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ABSTRACT

Uncertainty is a ubiquitous concern emphasized by policymakers. We study how uncertainty affects decision-making by the Federal Open Market Committee (FOMC). We distinguish between the notion of Fed-managed uncertainty vis-a-vis uncertainty that emanates from within the economy and which the Fed takes as given. A simple theoretical framework illustrates how Fed-managed uncertainty introduces a wedge between the standard Taylor-type policy rule and the optimal decision. Using private Fed deliberations, we quantify the types of uncertainty the FOMC perceives and their effects on its policy stance. The FOMC's expressed inflation uncertainty strongly predicts a more hawkish policy stance that is not explained either by the Fed's macroeconomic forecasts or by public uncertainty proxies. We rationalize these results with a model of inflation tail risks and argue that the effect of uncertainty on the FOMC's decisions reflects policymakers' concern with maintaining credibility for the inflation anchor.

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A data appendix is available at http://www.nber.org/data-appendix/w31849
Data link is available at http://feduncertainty.com/

I. Introduction

Alan Greenspan famously said, "(...) uncertainty is not just a pervasive feature of the monetary policy landscape; it is the defining characteristic of that landscape" (Greenspan, 2004). Yet, despite the ubiquitous emphasis on uncertainty in central bankers' speeches and statements, we know little about how policymakers' uncertainty perceptions and, more broadly, their beliefs about higher-order moments of economic outcomes affect policy decisions. In this paper, we evaluate how uncertainty affects policymaking in the context of the Federal Open Market Committee (FOMC).

In a frequently-quoted result, Brainard (1967) postulated that policymakers should adopt a more conservative stance when faced with uncertainty about policy transmission. However, the effect of uncertainty on monetary policy has since been shown to be model-specific. Depending on the assumptions about the structure of the economy and policymakers' preferences, uncertainty can induce a more or less aggressive optimal policy response or no response at all.[1]

To lay out the channels through which uncertainty can impact policymaking at the Fed, we use a simple theoretical framework delineating between two notions of uncertainty. The first, which we refer to as Fed-managed uncertainty, is uncertainty about the variables that the Fed targets (such as output and inflation) that is influenced by the policy choice itself. The second type, which we generically label as economic uncertainty, emanates from uncertainty in the economy or financial markets, but importantly, it is exogenous to policy.

We provide new empirical results on how the different uncertainty types affect the Fed's behavior. Fed-managed uncertainty is one reason why policymakers may deviate from the standard Taylor-type policy prescriptions. While many existing models of monetary policy under uncertainty implicitly capture Fed-managed uncertainty, the ambiguous predictions from this literature are easy to illustrate in our framework, leaving mixed guidance for what to expect empirically. We first document that policymakers' perceptions of increased *inflation uncertainty* in particular predict a significantly more hawkish policy stance, beyond what traditional policy rules would indicate, and in contrast to Brainard (1967) conservatism. To rationalize this finding, we then argue that a prominent source of Fed-managed uncertainty relates to the FOMC's concern about inflation tail risk, i.e., unlikely but costly outcomes, whose probability depends on policy choice. Narrative evidence suggests that Fed-managed

[1] The models characterizing optimal rules under uncertainty can be broadly divided into two strands, see, e.g., Blinder (1999), Rudebusch (2001), Walsh (2003), and Bernanke (2007) for discussion of this literature. Following Brainard (1967), one strand considers Bayesian policymakers facing parameter uncertainty, e.g., Söderström (2002), Kimura and Kurozumi (2007), highlighting the non-robustness of the conservatism result. The other strand derives from the literature on model uncertainty considering a robust-control policymaker (e.g., Hansen and Sargent, 2001; Giannoni, 2007; Onatski and Stock, 2002; Levin and Williams, 2003).

uncertainty of this kind has been a hallmark of the Fed's decision-making since the late 1980s and that policymakers are especially worried about the risk of losing credibility if they do not take a strong enough stance on inflation.

The challenges to understanding the relationship between uncertainty and policymaking pertain to both measuring policymakers' perceptions of uncertainty and disentangling their effect from other confounders, most importantly, the first-moment beliefs about the state of the economy. The critical aspect of our analysis stems from inferring policymakers' beliefs directly from their internal private deliberations. By analyzing the transcripts of the scheduled FOMC meetings, containing nearly verbatim statements by individual FOMC members and the Fed staff between 1987 and 2015, we obtain a granular view of the Fed's policy process.

We develop three types of text-based measures to capture otherwise hard-to-quantify dimensions of policymaking. First, and most important for our analysis, we generate textual indices of policymakers' uncertainty—PMU, for short—distinguishing their perceived uncertainty about inflation and the real economy, as our main indices. Additionally, we also measure uncertainty about financial markets and models, and a residual unclassified uncertainty. For a precise attribution, we develop algorithms that match uncertainty phrases, obtained via word embeddings, with topic-specific phrases at a sentence level. Second, we construct proxies of policymakers' sentiments reflecting their directional views on the real economy and inflation. Finally, to analyze the effects of these perceptions on policy, we develop a new textual gauge of the policy stance based on the balance of hawkish and dovish language of the FOMC members: the hawk-dove (HD) score. The textual approach enables us to elicit a broad notion of policy stance encompassing forward-looking views beyond the current policy rate and is consistently available over the entire 1987–2015 sample, including the zero-lower-bound episode.[2]

To derive the above measures, we exploit the typical structure of the FOMC meetings. The meetings during our sample are comprised of two main rounds of deliberations, each serving different objectives. In the first round, which we refer to as the economy round, policymakers discuss economic and financial market developments and the baseline outlook. This step lays the foundation for the second round—the policy round—which contains discussions about the appropriate policy choice and during which the policy decision takes place. We thus study how uncertainty and sentiment that manifest in the economy round affect the FOMC's stance communicated in the policy round. The statements in the transcripts are

[2]We document that the hawk-dove score based on internal FOMC deliberations is a highly significant predictor of the federal funds rate (FFR) target. Importantly, its predictive power for the FFR is not subsumed by the Greenbook forecasts that are usually included in estimated Taylor rules, which implies that the policy stance derived from the text reflects in large part deviations from the standard policy rule.

individually attributed, allowing us to study the decision-making not only at the level of the entire committee, but also its individual members, and to delineate the differences between the FOMC and the staff.

Our core empirical finding is that policymakers' perception of higher inflation uncertainty in the economy round—higher inflation PMU—predicts a more hawkish (tighter) policy stance in the meeting. This result remains robust to controlling for various plausible confounding factors, including the Greenbook forecasts and public uncertainty measures such as the VIX or economic policy uncertainty index of Baker et al. (2016). The magnitude is economically large: A one standard deviation increase in FOMC members' inflation PMU predicts a 0.18 standard deviation more hawkish policy stance expressed in the FOMC's language, in the most restrictive specification with a host of controls. Inflation PMU is also quantitatively important for the Fed's actual policy choice. Its effect on the federal funds rate (FFR) accumulates with horizon reaching 31 basis points at eight meetings ahead, or roughly 1.5 times the size of a typical interest rate increase, per one-standard-deviation increase in the FOMC's inflation PMU. A similar result continues to hold for the sample extended through the zero-lower-bound period using a shadow rate. The magnitude of the cumulative impact of inflation PMU exceeds that of the Greenbook/Tealbook economic forecasts, typically viewed as key determinants of policy action.

Importantly, the effect of policymakers' inflation uncertainty is distinct from that of their perceived uncertainty about the real economy. Contrary to inflation PMU, we find that an increased real-economy PMU in the economy round predicts an easier policy stance, and it is largely driven out by controlling for Greenbook macroeconomic forecasts and measures of public uncertainty. This suggests that real-economy PMU describes uncertainty that policymakers take as given by the economic environment, and respond to it via its effect on the expected economic conditions. This interpretation of the real-economy PMU is consistent with models studying economic uncertainty outside the Fed (Bloom, 2009; Basu and Bundick, 2017), where increased uncertainty acts as a negative demand shock and operates through reduced economic growth forecasts. The different ways in which inflation PMU and real-economy PMU are linked to policy stance highlight the need to distinguish the implications of economic uncertainty versus Fed-managed uncertainty.

