate, as the data for the 1970s are publicly available and have the sample period longer than that of the target federal funds rate.

monetary policy gradualism, and u_t represents innovations to the effective federal funds rate.[17] Because our main interest is changes in these coefficients, we estimate the above model with rolling regression of a fixed window of 60 quarters.[18]

Figure 7 displays the evolution of the five coefficient estimates along with their 90% confidence intervals. The X-axis indicates the end date of each 60-quarter rolling sample.

Beginning with employment (Panel A), the estimated coefficient on the EPOP gap ($\hat{\phi}^e$) is sizable and statistically significant (blue line), while the coefficient on the EPOP trend or reference level ($\hat{\phi}^{e(trend)}$) receives almost zero weight (magenta line). This observation suggests that deviations of employment from its reference level are an important consideration in the implementation of monetary policy. Second, $\hat{\phi}^e$ fluctuated between 0.4 and 0.6 through the mid 1990s, increased from the mid-1990s and peaked at 0.9 prior to the Great Recession. This pattern suggests that the FOMC placed increasing emphasis on deviations of employment from its full-employment level as inflation stabilized. However, $\hat{\phi}^e$ declined after the Great Recession, likely reflecting reduced sensitivity to the employment gap in setting the policy interest rate during the period of the zero lower bound.[19]

Turning the focus to inflation (Panel B), the coefficients on $\hat{g}_t^{\pi}$ and $\hat{\pi}_t^*$ exhibit distinct patterns (Panel B). Before 2000, the coefficient on $\hat{g}_t^{\pi}$ is sizable, larger than 0.5 and statistically significant. Unlike its employment counterpart, $\hat{\phi}_t^{\pi(trend)}$ —the coefficient on $\hat{\pi}^*$— is generally positive and statistically significant (magenta line) and became larger than the coefficient of $\hat{g}_t^{\pi}$. Meanwhile, the coefficient on $\hat{g}_t^{\pi}$ varies close to zero, not statistically significant more than half of the sample period after 2000 (blue line). This suggests that the FOMC places greater weight on $\hat{\pi}_t^*$—their perceived inflation trend, while showing limited response to $\hat{g}_t^{\pi}$—transitory deviations from that trend. This observation likely reflects the fact that policymakers might have been hesitant to respond aggressively to temporary declines of inflation below the reference level during this period as shown in Panel A of Figure 5.

Prior to the mid-1990s, the FOMC placed roughly equal weight on both sides of the dual mandate, with a somewhat greater emphasis on inflation stabilization. As inflation moved down, the committee increasingly emphasized deviations of employment from its full-employment level and the inflation trend

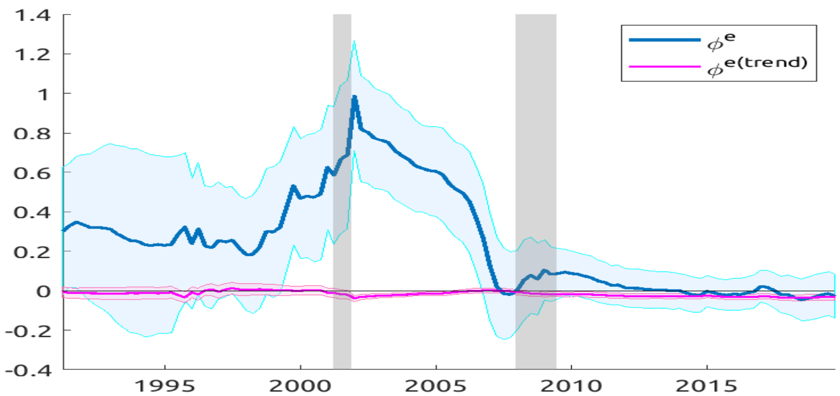
[17] We replace g_t^e and g_t^{π} with their lags and leads, but the results are robust regardless. In addition, results do not change much when we exclude text-sentiment data except for ρ_i, which is consistently close to 1 throughout the period when we do not use text-sentiment data in estimation.

[18] We exclude a constant from the rolling regression model, as its estimates exhibit somewhat erratic variation over time and we include responses to time-varying reference levels of EPOP and inflation.

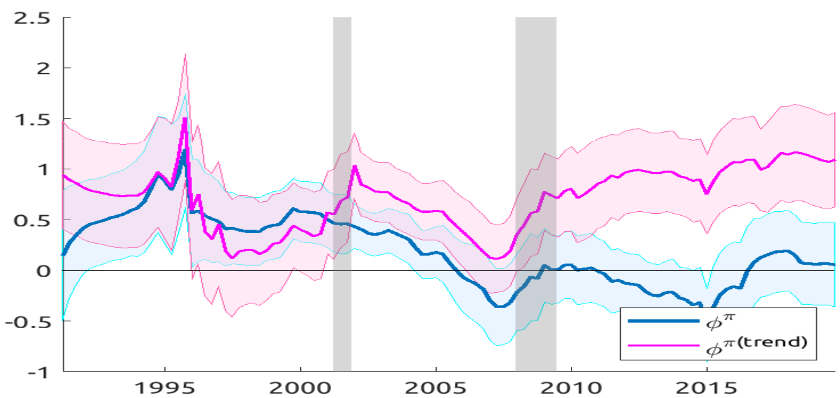
[19] With the shadow rate from Wu and Xia [2016], the weight on $\hat{\phi}^e$ becomes slightly above zero but the coefficient is not statistically different from zero.