The directional and independent effect of inflation PMU on policy stance leads us to revisit several candidate interpretations of Fed-managed uncertainty in setting policy. In particular, we argue that the Brainard (1967)-style parameter uncertainty is unlikely to explain our results. Indeed, while models of this kind predict that uncertainty can induce a more conservative (or more activist) behavior relative to a certainty-equivalence benchmark, they do not imply a clear directional effect of uncertainty on policy that we find. To rationalize the empirical findings, we propose an alternative channel building on the idea of inflation scares (e.g., Goodfriend, 1993), whereby policymakers are concerned about low-probability high inflation outcomes that could arise from their policy choices. We develop a stylized model, in which the effect of Fed-managed uncertainty on policy stems from the policymakers' perceptions of policy-dependent inflation tail risk. The tail risk idea rationalizes why higher PMU induces a more hawkish policy stance. Consistent with the model predictions, we show that inflation PMU tends to comove positively with current beliefs of rising inflation, and the effect of inflation PMU on policy stance emerges most strongly when expected inflation exceeds the target.

More broadly, our results suggest that the FOMC members' desire to maintain credibility for inflation control has been an important driver of their decisions. Consistent with credibility concerns introducing a wedge between the objective and policymakers' perceived uncertainty, we document that the FOMC members' inflation PMU is distinct from that of the Fed staff, and the PMU's impact on policy stance is entirely driven by the views of the FOMC members. Given that neither PMU nor directional inflation sentiment significantly predicts future inflation outcomes, policymakers' inflation beliefs in the meeting are an expression of concern that does not materialize in the sample we study. We present narrative evidence from the transcripts' language consistent with the credibility channel.

We draw on multiple strands of empirical and theoretical literature. Rather than providing a stand-alone literature review, we discuss the connections between our work and related literature throughout the paper. The implications of our analysis are likewise far-reaching. Our results suggest that policymakers' inflation uncertainty is time-varying and fluctuates with inflation conditions. Concerns about FOMC's perceived ability to control inflation, which have come to the fore of policy discussions again recently, are generally not captured empirically or theoretically by standard approaches to the monetary reaction function.

The rest of the paper is structured as follows. Section II introduces a conceptual framework through which we summarize the channels in the literature linking uncertainty and monetary policy. Section III discusses the data and the measurement. Section IV empirically analyzes the relationship between uncertainty and policy stance. Section V interprets the results within an inflation tail risk model, and provides narrative evidence linking the Fed's uncertainty perceptions with credibility concerns. Section VI concludes.

II. Uncertainty and Optimal Monetary Policy

To clarify the impact of uncertainty on monetary policy, we introduce a simple static framework describing the policymaker's decision problem. We use this framework to summarize the leading uncertainty channels in the literature and to guide our empirical analysis.

We assume that the policymaker has a standard quadratic loss function over deviations of inflation from the target and the output gap

$$L(\pi_t, y_t) = (\pi_t - \pi^*)^2 + \lambda(y_t - y^*)^2, \tag{1}$$

where π_t is period t inflation, π^* is the inflation target, y_t is period t output, and y^* is medium-term potential output. While the typical policy choice focuses on setting the nominal interest rate, we view r_t more broadly as subsuming a range of instruments the policymaker uses to achieve their goals, including asset purchases and forward guidance, in addition to the nominal interest rates. Thus, a tighter policy stance could reflect higher nominal interest rates, quantitative tightening, or a credible change in the communicated interest rate outlook.

Inflation and output are random variables, and the policymaker chooses r_t relative to a neutral level to minimize expected losses. The expectation of the loss function (1) is

$$\mathbb{E}\left[\, L(\pi_t, y_t)\,\right] = \left(\mathbb{E}\left[\,\pi_t\,\right] - \pi^*\right)^2 + \sigma_{\pi,t}^2 + \lambda\left(\mathbb{E}\left[\,y_t\,\right] - y^*\right)^2 + \lambda\sigma_{y,t}^2, \tag{2}$$

where the $\sigma_{\cdot,t}^2$ terms denote variances. Since the period t objective depends on the inflation and output distributions solely via their means and variances, these are the key moments to specify. In keeping with many macro models, we assume the means of output and inflation are decreasing in r_t and satisfy $\mathbb{E}\left[\,\pi_t\,\right] = \overline{\pi}_t - a_\pi r_t$ and $\mathbb{E}\left[\,y_t\,\right] = \overline{y}_t - a_y r_t$ where $a_\pi, a_y > 0$ and $\overline{\pi}_t, \overline{y}_t$ capture the component of macroeconomic expectations that are driven by factors pre-determined with respect to r_t. The dependence of the first moments on policy reflects the standard notion that the Fed manages macroeconomic expectations. Less standard is that we allow the variance terms to also depend on r_t, thus extending the idea to incorporate Fed-managed uncertainty. For now, we do not specify the precise channel leading to this dependence but simply seek to illustrate its potential effects on policy choices. In Section V, we propose a specific model of tail risks, in which r_t changes the probability of tail-event outcomes.

The policymaker's first-order condition yields the optimal policy:

$$\widehat{r}_t = \frac{a_\pi}{\overline{a}}(\overline{\pi}_t - \pi^*) - \frac{1}{2\overline{a}}\left(\frac{\partial \sigma_{\pi,t}^2}{\partial r_t}\right)_{r_t=\widehat{r}_t} + \lambda\left[\frac{a_y}{\overline{a}}(\overline{y}_t - y^*) - \frac{1}{2\overline{a}}\left(\frac{\partial \sigma_{y,t}^2}{\partial r_t}\right)_{r_t=\widehat{r}_t}\right], \tag{3}$$

where we define $\overline{a} \equiv a_\pi^2 + \lambda a_y^2$. The policy rule (3) clarifies that, in line with the usual intuition, the policy is tighter ($\widehat{r}_t$ increases) when baseline expected inflation $\overline{\pi}_t$ and output

$\overline{y}_t$ are above targets.[3] In addition, $\widehat{r}_t$ also depends on how policy impacts uncertainty via the $\frac{\partial \sigma^2_{\cdot,t}}{\partial r_t}$ terms. Intuitively, these terms represent shifters that affect the "burden of proof" policymakers need in order to tighten policy. That is, the same expected inflation and output gaps could be associated with a tighter or looser policy, depending on the nature and sign of the relationship between policy and volatility. To guide our subsequent analysis, we focus on three broad cases considered in the literature.

1. Certainty Equivalence. We refer to certainty equivalence as a situation in which uncertainty is irrelevant to decision-making. The central bank reacts to its assessment of the economy in the same way, no matter if uncertainty about economic outcomes is high or low. Suppose that inflation and output are not subject to uncertainty and relate to r_t deterministically via the relationships $\pi_t = \overline{\pi}_t - a_\pi r_t$ and $y_t = \overline{y}_t - a_y r_t$, respectively. The policy rule (3) then simplifies to

$$\widehat{r}_t = \frac{a_\pi}{\overline{a}}(\overline{\pi}_t - \pi^*) + \lambda \frac{a_y}{\overline{a}}(\overline{y}_t - y^*). \tag{4}$$

The same decision rule as (4) emerges when inflation and output are subject to some baseline uncertainty, but this uncertainty is not related to the policy choice, i.e., $\frac{\partial \sigma^2_{\pi,t}}{\partial r_t} = 0$ and $\frac{\partial \sigma^2_{y,t}}{\partial r_t} = 0$ for all r_t. As such, certainty equivalence obtains when uncertainty in the economic environment is exogenous to the policy itself. This situation arises in classic monetary models in which the policymakers' losses are quadratic as in (1), and shocks affecting π_t and y_t are additive, symmetrically distributed, and independent of the policy choice (see, e.g., Blinder, 1999 for discussion of this literature). Notably, the standard Taylor rule, prescribing no role for uncertainty in policy decisions, can be derived under such conditions.

2. Uncertainty as a Negative Demand Shock. A recent literature focuses on how uncertainty impacts economic agents outside the central bank. While specific theoretical mechanisms differ, greater uncertainty about the real economy tends to act similarly to a negative demand shock, which causes a drop in employment and output (e.g., Bloom, 2009; Basu and Bundick, 2017; Leduc and Liu, 2016).[4] An increase in this type of uncertainty is associated with a loosening of monetary policy, even though uncertainty shocks in these models are exogenous to policy. The demand shock logic does not overturn the certainty equivalence in that the optimal policy (4) still holds, but uncertainty now affects economic outcomes, to which the Fed responds.[5]

[3] This standard effect, linear in $\overline{\pi}_t, \overline{y}_t$, stems from the sensitivity of macroeconomic expectations to policy rate via $\frac{\partial (\mathbb{E}[x_t] - x^*)^2}{\partial r_t}$, $x \in \{\pi, y\}$.

[4] See also empirical evidence of Jurado et al. (2015) and Kumar et al. (2023) documenting the effects of uncertainty on the macroeconomy.

[5] We can represent this scenario by an exogenous uncertainty shifter $\zeta_t > 0$ such that the variance of output conditional on r_t is $\sigma^2_{y,t}(r_t) + \zeta_t$. Consistent with the above models, since ζ_t does not depend on r_t,

3. Fed-managed Uncertainty. Finally, uncertainty can directly influence policymakers' decisions when the policy choice affects the variance of macroeconomic outcomes. Such a situation is captured by non-zero $\frac{\partial \sigma^2_{\cdot,t}}{\partial r_t}$ terms in the policy rule (3), which we refer to as Fed-managed uncertainty. Given the expected loss function (2), the policymaker dislikes volatility in output and inflation and, therefore, chooses policy in part to reduce uncertainty. Unlike the demand channel of uncertainty described above, this effect is endogenous to policy. For example, the policymaker has an additional incentive to set a higher interest rate if hiking reduces inflation uncertainty, $\frac{\partial \sigma^2_{\pi,t}}{\partial r_t} < 0$.

The leading example of Fed-managed uncertainty arises in the classic work on optimal policy under parameter uncertainty[6] by Brainard (1967). In Brainard (1967), the policymaker faces uncertainty about policy transmission: to the extent that the policymaker only knows the distribution from which the policy multiplier is drawn, the policy effect on the economy is stochastic. The famous result—known as the Brainard conservatism—is that optimal policy should be less aggressive relative to a policy pursued under certainty. Interpreted through the lens of the expected loss function (2), conservatism arises if any decision to move interest rates leads to an increase in uncertainty, disincentivizing the policymaker to act.[7] The effect on the policy rule (3) is to raise the "burden of proof" for changing rates.

Notably, conservatism is not an unambiguous prediction of models of optimal policy under parameter uncertainty. In contrast to Brainard, Söderström (2002) emphasizes that uncertainty about inflation persistence (as opposed to policy multipliers) can induce the policymaker to become more activist. The intuition is that the policymaker faces greater uncertainty the further away inflation is from the target; they can reduce that uncertainty by decisively bringing inflation back to the target. Therefore, the optimal policy is more aggressive in attaining its goals than what the certainty equivalent rule would imply.

It is important to recognize that neither conservatism or activism of the above form delivers clear directional predictions in terms of a tighter or looser policy. A conservative (activist) policymaker is simply less (more) likely to tighten or ease policy relative to a situation in which parameters are known. More generally, however, the optimal policy (3) does not rule

it does not affect the $\frac{\partial \sigma^2_{y,t}}{\partial r_t}$ term in the policy rule (3). However, ζ_t causes the decline in the outlook for output, $\overline{y}_t(\zeta_t)$. Thus, while an increase in uncertainty via ζ_t lowers $\widehat{r}_t$, the central bank responds to it to the extent that an uncertainty shock negatively impacts expected output.

[6] Another channel is the policymakers' desire for a policy that is robust to the worst possible form of model misspecification (Hansen and Sargent, 2001, 2008; Giordani and Söderlind, 2004; Giannoni, 2002, 2007), though these models are not quite the same as the Fed-managed uncertainty that we emphasize. Robust control policymakers, in an environment of uncertainty, fear the worst-case scenario (parameterization), and as a result, the optimal policy becomes more aggressive.

[7] Mathematically, this can be captured by a $\sigma^2_{\cdot,t}$ which is convex in r_t, such that any change of r_t, whether up or down, raises $\sigma_{\cdot,t}$.

out a directional policy bias. Fed-managed uncertainty can generate a more hawkish or dovish response. For example, if raising rates unambiguously shrinks inflation uncertainty, $\frac{\partial \sigma^2_{\pi,t}}{\partial r_t} < 0$, the "burden of proof" to hike is lower, which in turn raises r_t relative to certainty equivalence. In Section V, we discuss how the presence of tail risks, which are endogenous to policy, generates a decision rule with the same qualitative structure as equation (3) and a prediction of hawkishness.

In sum, while certainty equivalence is a useful benchmark in policy analysis, there are multiple channels through which uncertainty can impact decision-making, breaking away from that benchmark. As a general insight, uncertainty should matter for the Fed's decisions only to the extent that the Fed can influence it. Such Fed-managed uncertainty motivates policymakers' deviation from the certainty equivalent rule that would otherwise prevail. Economic uncertainty exogenous to policy, instead, should not have an additional effect on policy so long as the Fed's macroeconomic expectations are adequately controlled for. Understanding the actual connection between policymakers' uncertainty perceptions and their policy decisions is an empirical question, albeit a challenging one to answer. We turn our attention to this challenge now.

III. Measuring Policymakers' Uncertainty and Policy Stance with Text

Testing whether uncertainty impacts policymaking requires a gauge of uncertainty about economic conditions that policymakers perceive as well as the policy stances they adopt. Since FOMC members' views on uncertainty are not reported in structured surveys over our whole sample period, we instead develop textual measures of policymakers' uncertainty (**PMU**) about different topics using their deliberations in the FOMC meeting transcripts.[8] In principle, the FOMC's discussion of uncertainty could reflect a variety of factors. At this stage, we measure *how much* the FOMC discusses uncertainty and delay discussing *why* it does so until later sections.

The second main measurement challenge pertains to eliciting the FOMC's policy stance. Relying on the announced policy rate is problematic for several reasons. Fed observers have noted that a given meeting's decision is largely pre-determined and that a primary purpose of FOMC deliberations is to shape forward-looking views on appropriate *future* actions (e.g., Meyer, 2004). Furthermore, public communication is an increasingly important policy tool and, thus, a subject of extensive FOMC discussion in our sample, which is not necessarily

[8] Beginning in 2007, individual member views on inflation, output, and employment are recorded in the Summary of Economic Projections (SEP) conducted every other meeting. One role of the SEP is to communicate the FOMC's views to the public, so forecasts have a signaling role. In contrast, transcripts are released with a five-year lag and capture private views, in addition to covering a longer sample period.

reflected by the current policy rate. Finally, the last years of our sample coincide with the zero lower bound (ZLB) on the policy rate, necessitating an alternative approach that consistently reflects FOMC's views before and during the ZLB. To address these challenges, we again use the FOMC's language in the transcripts to construct a novel text-based policy stance proxy, which we label as the hawk-dove score (**HD**).

The focus on private FOMC deliberations (as opposed to the Fed's public communication via statements and speeches) is the key aspect of our analysis, providing a window into the decision-making process at the Fed.[9] Below, we first review the FOMC transcript corpus that forms the basis of our constructions, followed by a description and validation of our core measures. Appendix A and B contain further details.

III.A. Transcript data

The main textual source we draw from is the nearly verbatim transcripts of Federal Open Market Committee (FOMC) meetings, available online.[10] These transcripts contain a fully attributed, statement-by-statement account of meetings with minimal editing, for example, to remove the names of specific banks with which the Fed conducts open market operations. The sample period we consider consists of the 227 meetings from August 1987 (the first meeting of Alan Greenspan's chairmanship) through December 2015 (the last meeting for which a transcript was available at the time of data processing). Regular FOMC meetings occur eight times per year. The typical composition of the FOMC consists of 19 members, of which twelve are regional Fed Presidents, and seven are Governors. During our sample, a total of 75 unique FOMC members appear in the transcripts in at least one meeting. A number of Fed staff economists also participate in the meetings.

Our measurement strategy exploits the regular structure of FOMC meetings. The first core part of the FOMC meetings is the *economy round*, which makes up 43% of the total sentences in the transcripts. The Fed staff economists first present their forecasts of economic activity (contained in Greenbooks/Tealbooks) along with supporting contextual information. Each

[9]Meade (2005) pioneers the use of transcripts to analyze the FOMC voting behavior. More recently, Hansen et al. (2018) study how transparency affects policymakers' deliberations. Shapiro and Wilson (2022) exploit the transcripts to estimate the Fed's loss function, approximating losses via the negative sentiment in the meeting's language. A separate literature explores the Fed's public communication. Lucca and Trebbi (2009), Apel and Blix Grimaldi (2012), Handlan (2020), among others, use central bank communication to measure the implied policy stance. Istrefi (2019) and Bordo and Istrefi (2023) study individual FOMC member policy preferences based on narrative records in the public media. Malmendier et al. (2021) analyze individual FOMC member policy preferences based on their public speeches.