Figure 7: CHANGES IN MONETARY POLICY PREFERENCE

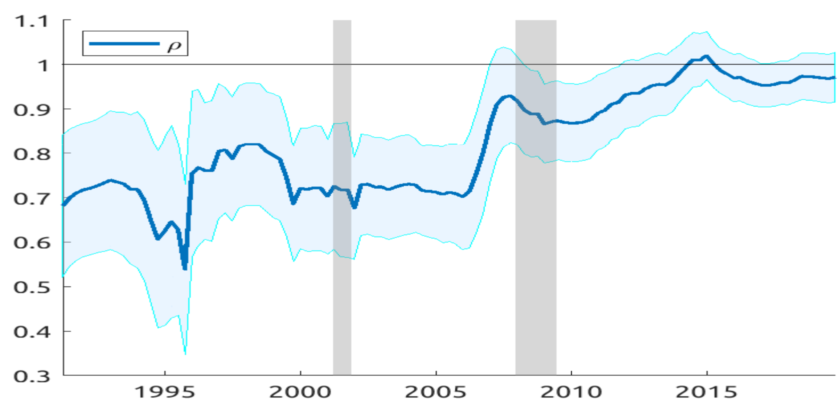
Panel A: Evolution of $\hat{\phi}^{e}$ and $\hat{\phi}^{e(trend)}$



Panel B: Evolution of $\hat{\phi}^{\pi}$ and $\hat{\phi}^{\pi(trend)}$



Panel C: Evolution of $\hat{\rho}$

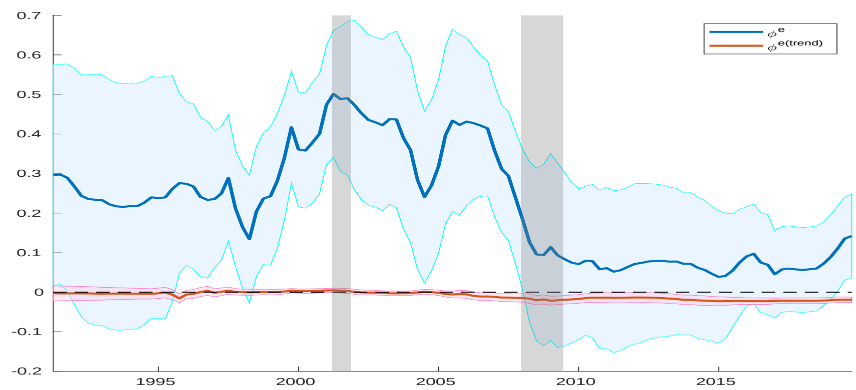


Note to figure: The colored shaded areas (CI) represent the 90% confidence intervals of the estimated gaps, while the gray shaded areas indicate NBER recessions.

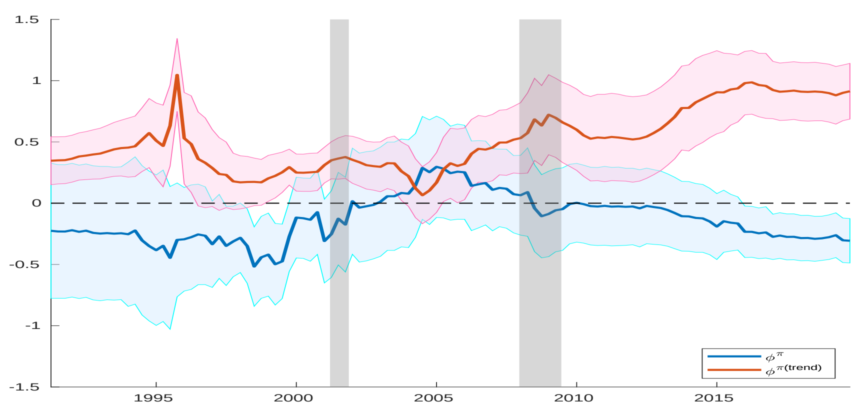
Source: Authors' calculation.

Figure 8: CHANGES IN MONETARY POLICY PREFERENCE WITHOUT TEXT-SENTIMENT DATA

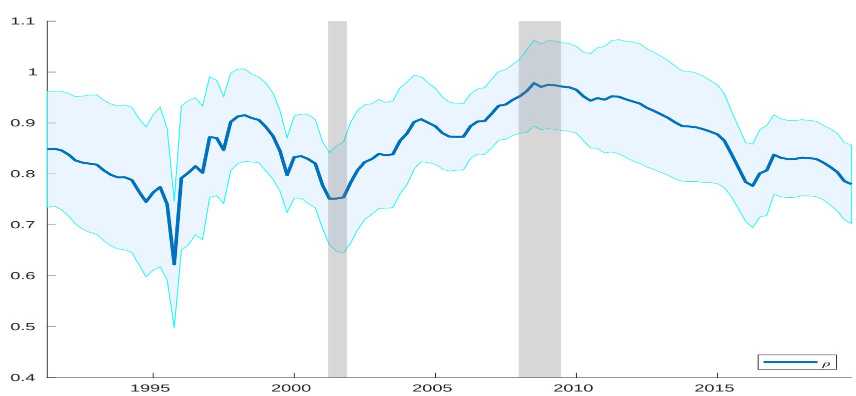
Panel A: Evolution of $\hat{\phi}^{e}$ and $\hat{\phi}^{e(trend)}$



Panel B: Evolution of $\hat{\phi}^{\pi}$ and $\hat{\phi}^{\pi(trend)}$



Panel C: Evolution of $\hat{\rho}$



Note to figure: The colored shaded areas (CI) represent the 90% confidence intervals of the estimated gaps, while the gray shaded areas indicate NBER recessions.

Source: Authors' calculation.

itself between the mid-1990s and the mid-2000s, likely reflecting the reduced responsiveness of inflation to economic slack—often described as "the death of the Phillips curve." After that, the focus shifted more toward the inflation trend, coinciding with the run-up in oil prices prior to the Great Recession and with persistently low inflation during and after the Great Recession—at times below two percent. This low inflation prompted policymakers to focus more closely on underlying inflation and the risk of not achieving the two-percent inflation target. During the zero lower bound period, forward guidance became a key monetary policy tool, relying heavily on medium-term inflation projections and hence elevating the committee's focus on trend inflation.