[10]See `https://www.federalreserve.gov/monetarypolicy/fomc_historical.htm`. Only a small part of the May 1988 meeting was transcribed, so we treat it as a missing observation. The FOMC also conducts occasional special meetings convened via conference call during times of macroeconomic turbulence. Since the format of these calls is somewhat irregular, we only consider regular meetings in our analysis.

FOMC member in turn presents his or her views on economic developments, which can differ from the views of the staff. These developments can be discussed in the context of alternative interest rate paths, but FOMC members do not advocate for particular policy choices at this stage. We use the economy round to construct our PMU measures.

The second core part of the meeting is the *policy round*, which accounts for 24% of all sentences.[11] This round begins with the staff laying out different policy alternatives, after which FOMC members debate on which alternative to adopt before proceeding to a final vote. This section also includes a discussion of the public statement released along with the policy announcement. We use the policy round to measure the policy stance.

While uncertainty language might appear in the policy round in discussion of economic conditions related to policy stance, it can also reflect other factors such as hesitance about the correct policy stance, or how to communicate uncertainty to the public. In practice, separating out these distinct forms of uncertainty is a formidable challenge and, for this reason, we do not use uncertainty language in the policy round to measure uncertainty about economic conditions.

Below, we primarily focus on constructing measures at the meeting level. However, the structure of the transcripts allows us to consider more granular data by attributing each statement to individual meeting participants, which we exploit in part of the analysis. In Section IV, we distinguish between statements made by FOMC staff vs. by FOMC members, and between statements made by individual FOMC members.

III.B. Core empirical measures

III.B.1. Policymakers' uncertainty (PMU)

Our measurement of topic-specific uncertainty is based on the local co-occurrence of terms denoting uncertainty and terms denoting the topic of interest.[12] To obtain the uncertainty terms, we begin with the four seed terms 'uncertain', 'uncertainty', 'risk', and 'risks'.[13]

[11]The remainder of the transcripts, which we do not use, is largely made up of staff discussion of financial market conditions and discussion of special topics in monetary policy. The sectioning of meetings is done manually by us. One outlier in the meeting structure is the September 2009 meeting, for which the policy and economic rounds were merged into one round. In this case, we manually classify sentences as either belonging to the economy round or the policy round. For further details on the structure of FOMC meetings and the composition of the committee, see Hansen et al. (2018).

[12]The use of local co-occurrence patterns to build text-based proxies for economic phenomena has been pioneered by Mikael and Blix (2014) in the monetary policy context and by Hassan et al. (2019) to measure specific types of uncertainty in a corporate context. Our innovation is to apply these ideas to analyze the impact of perceived risk and uncertainty on policy stances.

[13]The motivation for the seeds is that 'risk' and 'risks' capture objective uncertainty, while 'uncertain' and 'uncertainty' capture Knightian uncertainty. Combining both in the discussion of economic uncertainty is

We then use a word embedding model—specifically the Continuous Bag-of-Words model (Mikolov et al., 2013)—applied to FOMC transcripts to generate an expanded set of terms.[14] A word embedding model represents each unique term in a corpus as a relatively low-dimensional vector in a vector space. Words whose vectors lie close together in the vector space share similar meanings.

In general, the neighbors are synonyms of the seeds, such as 'unclear' and 'unsure,' or terms reflecting worries and concerns, such as 'threat', 'fear', and 'wary.' The nearest neighbors can also contain generic terms not obviously related to uncertainty. We therefore further organize the lists using our domain expertise, and after removing irrelevant terms, we obtain 78 terms in total.[15] We provide fifty nearest neighbors for each of the seed words in Appendix Tables A.1 and A.2.

Our topic-specific PMU indices cover four dimensions of uncertainty that one would expect to be relevant for policymaking, as motivated by the framework in Section II: (i) inflation and (ii) real economy, as both are standard inputs into monetary policymakers' loss functions; (iii) financial markets, as market uncertainty might spill over into the real economy; and (iv) model uncertainty, in line with the theoretical literature on the role of parameter and model uncertainty in optimal policy. The term lists we use to measure topics come from our judgment[16] and are reported in Appendix Tables A.3 through A.11.

An uncertainty word in the economy round is assigned to topic k if it occurs in a sentence that also contains a topic-k keyword, or if a topic-k keyword appears in an immediately surrounding sentence. Meeting-level PMU for topic k is then the number of topic-k uncertainty words expressed as a fraction of total words spoken in the economy round overall. We denote the four meeting-level indices by $InfPMU_t$ for inflation PMU, $EcoPMU_t$ for the real-economy PMU, $MktPMU_t$ for financial markets PMU, and $ModPMU_t$ for model PMU, which can be interpreted as the intensity with which policymakers discuss topic-specific uncertainty. With uncertainty mentions that cannot be classified into a specific topic, we form a residual category, $OthPMU_t$, for other PMU. Appendix B.1 provides full details of the construction of the topic-specific PMU indices. Appendix Figure A.1 presents the distribution of terms in topic-k uncertainty sentences, establishing that the presence of one of our topic keywords in a sentence is a good indicator of its overall topical focus.

common. For example, Bloom (2014) writes: "I'll refer to a single concept of uncertainty, but it will typically be a stand-in for a mixture of risk and uncertainty."

[14]This approach follows recent studies such as Hanley and Hoberg (2019), Atalay et al. (2020), Davis et al. (2020), and Bloom et al. (2021). See Ash and Hansen (2023) for additional details.

[15]The separate lists contain substantial overlap, which is another reason for the reduction to 78 terms.

[16]The reason we use a purely manual rather than partially automated approach as for the uncertainty list is that the topical terms are largely made up of phrases, and sequence embeddings are substantially more complex to build than single word embeddings.

A. Summary statistics for PMU indices

	N	Mean	SD	P10	P50	P90	AR1
$InfPMU_t$	227	0.302	0.153	0.131	0.276	0.529	0.550
$EcoPMU_t$	227	0.388	0.138	0.226	0.386	0.566	0.463
$MktPMU_t$	227	0.222	0.149	0.071	0.180	0.426	0.571
$ModPMU_t$	227	0.066	0.044	0.018	0.061	0.119	0.107
$OthPMU_t$	227	0.282	0.135	0.128	0.260	0.456	0.481

B. Correlations of topic-specific PMU indices

	InfPMU	*EcoPMU*	*MktPMU*	*ModPMU*
EcoPMU	0.074			
MktPMU	0.122	0.375		
ModPMU	0.222	0.113	0.096	
OthPMU	-0.335	0.132	0.161	-0.209

Table I. Descriptive statistics for PMU. The table reports summary statistics for the topic-specific PMU indices. All indices are obtained from the economy round of the FOMC meeting and represent the share of uncertainty-related mentions (by topic) relative to the total number of words in the economy round of the meeting. The sample period is 1987:08–2015:12, covering 227 meetings. Panel A expresses the summary statistics for PMU in percentages (e.g., the number 0.302 for the mean inflation PMU implies that on average uncertainty-related mentions constitute 0.302% of all words in the economy round). Column "AR(1)" reports the first-order autoregressive coefficient (at the meeting frequency). Panel B reports the pairwise correlations between topic-specific PMU indices.

Table I presents summary statistics for each PMU index. The economic uncertainty topic is most common, followed by inflation and financial market uncertainty, respectively. Model uncertainty makes up a small fraction of discussions. For this reason, we focus the empirical analysis on the other three PMU indices. These have substantial independent variation that cannot be captured by a single common factor. The pairwise correlations between the three main indices are 0.07 for $InfPMU_t$ and $EcoPMU_t$, 0.12 for $InfPMU_t$ and $MktPMU_t$, and 0.38 for $EcoPMU_t$ and $MktPMU_t$.

Figure 1 plots the PMU time series. To highlight their features over time, we graph both unsmoothed series and their moving averages over the past eight meetings; in the empirical analysis, we rely on the unsmoothed series. In contrast to the countercyclical behavior which is usually expected from uncertainty indicators (Bloom, 2014), $InfPMU_t$ is strongly procyclical: it rises following each of three recessions in the sample and most quickly during the 2000s-era expansion. While $EcoPMU_t$ rises at the onsets of the bursting of the dot-com bubble and the Global Financial Crisis (GFC), its variation is also not purely countercyclical.[17] Finally, $MktPMU_t$ is most elevated at the height of the GFC, a major

[17] Its highest reading occurs during the March 18, 2003 meeting, driven by the uncertainty about the timing and extent of the Iraq war and about the underlying economic conditions. In another major episode, $EcoPMU_t$ becomes elevated in the first half of 2007 before the start of the official NBER-dated recession. The transcripts of the March 21, 2007 meeting highlight rising concerns about the growth outlook and

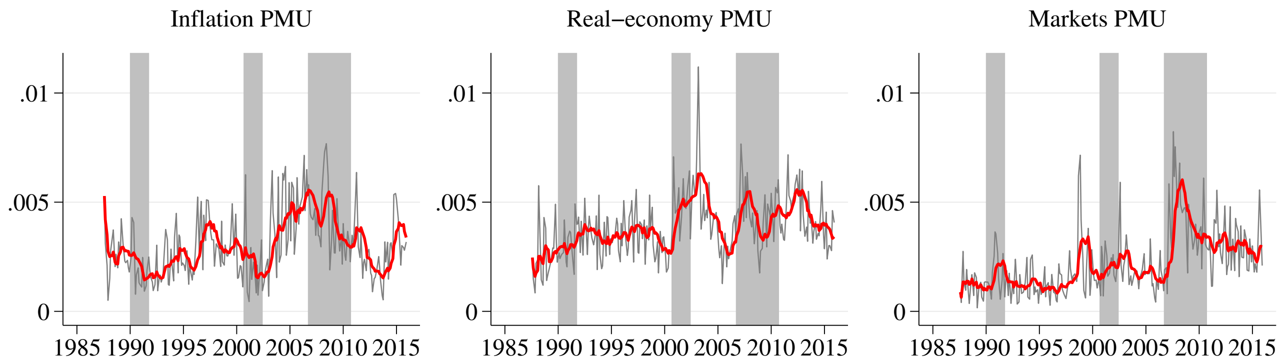

Figure 1. Topic-specific PMU time series. This figure displays the time series of the topic-specific PMU measures during the sample period 1987:08–2015:12. The grey curves represent the raw time series. The red curves are moving averages over the last eight meetings. The y-axis is expressed as the fraction of total economy round words contained in topic-k uncertainty sentences. NBER recessions are shaded.

market turmoil. The substantial independent variation in the topic-specific PMU suggests that the FOMC shifts its discussions depending on which sources of uncertainty are most salient, given the underlying evolution of the economy.

III.B.2. FOMC's policy stance: The Hawk-dove score (HD)

To construct a text-based policy stance measure, we start by identifying sentences that express views on policy in the policy round of the meeting. We define rules to flag sentences that pertain to monetary policy specifically rather than other types of policy (see Appendix B.3 for details). Within this set, we then count the number of words that suggest a policy tightening ($Hawk'_t$) and a policy easing ($Dove'_t$). For meetings beginning in 2009, we additionally consider as policy sentences those that contain keywords related to asset purchases and count the number of words within them that suggest a reduction ($Hawk''_t$) and an increase ($Dove''_t$) in those purchases.

To each meeting, we assign $Hawk_t$ and $Dove_t$ scores measuring the intensity of hawkish and dovish views expressed in that meeting. The $Hawk_t$ score equals the sum $Hawk'_t + Hawk''_t$, scaled by the total number of words spoken in the policy round, and analogously for the $Dove_t$ score. The overall policy stance for meeting t is the difference between the directional scores:

$$HD_t = Hawk_t - Dove_t. \tag{5}$$

heightened forecast uncertainty that are not yet associated with a direct downgrade of the economic forecasts. The uncertainty actually declines during the height of the financial crisis, even as policymakers continue to express negative sentiment about the real economy.

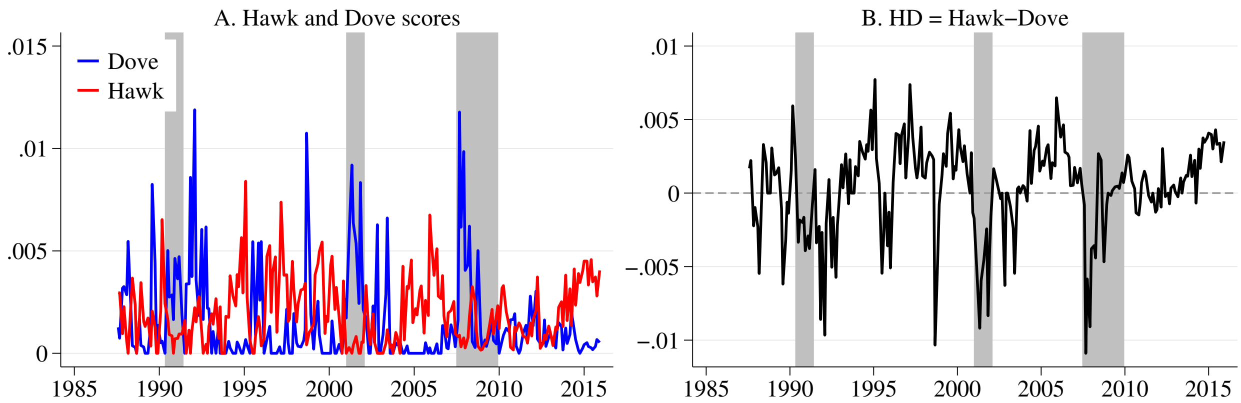

Figure 2. Time series of textual measures of policy stance. The figure presents textual measures of policy preferences derived from the statements of FOMC members during the policy round of the FOMC meetings. The construction of the measures is described in Appendix B.3.

Figure 2 presents the time series of the $Hawk_t$, $Dove_t$ and HD_t scores. The dynamics of these variables display intuitive properties, with $Dove_t$ becoming elevated around recessions and in periods of financial turmoil, and $Hawk_t$ increasing in expansions. Importantly, the text-derived policy stance shows substantial variation in the post-2008 sample when short-term nominal interest rates are constrained at zero.

III.B.3. Other control variables

Numerous factors beyond perceived uncertainty drive policymaking and are important to account for in assessing the relationship between PMU and HD. Here, we enumerate the main variables we include as controls.

Greenbook forecasts. To capture economic expectations influencing policy, we follow the literature relying on the Greenbook (now Tealbook) forecasts prepared by the Fed staff before the scheduled FOMC meetings. Greenbook forecasts are specified for quarterly forecast horizons. We denote a forecast formed at meeting t about variable Z as $F_t(Z_q)$, where subscript q indicates the target forecast horizon (in quarters) relative to the calendar quarter in which meeting t takes place, e.g., $q = 0$ meaning the current quarter of meeting t, and $q = 4$ meaning four quarters ahead from meeting t. In our main specifications, we use a four-quarter ahead CPI inflation forecast ($F_t(\pi_4)$), to reflect the more persistent inflation components that the Fed focuses on, and the current quarter real GDP growth forecast (nowcast, $F_t(g_0)$) as in Coibion and Gorodnichenko (2012). We also add forecast revisions between meetings ($FR_t(\pi_3), FR_t(g_1)$), following Romer and Romer (2004) to account for changes in forecasts in addition to levels. We calculate the forecast revision as $FR_t(Z_q) = F_t(Z_q) - F_{t-1}(Z_q)$ ensuring that the target forecast horizon at t and $t-1$ refers to the same calendar quarter.

Trend inflation. Both interest rates and inflation expectations feature a pronounced common trend (e.g., Kozicki and Tinsley, 2001; Rudebusch and Wu, 2008). To control for these slow-moving dynamics, we construct a measure of the perceived long-run inflation target or the so-called trend inflation, denoted τ_t, as the discounted moving average of past core inflation, following Cieslak and Povala (2015) and motivated by Sargent (1999) (see also Bianchi et al. (2022), Pflueger (2023) for a related approach). Including trend inflation in our policy regressions allows us to capture the effect that deviations of expected inflation from the target have on policy.