The degree of interest rate smoothing is sizable throughout the sample period but varies over time. The estimate $\hat{\rho}$ remains around 0.6 – 0.7 prior to the Great Recession, before stepping to the level of 0.9 during the Great Recession and the zero lower bound period.

While the broad patterns in the time variations of Taylor rule coefficients estimates without using text-sentiment data in Figure 8 are similar to our results with text-sentiment data in Figure 7, there are some differences from time to time. For instance, the response to inflation gap is positive in the late 1990s in the Panel B of Figure 7 but negative in the Panel B of Figure 8. This might be explained by the fact that inflation gap was negative with text-sentiment data but mostly positive without text-sentiment data during this period as shown in Figure 5.

We further assess effects of the deviation of financial conditions from its trend or reference level. For this, we further include $\hat{g}_t^f$ in the equation (5.1) as follows:

$$i_t = \phi^e \hat{g}_t^e + \phi^\pi \hat{g}_t^\pi + \phi^f \hat{g}_t^f + \phi^{e(trend)} \hat{e}_t^* + \phi^{\pi(trend)} \hat{\pi}_t^* + \rho_i i_{t-1} + u_t, \tag{5.2}$$

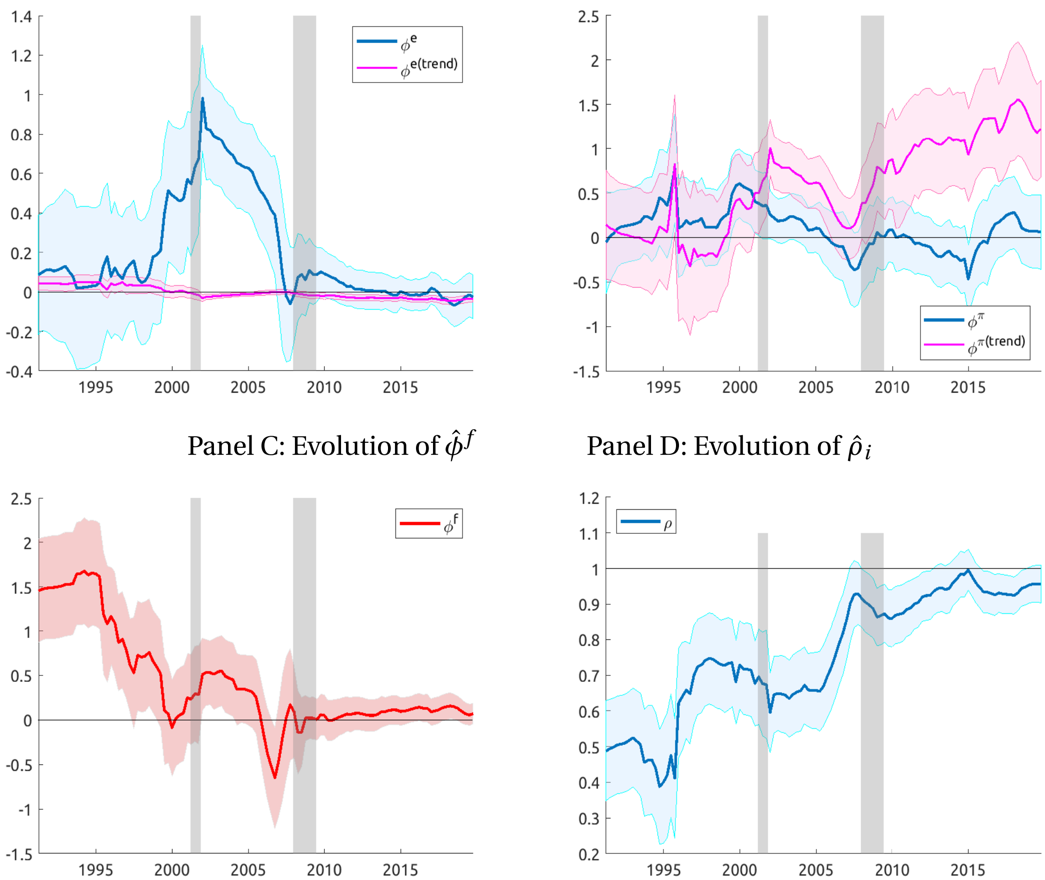
where ϕ^f captures the relative weight on the financial conditions. Note that we do not include the FCI star, $\hat{f}_t^*$, because this estimate likely reflects the financial market conditions implied by the policy rate directly. Likewise, we estimate this model with a rolling regression with a 60-quarter window.

Figure 9 shows the evolution of the coefficients along with their 90% confidence intervals. The x-axis indicates the end date of each 60-quarter rolling sample. Notably, $\hat{\phi}^f$ is positive prior to the mid-1990s and then turns negative, suggesting that tight financial conditions raised the policy interest rate before the mid-1990s but lowered it thereafter. This pattern likely reflects the monetary targeting regime of the 1970s and 1980s: when inflation posed risks to financial markets, policymakers implemented contractionary

Figure 9: CHANGES IN MONETARY POLICY PREFERENCE

Panel A: Evolution of $\hat{\phi}^e$ Panel B: Evolution of $\hat{\phi}^\pi$

Panel C: Evolution of $\hat{\phi}^f$ Panel D: Evolution of $\hat{\rho}_i$



Note to figure: The colored shaded areas (CI) represent the 90% confidence intervals of the estimated gaps, while the gray shaded areas indicate NBER recessions.

Source: Authors' calculation.

monetary policy to stabilize prices and mitigate financial instability. Once inflation subsided in the 1990s, however, loose financial conditions became associated with policy tightening via increases in the policy rate. The downward trend and sign reversal of $\hat{\phi}^f$ likely capture broader shifts in monetary policy regimes under the changing inflation environment. Despite the inclusion of $\hat{g}_t^f$, the overall patterns are broadly similar to those from the model without it.

To summarize, these empirical analyses indicate that the FOMC's emphasis on the two components of the dual mandate has shifted over time. Before the mid-1990s, the committee placed roughly equal, but somewhat greater, weight on the deviation of inflation from their perceived reference level than on deviations of employment from its full-employment level. Since the mid-1990s, however, the committee has placed significantly greater weight on the employment gap and the inflation trend itself for the implementation of monetary policy. During the Great Recession and the period at the zero lower bound, the focus shifted toward the inflation trend in response to the run-up in oil prices during the 2000s and persistently low inflation below the two-percent target. Finally, the degree of gradualism remains sizable prior to the Great Recession and increases further following the Great Recession.

All told, our empirical analyses highlight changing preferences in the monetary policy rule that reflect the structural evolution of the macroeconomic environment, underscoring the importance of time-varying parameters for evaluating policy effectiveness.

5.2 Corroborating evidence from remarks of the FOMC members

This section presents FOMC members' remarks from meeting transcripts and other venues (e.g., press conferences and speeches) that corroborate our empirical findings. We focus on three themes: (i) the emphasis on labor market slack and the inflation trend, (ii) shifts in the relative weight on the dual mandate, and (iii) the level and evolution of monetary policy gradualism.

5.2.1 Remarks on the emphasis on the inflation trend

To begin with, the remark of Chair Bernanke at the FOMC press conference on April 27, 2011 highlights that the committee primarily focuses on inflation trends along with resource utilization and inflation expectations for policy decisions.

> "the committee continues to anticipate that economic conditions, including low rates of

resource utilization, subdued inflation trends, and stable inflation expectations, are likely to warrant exceptionally low levels for the federal funds rate for an extended period." — *Chair Bernanke, FOMC Press Conference April 27, 2011*

The focus on inflation trend is also highlighted in two different times as noticed in the remarks by Chair Volcker and Chair Powell, each shown in panels [1] and [7] of Table 2. Specifically, Chair Volcker at the FOMC meeting on July 6-7 1981 mentions the following:

> "The hardest part of the battle is ahead in terms of affecting the underlying rate of inflation. Maybe something is happening there but it's still in the "maybe" stage. Nevertheless, the stage is at least set more favorably than we've had it in the past." — *Chair Volcker, FOMC meeting, July 6-7 1981*

In addition, Chair Powell at the FOMC meeting on May 1 2019 mentions the following:

> "... it is disappointing that we are once again explaining away an unanticipated softening in inflation on the basis of transient factors. This pattern suggests the possibility of downside risk to longer-term inflation expectations and, therefore, to our ability to achieve our symmetric inflation goal on a sustained basis." — *Chair Volcker, FOMC meeting , July 6-7 1981*

Given that long-term inflation expectations essentially represent the inflation trend, this remark underscores the committee's focus on the trend component of inflation over its transitory fluctuations.

5.2.2 Remarks on changing monetary policy preference

The remarks in Table 2 illustrate how the FOMC's relative emphasis on the dual mandate has shifted over time. Panels [1] and [2] show that Chair Volcker initially underscored the need to curb inflation, but his emphasis shifted markedly in October 1982. These early statements suggest that the committee focused on both mandates, though with greater weight on inflation stabilization during periods of high inflation. Notably, the same individual—Chair Volcker—adjusted his relative emphasis on the dual mandate in response to changing economic conditions.

From the mid-1990s, the focus shifted toward the labor market. In July 1996, Governor Meyer indicated that policy action would depend more on labor market conditions unless inflation pressures clearly intensified. Similarly, in 2003, Governor Gramlich emphasized placing greater weight on employment conditions given the lower perceived risk of inflation.

From the mid-2000s, the emphasis shifted back toward inflation. In June 2008, Chair Bernanke noted that while both mandates were important, he was more concerned about inflation risks. After the Great Recession, Chair Powell emphasized the challenge of persistently low inflation and the risk of failing to achieve the committee's symmetric 2 percent inflation objective amid subdued price pressures.

Taken together, these remarks reflect a dynamic balancing of the dual mandate, with the relative emphasis shifting between inflation control and employment support in a way that is consistent with our empirical findings.

5.2.3 Remarks on monetary policy gradualism and its changes

We further document remarks highlighting changes in the FOMC's approach to monetary policy gradualism. Table 3 traces how the stance toward gradualism has evolved over several decades. On July 19, 1977, Chair Burns explicitly endorsed gradual policy adjustments. This approach was reversed by Chair Volcker in October 1979, when the committee implemented an abrupt tightening—often referred to as the *"Saturday night massacre"*—to alter market participants' inflation expectations and combat rising prices. These contrasting remarks suggest that while the committee placed substantial weight on interest rate smoothing, it was willing to reduce the degree of gradualism when necessary to restore price stability.

As inflation trended downward and stabilized, the degree of gradualism increased. At the Senate testimony in 1988, Chair Greenspan emphasized incremental adjustments to monetary policy—a theme he reiterated in 2000. Governor Bernanke's 2004 speech provided a theoretical foundation for gradualism, highlighting its benefits for financial stability and policy predictability.

Following the Great Recession and throughout the zero lower bound period, gradualism remained a central guiding principle. In December 2012, Chair Bernanke incorporated gradual tightening into the committee's forward guidance. Similarly, in June 2018, Chair Powell reaffirmed this stance, noting that the committee was gradually implementing monetary tightening and intended to maintain this approach going forward.