Sentiment. To the extent that Greenbooks contain the Fed staff's forecasts, they may not fully capture the FOMC's views on the economy. Additionally, it is likely that Greenbooks report modal forecasts.[18] These can differ from policymakers' mean beliefs if outcome distributions are skewed, and/or if FOMC and staff disagree on the modal forecast. We therefore augment our controls with text-based alsentiment indices as additional proxies for economic forecasts.[19]

To measure topic-specific sentiment, we estimate the frequency of topic-specific terms preceded or followed by direction words that indicate positive or negative sentiment, respectively. The topics generally overlap with those used for the topic-specific uncertainty. In analogy to the PMU indices, we measure meeting-level sentiment from the economy round and scale the topic-specific sentiment count by the number of total words in that round. For some applications, we further disaggregate the sentiment to distinguish between the staff versus FOMC and between the individual FOMC members. Importantly, to avoid a mechanical relationship with PMU, the sentiment construction excludes sentences used to obtain the PMU indices. We label the mentions of falling inflation in meeting t as negative inflation sentiment ($InfNeg_t$), mentions of weakening economic activity as negative sentiment about the real economy ($EcoNeg_t$), and mentions of deteriorating financial conditions as negative market sentiment ($MktNeg_t$). We reverse those relations for the positive sentiment ($InfPos_t$, $EcoPos_t$, and $MktPos_t$). As a proxy for the overall sentiment, we then define balance measures as the difference between the positive and negative sentiment, e.g., for inflation $InfSent_t = InfPos_t - InfNeg_t$. Increases in the balance indicate a positive tilt in views about a given variable. Appendix B.2 provides details of the sentiment construction.

[18] While there is uncertainty whether Greenbook forecasts in our sample reflect means or modes, Bernanke (2016) describes the more recent FOMC's Summary Economic Projections (SEP) as "SEP projections are explicitly of the 'most likely' or modal outcomes rather than the range of possible scenarios." Likewise, the New York Fed forecast "is referred to as the 'modal' forecast in that it is intended to be the most likely of a wide range of potential outcomes" (Alessi et al., 2014).

[19] Several authors show that text-based sentiments obtained from the Fed documents correlate with the Fed's policy action (Ochs, 2021; Aruoba and Drechsel, 2023) and improve forecasting (Sharpe et al., 2022).

Public uncertainty indices. In addition, we consider proxies based on information available to the public, which aim to reflect the uncertainty the public perceives about general economic policy and, more specifically, the Fed's policy actions and/or their consequences. We include (i) the economic policy uncertainty index (EPU) from Baker et al. (2016) based on the frequency of newspaper articles that mention both uncertainty and economic policy, (ii) the monetary policy uncertainty (MPU) newspaper-based index specific to the US monetary policy from Husted et al. (2020), (iii) the option-implied volatility index (VXO) following Bloom (2009), and (iv) dispersion of forecasts about CPI inflation and real GDP growth from the Blue Chip Financial Forecast survey.[20]

We find that our PMU indices are generally weakly related to public uncertainty (see Appendix Table C.12). Consistent with the procyclical dynamics visible in the left panel of Figure 1, inflation PMU is, in fact, negatively correlated with the EPU index, the VXO, and survey growth dispersion, all of which are strongly countercyclical (e.g., Bloom, 2014). This fact reinforces the idea that inflation PMU, in particular, captures a distinct dimension of policymakers' beliefs not subsumed by existing proxies.

III.C. Validation

III.C.1. Uncertainty, sentiment, and economic outcomes

The aim of PMU indices is to gauge policymakers' perceptions of the second moments of economic outcomes. The Greenbook forecast and text-based sentiment should instead capture directional beliefs on the evolution of economic conditions. To validate that we can distinguish between those concepts, we present a series of predictive regressions. Specifically, we regress inflation and real GDP growth observed at meeting $t + h$ on meeting t Greenbook forecasts, PMU, and sentiments indices. For consistent timing of the meetings and macroeconomic outcomes, we use future Greenbook nowcasts as the dependent variables and estimate regressions for $h = 1, \ldots, 8$, i.e., up to eight meetings ahead.

Table II presents the forecasting results. While the PMU does not predict future outcomes, contemporaneous Greenbook forecasts and sentiment do, with longer-lasting effects for the Greenbook forecast (sentiment measures) on inflation (growth). As such, our text-based proxies indeed organize language in a conceptually distinct way. The finding that PMU

[20] Bauer et al. (2022) and De Pooter et al. (2021) study market-perceived monetary policy uncertainty over the FOMC cycle using implied volatility of short-term interest rate derivatives. Using the Bauer et al. (2022) measure, we find that inflation and real-economy PMU are weakly correlated with market-based interest rate volatility (with correlations not exceeding 0.1 in absolute value). Since interest-rate implied volatility series are available starting from 1990, we do not include them in our main specification. We verify that including this measure does not materially change our conclusions about the link between PMU and policy stance.

A. Dependent variable: Greenbook CPI inflation nowcast h meetings ahead, $F_{t+h}(\pi_0)$

	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$
$InfPMU_t$	0.039	-0.038	-0.042	0.011	-0.107	-0.070	0.038	0.044
	(0.62)	(-0.48)	(-0.38)	(0.08)	(-0.69)	(-0.42)	(0.27)	(0.45)
$InfNeg_t$	-0.260***	-0.164*	0.012	0.093	0.086	0.010	-0.058	-0.025
	(-3.49)	(-1.87)	(0.18)	(1.30)	(1.04)	(0.17)	(-0.98)	(-0.39)
$InfPos_t$	0.173***	0.144***	0.025	-0.131	-0.100	-0.120	-0.169*	-0.138
	(3.81)	(2.67)	(0.38)	(-1.32)	(-0.97)	(-1.42)	(-1.80)	(-1.47)
$\overline{F}_t(\pi)$	0.560***	0.457***	0.378***	0.351***	0.319***	0.321***	0.337***	0.335***
	(8.46)	(6.91)	(4.30)	(3.39)	(2.82)	(2.90)	(3.73)	(4.01)
$\bar{R}^2$	0.50	0.30	0.13	0.11	0.11	0.11	0.12	0.10
N	226	225	224	223	222	221	220	219

B. Dependent variable: Greenbook real GDP growth nowcast h meetings ahead, $F_{t+h}(g_0)$

	$h=1$	$h=2$	$h=3$	$h=4$	$h=5$	$h=6$	$h=7$	$h=8$
$EcoPMU_t$	-0.081	-0.058	0.032	0.069	0.029	-0.001	0.087	0.113
	(-1.60)	(-1.15)	(0.69)	(1.03)	(0.36)	(-0.02)	(1.01)	(1.23)
$EcoNeg_t$	-0.150***	-0.163**	-0.220***	-0.275***	-0.313***	-0.226**	-0.238**	-0.237**
	(-2.92)	(-2.40)	(-2.65)	(-3.00)	(-4.29)	(-2.28)	(-2.05)	(-2.32)
$EcoPos_t$	0.116**	0.127**	0.147**	0.149*	0.151*	0.193**	0.203**	0.190**
	(2.39)	(2.17)	(2.07)	(1.68)	(1.72)	(2.25)	(2.30)	(2.14)
$\overline{F}_t(g)$	0.623***	0.553***	0.401***	0.287***	0.227**	0.174	0.112	0.075
	(7.20)	(5.78)	(5.03)	(3.20)	(2.12)	(1.31)	(0.80)	(0.51)
$\bar{R}^2$	0.56	0.48	0.35	0.28	0.26	0.19	0.16	0.13
N	226	225	224	223	222	221	220	219

Table II. Predicting macro variables with textual measures of uncertainty and sentiment. The table reports predictive regressions of inflation and real GDP growth by textual PMU and sentiment indices derived from the economy round of the FOMC meeting transcripts. The regressions are estimated at the FOMC meeting frequency with the forecast horizon ranging from the next meeting ($h = 1$) up to eight meetings ahead ($h = 8$). To make sure that the timing of the depend variable is consistent with the timing of the meetings, we use Greenbook nowcasts at future meetings as the dependent variable. The regression is $F_{t+h}(\pi_0) = \beta_0 + \beta_1 InfPMU_t + \beta_2 InfPos_t + \beta_3 InfNeg_t + \beta_4 \overline{F}_t(\pi) + \varepsilon_{t+h}$, where $F_{t+h}(\pi_0)$ is the CPI inflation nowcast at meeting $t+h$, and $\overline{F}_t(\pi)$ is the average forecast (across horizons) given at meeting t. We estimate analogous regressions for the real GDP growth. The coefficients are standardized. HAC standard errors to account for the overlap are reported in parentheses. The sample period is 1987:08–2015:12.

lacks predictive power is not sensitive to controls we include and is confirmed in univariate predictive regressions (see Appendix Table C.13). These results do not imply that economic conditions that the policymakers perceive can solely be described by the first and second moments. They do, however, suggest that PMU is not a simple reflection of directional beliefs. Instead, such beliefs (via means or skews) appear to be encoded in the text-based measure of expressed sentiment.