All told, these remarks corroborate our estimates of interest rate smoothing, which remained sizable throughout the sample period but were relatively low during the high-inflation years—consistent with the remarks of Chairs Burns and Volcker—before rising in the mid-1990s. The degree of gradualism increased

Table 2: REMARKS ON THE FOMC'S PREFERENCES OVER THE DUAL MANDATE

Date	**Concern**	**Source, Quotation, Speaker**
[1] July 6-7, 1981	Inflation	**FOMC transcript** "I do think there are some signs of progress on inflation and inflationary psychology; I'm not one to overstate that, as I suggested yesterday. Largely we have affected the things that are most likely to be affected by restraint in the short run: commodity prices, precious metals prices, and the exchange rate to some extent. The hardest part of the battle is ahead in terms of affecting the underlying rate of inflation. Maybe something is happening there but it's still in the "maybe" stage. Nevertheless, the stage is at least set more favorably than we've had it in the past. All that is on the plus side." — *Chair Volcker*
[2] July 6-7, 1981	Inflation	**FOMC transcript** "I haven't much doubt in my mind that it's appropriate in substance to take the risk of more softness in the economy in the short run than one might ideally like in order to capitalize on the anti-inflationary momentum to the extent it exists." — *Chair Volcker*
[3] October 5, 1982	Employment	**FOMC transcript** "In any event, as a setting for reaching a policy decision or a broader discussion first, ... A large part of that, of course, is the domestic business situation, which we've just gone over to some extent. We can discuss it further but I don't have anything particular to add there. We have been disappointed at least on the timing of the recovery. The inflation picture is going well but the business picture certainly is not. Everybody looks to the consumer. I don't see any place else to look." — *Chair Volcker*
[4] July 2–3, 1996	Employment	**FOMC transcript** "I for one would need to see either a decline in the unemployment rate below its recent range or an acceleration in core inflation measures to justify a tightening. ... I wonder if it would not be useful to think of NAIRU more as a range than as a point–say, 5-1/2 to 6 percent. If the unemployment rate remains within this range, then there is no case for intervening." — *Governor Meyer*
[5] September 16, 2003	Employment	**FOMC transcript** "So what's our problem? ... in the short run, the biggest puzzle is the strange performance of employment. ... Until the 1990s, employment was considered a coincident indicator ... Employment did lag output in the recovery of the early 1990s but not by nearly as much as today. What I think is less debatable is that the implied output gaps could also pull inflation down below our target range— the proverbial unwelcome fall in inflation. There's both an optimistic and a pessimistic explanation for this unusual behavior of employment." — *Governor Gramlich*
[6] June 25, 2008	Inflation	**FOMC transcript** "My bottom line is that I think the tail risks on the growth and financial side have moderated. I do think, however, that they remain significant. We cannot ignore them. I'm also becoming concerned about the inflation side, and I think our rhetoric, our statement, and our body language at this point need to reflect that concern. We need to begin to prepare ourselves to respond through policy to the inflation risk; but we need to pick our moment, and we cannot be halfhearted. When the time comes, we need to make that decision and move that way because a halfhearted approach is going to give us the worst of both worlds." — *Chair Bernanke*
[7] May 1, 2019	Inflation	**FOMC transcript** " Nonetheless, after a year with unemployment well below most current estimates of its natural rate, it is disappointing that we are once again explaining away an unanticipated softening in inflation on the basis of transient factors. This pattern suggests the possibility of downside risk to longer-term inflation expectations and, therefore, to our ability to achieve our symmetric inflation goal on a sustained basis." — *Chair Powell*

further in the mid-2000s and stayed elevated after the Great Recession, in line with the statements of FOMC members.

6 Conclusion

We estimate FOMC meeting participants' sentiment regarding the labor market, inflation, and financial conditions using text data from FOMC meeting transcripts. Based on topic-specific sentiment, we infer the FOMC members' perceived reference levels of full employment, inflation, and financial conditions—as well as the deviations from these levels—at each point in time using a state-space model. While estimates of reference levels are broadly consistent with statistical trend estimates, FOMC members had consistently lower estimate of the reference level of inflation between 1976 and 1982 including the Volcker dis-inflationary period than the statistical trend estimate based on only the realized macro data. In addition, the reference level of the full employment was lower during the 1990s than the statistical trend estimate. These occasional discrepancies highlight the difference between the real-time assessment by FOMC members and information from the ex-post realized data.

Incorporating these estimates into a Taylor rule, we find that the committee adjusts the policy interest rate in response to the deviation of employment from their perceived reference level and their perceived inflation trend, although the relative emphasis varies over time. The weights on the dual mandate are similar prior to the mid-1990s, shifts toward reducing the deviation of employment from its reference level and the inflation trend starting in the mid-1990s, and then mainly stabilizing inflation trend after the Great Recession and during the zero-lower-bound period. The degree of interest-rate smoothing, typically high, steps up further in the post–Great Recession period.

Table 3: Remarks on the FOMC's Preferences over monetary policy gradualism

Date	Preference	Source, Quotation, Speaker
[1] July 19, 1977	Gradualism	**FOMC transcript** "Now, to announce to the world that we are continuing the policy of moving our targets gradually downward is, I believe, a healthy thing." — *Chair Burns*
[2] October 6, 1979	⇓ Gradualism	**FOMC transcript (Saturday night massacre)** "Every time the interest rate goes up by a small amount [bankers] say okay, we'll raise the prime rate. Whatever you do is inadequate–you, the Federal Reserve– and we'll go along. We have access to liquidity at a fairly fixed federal funds rate–the rate isn't going to change all that abruptly– and you're not having much impact on market thinking or on market confidence in your ability to keep the money supply under control. I am not saying that that reasoning is correct but I think it is the reasoning in the market psychologically. So we run a risk, almost whatever we do, that [in response] to next week's changes they will say: "It's not quite enough; the interest rates should be a little higher. The Fed undershot again." And we won't get the psychological impact we are looking for. So there may be something to [be gained in] a change in the psychological atmosphere that in some sense will give us more bang for the buck, as I put it. It's possible." — *Chair Volcker*
[3] Spring 1988	⇑ Gradualism	**Senate Testimony** "Consequently, the FOMC applied increased restraint to reserve positions in a series of steps beginning in the spring of 1988 and extending to the current period." — *Chair Greenspan*
[4] February 23, 2000	Gradualism	**Senate Testimony** "The Fed was eager to tighten monetary policy gradually … we are trying to sustain this extraordinary recovery … in a manner which continues to absorb new people coming on the work force." — *Chair Greenspan*
[5] May 20, 2004	Gradualism	**Speech** "Less variable short-term rates reduce the risk that the policy rate will hit the zero lower bound on interest rates; they may also reduce stress in the financial system… the FOMC can attempt to minimize bond-market stress … by adopting regular and easily understood policy strategies. In the latter respect, gradualism may be helpful to some degree, because it establishes a relatively forecast-able pattern of adjustment by the central bank." — *Governor Bernanke*
[6] December 12, 2012	Gradualism	**FOMC press Conference (Forward Guidance Era)** "My anticipation is that the removal of accommodation after the takeoff point, whenever that occurs, would be relatively gradual. I don't think we're looking at a rapid increase." — *Chair Bernanke*
[7] June 13, 2018	Gradualism	**FOMC press conference** "For the past few years, we have been gradually raising interest rates, and along the way we've tried to explain the reasoning behind our decisions. In particular, we think that gradually returning interest rates to a more normal level as the economy strengthens is the best way the Fed can help sustain an environment in which American households and businesses can thrive. " — *Chair Powell*

References

Hie Joo Ahn and James D. Hamilton. Heterogeneity and unemployment dynamics. *Journal of Business & Economic Statistics*, 38(3):554–569, 2020.

Hie Joo Ahn, Taeyoung Doh, and Thomas Cook. Bargaining over words? text analysis of a model of monetary policy by a committee. *mimeo*, 2025.

Mikael Apel and Marianna Blix Grimaldi. How informative are central bank minutes? *Review of Economics*, 65(1):53–76, April 2014. doi: 10.1515/roe-2014-0104.

Ben Bernanke. The Taylor Rule: A benchmark for monetary policy? Technical report, The Hutchins Center on Fiscal and Monetary Policy, Brookings Insitutition, April 2015. URL `https://www.brookings.edu/blog/ben-bernanke/2015/04/28/the-taylor-rule-a-benchmark-for-monetary-policy/`.

Marc Dordal i Carreras, Olivier Coibion, Yuriy Gorodnichenko, and Cooper Howess. In their own words: Policy rules as told by fomc transcripts. mimeo, 2025.

Joshua Chan, Gary Koop, Dale J. Poirier, and Justin L. Tobias. *Bayesian Econometric Methods*. Number 9781108437493 in Cambridge Books. Cambridge University Press, 2019.

Hess Chung, Jean-Philippe Laforte, David Reifschneider, and John C. Williams. Have We Underestimated the Likelihood and Severity of Zero Lower Bound Events? *Journal of Money, Credit and Banking*, 44:47–82, February 2012. doi: j.1538-4616.2011.00478.x.

Olivier Coibion and Yuriy Gorodnichenko. Why are target interest rate changes so persistent? *American Economic Journal: Macroeconomics*, 4(4):126–62, May 2012. doi: 10.1257/mac.4.4.126. URL `https://www.aeaweb.org/articles?id=10.1257/mac.4.4.126`.

Taeyoung Doh, Joseph W. Gruber, and Dongho Song. Leaning against the data: Policymaker communications under state-based forward guidance. Research Working Paper RWP 22-11, Federal Reserve Bank of Kansas City, Kansas City, MO, September 2022. URL `https://doi.org/10.18651/RWP2022-11`.

Taeyoung Doh, Dogho Song, and Shu-Kuei Yang. Deciphering the Fed Communication via Text-Analysis of Alternative FOMC Statements. Working Paper ?, Federal Reserve Bank of Kansas City, 2025.

Gregory Duffee. Inertia in the fed's monetary policy rule. *mimeograph*, 2025.

Christopher J. Erceg and Andrew T. Levin. Labor Force Participation and Monetary Policy in the Wake of the Great Recession. *Journal of Money, Credit and Banking*, 46(S2):3–49, October 2014. doi: 10.1111/jmcb.12151.

Gregory E. Givens. Estimating Central Bank Preferences under Commitment and Discretion. *Journal of Money, Credit and Banking*, 44(6):1033–1061, September 2012. doi: 10.1111/j.1538-4616.2012.

Pelin Ilbas. Revealing the preferences of the US Federal Reserve. *Journal of Applied Econometrics*, 27(3):440–473, April 2012.

Klodiana Istrefi. In Fed Watchers' Eyes: Hawks, Doves and Monetary Policy. Working Paper 725, Banque de France, March 2019. URL `https://ideas.repec.org/p/bfr/banfra/725.html`.

Aeimit Lakdawala. Changes in Federal Reserve preferences. *Journal of Economic Dynamics and Control*, 70:124–143, June 2016. URL `https://www.sciencedirect.com/science/article/pii/S0165188916301087`.

Tim Loughran and Bill McDonald. When is a liability not a liability? textual analysis, dictionaries, and 10-ks. *The Journal of Finance*, 66(1):35–65, 2011. ISSN 00221082, 15406261. URL http://www.jstor.org/stable/29789771.

Michael T. Owyang and Garey Ramey. Regime switching and monetary policy measurement. *Journal of Monetary Economics*, 51(8):1577–1597, November 2004.

Glenn D. Rudebusch and John C. Williams. A wedge in the dual mandate: Monetary policy and long-term unemployment. *Journal of Macroeconomics*, 47(PA):5–18, 2016. doi: 10.1016/j.jmacro.2015.05.