III.C.2. Hawk-dove score and policy actions

To validate the hawk-dove score, HD, as a measure of policy stance, we analyze its relationship with the policy rate, FFR, adopted by the FOMC in meeting t. In Panel A of Table III, we first project HD_t on typical variables included in policy rules. Column (1) serves as a benchmark to describe the systematic policy component reflected in language. The explanatory variables include the Greenbook forecasts and forecast revisions for inflation and real GDP growth, as well as the trend inflation variable τ_t to account for slow adjustment in the inflation target over our sample. Most loadings in column (1) are highly significant and have expected signs: higher expected growth and higher expected deviation of inflation from the target predict a more hawkish tilt in the policy language. However, with $\bar{R}^2$ of 29%, the regression leaves more than two-thirds of the variation in the policy language unexplained by the macro forecasts.

Columns (2)–(4) focus on explaining changes in the FFR target from $t-1$ to t with the policy stance language in meeting t. Although our textual proxies are available until 2015:12, we estimate these regressions through 2008:12, given that the FFR is at the zero-lower bounds thereafter. To account for policy inertia, we include two lags of the FFR, following Coibion and Gorodnichenko (2012). The estimates indicate a high explanatory content of policy language for the FFR target. In column (3), a one-standard-deviation increase in HD_t is associated with a 14 basis point increase in the FFR, with a t-statistic of 6.8. Given the results in column (1), the significance of HD_t could simply reflect the policy rule as opposed to the deviation from the rule. However, column (4) shows that this is not the case: HD_t remains an economically and statistically significant predictor of FFR with a full set of controls.

The FOMC's policy stance measured in language is likely to reflect broader forward-looking views on policy, as opposed to just the contemporaneous action. To evaluate this idea, Panel B of Table III presents predictive regressions using the same controls as column (4) of Panel A but with the dependent variable $FFR_{t+h} - FFR_t$, i.e., the cumulative change in FFR from meeting t through $t+h$. The information contained in HD_t about future policy is notably

A. HD and changes to the Fed Funds Rate target: contemporaneous effect

	(1) HD_t	(2) ΔFFR_t	(3) ΔFFR_t	(4) ΔFFR_t
HD_t			0.14***	0.096***
			(6.83)	(5.30)
$F_t(\pi_4)$	0.62***	0.23***		0.18***
	(3.64)	(3.79)		(2.97)
$F_t(g_0)$	0.38***	0.18***		0.15***
	(2.99)	(6.60)		(5.75)
τ_t	-0.70***	-0.13***		-0.078**
	(-3.81)	(-3.30)		(-2.06)
$FR_t(\pi_3)$	0.073	0.015		0.0067
	(1.43)	(0.86)		(0.39)
$FR_t(g_1)$	0.15***	0.039**		0.026
	(2.79)	(2.30)		(1.32)
L.FFR_t		0.087	0.26***	-0.013
		(1.14)	(3.18)	(-0.15)
L2.FFR_t		-0.13*	-0.27***	-0.024
		(-1.84)	(-3.40)	(-0.29)
Constant	0.00	0.14**	0.0088	0.11**
	(0.00)	(2.54)	(0.20)	(2.23)
$\bar{R}^2$	0.29	0.52	0.45	0.59
N	227	169	169	169

B. HD and changes to the Fed Funds Rate target: future effect

	(1) $h=1$	(2) $h=2$	(3) $h=3$	(4) $h=4$	(5) $h=5$	(6) $h=6$	(7) $h=7$	(8) $h=8$
HD_t	0.087***	0.14***	0.20***	0.27***	0.28***	0.24**	0.22*	0.25*
	(4.10)	(3.18)	(2.62)	(2.84)	(2.88)	(2.46)	(1.88)	(1.83)
GB controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$\bar{R}^2$	0.43	0.41	0.43	0.46	0.51	0.52	0.53	0.53
$\Delta\bar{R}^2$	0.033	0.026	0.028	0.034	0.026	0.010	0.0045	0.0064
N	169	168	167	166	165	164	163	162

Table III. Validity of HD as a measure of policy stance. This table reports results on the relationship between the textual *HD* score derived from the policy round of FOMC meeting transcripts and the target Fed Funds Rate adopted by the FOMC. Panel A, column (1) reports estimates from a regression of *HD* on Greenbook controls (forecasts $F_t(\cdot)$ and forecast updates $FR_t(\cdot)$), and the perceived inflation target τ_t. The sample period for column (1) is 1987:08–2015:12. The dependent variable in columns (2)–(4) is $FFR_t - FFR_{t-1}$ where FFR_t is the target rate adopted by the FOMC in meeting t. The sample period for columns (2)–(4) is 1987:08–2008:12, which excludes the zero-lower-bound episode. The dependent variable in Panel B is $FFR_{t+h} - FFR_t$ for $h = 1$ through $h = 8$, and each regression includes the same controls as in column (4) of Panel A. HAC t-statistics with eight lags are reported in parentheses in both Panels. All regressions are estimated at the frequency of FOMC meetings. The *HD* variable is standardized, and FFR_t is expressed in percent.

larger than its impact on the contemporaneous action: a one-standard-deviation increase in HD_t is associated with more than 25-basis-point cumulative increase in the FFR over the following four and five meetings. HD_t remains significant at the five percent level up to six meetings ahead, suggesting that it encapsulates how the FOMC positions itself in meeting t for future policy actions.

IV. Uncertainty and Policy Stance

This section establishes the empirical relationship between policymakers' uncertainty and their policy stance. Our primary finding is that an increase in inflation PMU, $InfPMU_t$, is associated with a significantly more hawkish stance, as revealed by the hawk-dove score, HD_t. This result survives a host of controls, including directional beliefs on inflation and public uncertainty proxies. We show that the relationship arises specifically from inflation uncertainty as perceived by the FOMC members rather than the staff; is not explained by the composition or cross-sectional heterogeneity of the FOMC; and induces a large cumulative response in the future path of the actual policy rate. While the evidence indicates that Fed-managed inflation uncertainty is an important channel affecting the Fed's decisions, we contrast the empirical results with predictions from leading theories of monetary policymaking under uncertainty.

The conceptual framework in Section II describes an equilibrium relationship between Fed-managed uncertainty and policy stance, as opposed to a causal relationship. It is, therefore, important to clarify the assumptions underlying our empirical approach, based on which we can assert any potential effects of uncertainty on policy stance. In order to interpret the subsequent evidence as uncertainty affecting policy choice rather than the reverse, the PMU at meeting t should reflect uncertainty perceived *before* the policy stance is determined within that meeting, i.e., before the policy decision feeds back onto the uncertainty perceptions. The structure of the FOMC meeting, with the economy round separated from and preceding the policy round, allows us to argue that this is plausibly the case. By constructing PMU from the economy round *before* the FOMC members discuss policy stance, we interpret it as uncertainty that policymakers perceive when they enter the meeting, and *not* the uncertainty they expect to prevail after their policy choice.[21]

[21] To take a concrete example, suppose that prior to a meeting, a negative demand shock hits the economy, which increases the uncertainty of a recession. In response to this shock, the Fed wishes to lower interest rates, which in turn reduces the recessionary risk. In this case, the PMU should be high, given the baseline setting at the start of the meeting (the arrival of the negative shock) rather than low (which would reflect a diminished uncertainty after the accommodative action). The timing of deliberations within the FOMC meeting largely rules out a reverse causation whereby policy decision drives PMU within meeting t, rather than vice versa. This is plausible even if the policy choice at meeting t is largely agreed upon before the meeting, as some Fed observers have argued. In this case, the economy round would focus on the prevailing conditions that justify whatever policy choice is to follow rather than an assessment of how the economy will look in future periods after the policy action has been implemented.