Adam Hale Shapiro and Daniel J. Wilson. Taking the fed at its word: A new approach to estimating central bank objectives using text analysis. *The Review of Economic Studies*, 89(5):2768–2805, 2022. doi: 10.1093/restud/rdab094. URL https://doi.org/10.1093/restud/rdab094.

James H. Stock and Mark W. Watson. Core inflation and trend inflation. *Review of Economics and Statistics*, 98(4):770–784, 2016. doi: 10.1162/REST_a_00560.

John B. Taylor. Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series on Public Policy*, 39(1):195–214, December 1993. URL https://ideas.repec.org/a/eee/crcspp/v39y1993ip195-214.html.

Halbert White. Maximum likelihood estimation of misspecified models. *Econometrica*, 50(1):1–25, 1982.

Jing Cynthia Wu and Fan Dora Xia. Measuring the macroeconomic impact of monetary policy at the zero lower bound. *Journal of Money, Credit and Banking*, 48(2-3):253–291, 2016.

A Appendix

A.1 State space model

Section A.1.1 describes the model, and Section A.1.2 outlines the computation of standard errors and confidence intervals for the smoothed estimates.

A.1.1 Model

State Equation Let $\boldsymbol{\xi}_t$ be the vector of latent variables at t, $\boldsymbol{\xi}_t = [g_t^e, g_t^\pi, g_t^f, e_t^*, \pi_t^*, f_t^*]'$. Since the trend EPOP ratio follows an integrated random walk, the state equation should describe the evolution of $[\boldsymbol{\xi}_t', \boldsymbol{\xi}_{t-1}']'$ as follows.

$$\begin{bmatrix} \boldsymbol{\xi}_t \\ \boldsymbol{\xi}_{t-1} \end{bmatrix} = \underbrace{\begin{bmatrix} \boldsymbol{\varrho}_1 & \boldsymbol{\varrho}_2 \\ \boldsymbol{I} & \boldsymbol{0} \end{bmatrix}}_{\boldsymbol{F}} \begin{bmatrix} \boldsymbol{\xi}_{t-1} \\ \boldsymbol{\xi}_{t-2} \end{bmatrix} + \begin{bmatrix} \boldsymbol{\epsilon}_t \\ \underbrace{\boldsymbol{0}}_{6\times 1} \end{bmatrix},$$

where the identity and zero matrices in $\boldsymbol{F}$ are (6×6) matrices, and ϱ_1 and ϱ_2 have the following structure:

$$\varrho_1 = \underbrace{\begin{bmatrix} \rho_1^e & 0 & 0 & 0 & 0 & 0 \\ 0 & \rho_1^\pi & 0 & 0 & 0 & 0 \\ 0 & 0 & \rho_1^f & 0 & 0 & 0 \\ 0 & 0 & 0 & 2 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}}_{6\times 6}, \quad \varrho_2 = \underbrace{\begin{bmatrix} \rho_2^e & 0 & 0 & 0 & 0 & 0 \\ 0 & \rho_2^\pi & 0 & 0 & 0 & 0 \\ 0 & 0 & \rho_2^f & 0 & 0 & 0 \\ 0 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}}_{6\times 6},$$

and the covariance matrix

$$\begin{bmatrix} \boldsymbol{\epsilon}_t \\ \boldsymbol{0} \end{bmatrix} \sim N\left(\begin{bmatrix} \underbrace{\boldsymbol{0}}_{6\times 1} \\ \boldsymbol{0} \end{bmatrix}, \begin{bmatrix} \boldsymbol{Q} & \underbrace{\boldsymbol{0}}_{6\times 6} \\ \boldsymbol{0} & \boldsymbol{0} \end{bmatrix} \right).$$

Measurement Equation

The measurement equation relates the data to latent state variables. Let $\boldsymbol{y}_t$ denote the vector of six observable variables, $\boldsymbol{y}_t = [S^e_t, S^\pi_t, S^f_t, e_t, \pi_t, f_t]'$. The measurement equation is written as follows:

$$\boldsymbol{y}_t = \boldsymbol{h}_0 + \boldsymbol{H}\boldsymbol{\xi}_t + \boldsymbol{r}_t, \quad \boldsymbol{r}_t \sim N(\mathbf{0}, \boldsymbol{R}),$$

where $\boldsymbol{h}_0$ is a (6×1) vector of constants and $\boldsymbol{H}$ is a matrix of coefficients. The matrix $\boldsymbol{H}$ is written as follows:

$$\boldsymbol{h}_0 = \begin{bmatrix} c_e \\ c_\pi \\ c_f \\ 0 \\ 0 \\ 0 \end{bmatrix}, \quad \boldsymbol{H} = \begin{bmatrix} b_e & 0 & 0 & 0 & 0 & 0 \\ 0 & b_\pi & 0 & 0 & 0 & 0 \\ 0 & 0 & b_f & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 1 & 0 \\ 0 & 0 & 1 & 0 & 0 & 1 \end{bmatrix}.$$

The six measurement errors have zero mean and are mutually independent, with a diagonal covariance matrix denoted by $\mathbf{R}$. Denoting the vector of measurement errors, $\boldsymbol{r}_t = [r_{e,t}, r_{\pi,t}, r_{f,t}, r^s_{e,t}, r^s_{\pi,t}, r^s_{f,t}]'$, the vector of measurement errors is assumed to be normally distributed as follows:

$$\boldsymbol{r}_t \sim N(\mathbf{0}, \mathbf{R}),$$

$$\mathbf{R} = \begin{bmatrix} R_e & 0 & 0 & 0 & 0 & 0 \\ 0 & R_\pi & 0 & 0 & 0 & 0 \\ 0 & 0 & R_f & 0 & 0 & 0 \\ 0 & 0 & 0 & R_{se} & 0 & 0 \\ 0 & 0 & 0 & 0 & R_{s\pi} & 0 \\ 0 & 0 & 0 & 0 & 0 & R_{sf} \end{bmatrix}$$

For the initial value for the Kalman filter, we assume large uncertainties surrounding the estimate of initial vector $(\bar{\xi}_0)$. Our initial guess is then $\hat{x}_{1|0} = \iota_2 \otimes \bar{\xi}_0$ where ι_2 denotes a (2×1) vector of ones.[20] Diagonal elements of $P_{1|0}$ determine how much the presample values of ξ_l are allowed to differ from this initial guess $\hat{\xi}_{l|0}$. For this we set $E(\xi_l - \hat{\xi}_{l|0})(\xi_l - \hat{\xi}_{l|0})' = c_0 I_2 + (1-l)c_1 I_2$ with $c_0 = 1$ and $c_1 = 0.1$. The value for c_0 is quite large relative to the range of $\xi_{jt|T}$ over the complete observed sample, ensuring

[20] Discussions on the initial value are largely borrowed from Ahn and Hamilton [2020].

that the particular value we specified for $\hat{x}_{1|0}$ has little influence. For $k < l$ we specify the covariance $E(\xi_l - \bar{\xi}_0)(\xi_k - \bar{\xi}_0)' = E(\xi_k - \bar{\xi}_0)(\xi_l - \bar{\xi}_0)'$.[21] The small value for c_1 forces presample ξ_l to be close to ξ_k when l is close to k, again consistent with the observed month-to-month variation in $\hat{\xi}_{t|T}$.

A.1.2 Standard errors and confidence intervals

We calculated standard errors for the estimate $\hat{\theta}$ as in equation (3.13) in Hamilton (1994):

$$E(\hat{\theta} - \theta)(\hat{\theta} - \theta)' \simeq V = K_1^{-1} K_2 K_1^{-1}$$

$$K_1 = \left.\frac{\partial \ell(\theta)}{\partial\theta\partial\theta'}\right|_{\theta=\hat{\theta}}$$

$$K_2 = {}_{t=1}^{T} \left\{ \left[\left.\frac{\partial \ln f(y_t | Y_{t-1}; \theta)}{\partial\theta}\right|_{\theta=\hat{\theta}} \right] \left[\left.\frac{\partial \ln f(y_t | Y_{t-1}; \theta)}{\partial\theta}\right|_{\theta=\hat{\theta}} \right]' \right\}.$$

The standard errors used for the smoothed estimates incorporate both filter and parameter uncertainty. The matrix $P_{t|T}$ summarizes uncertainty we would have about x_t even if we knew the true value of the parameters in θ. Given that we also have to estimate θ, the true uncertainty is greater than that represented by $P_{t|T}$. Following Ansley and Kohn (1986) we calculate the total variance as

$$P_{t|T}\big|_{\theta=\hat{\theta}} + Z_t V Z_t^{'}$$

$$\underset{(4\times12)}{Z_t} = \left.\frac{\partial \hat{x}_{t|T}}{\partial\theta'}\right|_{\theta=\hat{\theta}}.$$

The values of $\{Z_t\}_{t=1}^{T}$ can be found by numerical differentiation, e.g., replace $\hat{\theta}$ with $\hat{\theta} + \delta e_i$ and e_i the ith column of I_{12} and then redo the iteration to calculate $\hat{x}_{t|T}(\hat{\theta} + \delta e_i)$. The ith column of Z_t is then $\delta^{-1}[\hat{x}_{t|T}(\hat{\theta} + \delta e_i) - \hat{x}_{t|T}|(\hat{\theta})]$.[22]

A.2 Parameter Estimates

Table A.1 reports the parameter estimates along with the standard errors.

[21] In other words,

$$P_{1|0} = \begin{bmatrix} c_0 I_4 & c_0 I_4 & c_0 I_4 \\ c_0 I_4 & c_0 I_4 + c_1 I_4 & c_0 I_4 + c_1 I_4 \\ c_0 I_4 & c_0 I_4 + c_1 I_4 & c_0 I_4 + 2c_1 I_4 \end{bmatrix}.$$

[22] This section is largely borrowed from the appendix of Ahn and Hamilton [2020].

Table A.1: PARAMETER ESTIMATES

Notation	Parameter	SE	t-stat
ρ_1^e	1.48	0.23	6.28
ρ_1^π	1.09	0.12	9.01
ρ_1^f	0.97	0.36	2.66
ρ_2^e	-0.53	0.19	-2.78
ρ_2^π	-0.13	0.12	-1.06
ρ_2^f	-0.02	0.33	-0.05
c_e	2.23	0.18	12.75
c_π	1.1	0.9	1.23
c_f	2.01	0.28	7.07
b_e	-0.32	0.19	-1.69
b_π	1.66	0.3	5.51
b_f	0.59	0.17	3.43
Q1	0.05	0.03	1.87
Q2	0.08	0.05	1.58
Q3	0.16	0.22	0.71
Q4	0	0	0.61
Q5	0.04	0.01	4.43
Q6	0	0	2.52
R1	0.92	0.24	3.89
R2	0	0.02	0
R3	0.53	0.16	3.24
R4	0	0.01	0
R5	0.49	0.1	5.15
R6	0.01	0.1	0.11
"$\xi_{0,1}$"	-5.85	2.81	-2.08
"$\xi_{0,2}$"	2.2	0.68	3.24
"$\xi_{0,3}$"	0.07	0.7	0.11
"$\xi_{0,4}$"	62.76	2.81	22.31
"$\xi_{0,5}$"	3.56	1.11	3.21
"$\xi_{0,6}$"	-0.66	0.7	-0.94
No-obs	175		
Log-Likelihood	-857.72		

Note to table: The standard errors are computed based on White [1982]. Zero estimates are due to rounding; the exact values are nonzero.

Source: Authors' calculation.