It is worth noting that the above assumption is analogous to the one underlying the estimates of forward-looking Taylor rules using Greenbook forecasts (e.g., Romer and Romer, 2004; Coibion and Gorodnichenko, 2012). The typical assumption is that the forecast is pre-determined relative to the current decision.[22] Just like the Greenbook forecasts capture the first-moment effects in the rule due to the Fed minimizing the squared deviations of expected inflation and output from targets (equation (2)), PMU attempts to capture the second-moment effects in the rule due to the Fed minimizing variances of inflation and output. Similar to Greenbooks being prepared a few days before the meeting, the economy-round statements are often formulated in advance, especially since 1994 when the Fed committed to releasing the transcripts to the public (Meyer, 2004; Hansen et al., 2018).

IV.A. Meeting-level results

Table IV studies the meeting-level predictability of the policy stance HD with PMU measures using a variety of controls. We estimate the following regression:

$$HD_t = \alpha + \beta_1' \mathbf{PMU}_t + \beta_2' \mathbf{Controls}_t + \varepsilon_t, \tag{6}$$

where $\mathbf{PMU}_t$ is the vector of PMU indices. All variables are observed at the meeting level as of time t, and are standardized; coefficients are expressed in standard-deviation units.

We begin with the least restrictive specification and gradually add controls for additional covariates. To provide a baseline, columns (1) and (2) project *HD* on the inflation and real-economy PMU and sentiment, respectively, without any controls. The PMUs in column (1) are highly significant and jointly explain 15% of the HD's variance. Notably, inflation and real-economy PMU predict policy stance with opposite signs. A one-sigma increase in *InfPMU* is associated with a 0.34-sigma increase *HD* (t-statistic = 3.39), indicating a more hawkish stance; in contrast, a one-sigma increase in *EcoPMU* is associated with a 0.24-sigma decrease in *HD* (t-statistic = −3.97). Column (2) shows that the text-based sentiment is also strongly predictive of policy stance. The coefficients have the expected signs: sentiments indicating rising inflation or a stronger real economy anticipate a more hawkish policy round of the meeting.

Importantly for subsequent interpretation, column (3) shows that the predictive content of uncertainty for policy stance is not subsumed by variation in sentiment. In fact, inflation *PMU* drives out the significance of inflation sentiment. In contrast, uncertainty and sentiment about the real economy contain largely independent information. Views of a stronger

[22] See, e.g., Reifschneider et al. (1997) for the discussion of assumptions in the Greenbook forecasts.

Dependent variable: Meeting-level HD_t policy stance score

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$InfPMU_t$	0.341***		0.281***	0.291***	0.177***	0.182***	0.159**
	(3.39)		(3.89)	(4.06)	(2.79)	(2.80)	(2.32)
$EcoPMU_t$	-0.238***		-0.151***	-0.128**	-0.124*	-0.116	-0.105
	(-3.97)		(-3.10)	(-2.37)	(-1.69)	(-1.49)	(-1.46)
$MktPMU_t$				-0.069			-0.120
				(-0.70)			(-1.19)
$InfSent_t$		0.204**	0.085	0.081	0.066	0.084	0.063
		(2.54)	(1.17)	(1.08)	(1.16)	(1.42)	(1.07)
$EcoSent_t$		0.498***	0.471***	0.436***	0.392***	0.381***	0.347***
		(5.71)	(5.91)	(5.60)	(4.38)	(3.52)	(3.91)
$MktSent_t$				0.048			0.038
				(0.66)			(0.54)
GB controls	No	No	No	No	Yes	Yes	Yes
Public uncertainty	No	No	No	No	No	Yes	No
Other PMUs	No	No	No	No	No	No	Yes
$\bar{R}^2$	0.15	0.30	0.38	0.38	0.43	0.43	0.45
N	227	227	227	227	227	227	227

Table IV. Predicting policy stance *HD* with PMU at the meeting-level. The table reports regressions of the policy stance score *HD* on topic-specific PMU indices. The controls include textual sentiment measures, GB forecasts, and proxies for public perceived uncertainty described in Section III.B.3. The *HD* variable is derived from the statements of FOMC members in the policy round of the FOMC meeting, while the PMU and sentiment indices are based on the statements by the staff and FOMC members in the economy round of the meeting. All regressions are estimated at the FOMC meeting frequency. The coefficients are standardized. HAC t-statistics with eight lags are reported in parentheses. The sample period is 1987:08–2015:12.

economy captured by a heightened *EcoSent* predict hawkishness, while increased uncertainty about the economy captured by *EcoPMU* predicts a more dovish stance.

Controlling for financial markets *PMU* and sentiment (*MktPMU* and *MktSent*) in column (4) weakens somewhat the economic and statistical significance of the real-economy PMU, but not that of inflation. The financial markets-based measures are themselves insignificant, echoing Cieslak and Vissing-Jorgensen (2021) that the Fed reacts to financial markets only to the extent that they affect the Fed's beliefs about the real economy. Therefore, in the subsequent analysis, we do not focus on the financial markets *PMU*.

Columns (5) through (7) augment the specification to account for various potential confounders, as detailed in Section III.B.3. Column (5) includes, in addition to text-based sentiment, the Greenbook forecasts and the trend inflation (as used in Table III). Even with these variables, inflation PMU maintains a material effect on the policy stance: Compared to the specification in column (3), the coefficient on inflation PMU is reduced by about a third (from 0.28 to 0.18 standard deviation units) but remains significant at the 1% level. Instead, the real-economy PMU becomes only marginally significant, suggesting that it can be largely absorbed by Greenbook forecasts and sentiment.

Column (6) introduces measures of public perceptions of policy and macroeconomic uncertainty, with the aim to account for the broad demand-shock channel of uncertainty described in Section II. Considering an extensive set of proxies from the literature, we find that none of them drives out inflation PMU, while the importance of the real-economy PMU is further diminished.

Finally, for robustness, column (7) exploits the full suite of PMU indices, including the model PMU and the unclassified PMU category. Inflation PMU is only marginally affected and remains significant at the 5% level. It is thus unlikely that our main macro PMU indices omit a key aspect of policymakers' uncertainty regarding the policy-relevant outcomes.

IV.A.1. Interpretation

The framework from Section II helps assess which channels could explain the empirical relationship between policymakers' uncertainty and their policy stance. Here, we treat HD_t as a proxy for r_t and discuss the theoretical interpretation of how variation in uncertainty drives variation in the optimal stance via the policy rule (3).

As a starting point, under certainty equivalence, one would not expect to find *any* relationship between policymakers' expressed uncertainty and their policy stance beyond controls for the expected economic conditions. The fact that uncertainty does predict stance points to a wedge between the standard policy rule (obtained under the linear-quadratic framework) and the actual decision-making of the FOMC. This finding itself is informative because many macro models are set up to satisfy certainty equivalence.

The policy rule (3) indicates that once one adequately controls for the FOMC's beliefs about future economic outcomes, any remaining correlation between PMU and policy stance should arise from Fed-managed uncertainty. Thus, a significant relationship between $InfPMU_t$ and HD_t in Table IV suggests that Fed-managed uncertainty is a meaningful channel, i.e., $\frac{\partial \sigma^2_{\pi,t}}{\partial r_t} \neq 0$ and that sensitivity varies with inflation PMU.[23] Under this interpretation, PMU measures the salience of risks the Fed needs to manage, and the main takeaway from Table IV is that uncertainty regarding inflation is especially relevant for formulating policy views. To our knowledge, the significance of inflation PMU for stance is a novel finding in the literature. It also contrasts with the real-economy PMU, suggesting that inflation and real-economy PMU operate via different channels.[24]

[23] To the extent that controlling for sentiment may also capture policymakers' perceptions of higher-order moments, the estimated effect of PMU on HD represents a lower bound on the actual impact of perceived uncertainty on stance.

[24] Relatedly, Evans et al. (2015) study how uncertainty affects policymaking. They identify uncertainty mentions in the FOMC minutes, but do not separately consider uncertainty types. Based on reading the

The lack of an independent effect of the real-economy PMU on stance, after controlling for expected economic conditions and public uncertainty, is consistent with it capturing the demand channel of uncertainty. Column (1) of Table IV indicates that the FOMC adopts a softer policy stance in the face of higher uncertainty about the real economy, which aligns with its accommodating a negative demand shock. However, this effect should come entirely from the Fed responding to a downgrade in growth outlook caused by an uncertainty shock exogenous to its policy. The theory discussed in Section II predicts that once one controls for the growth outlook and public uncertainty, there should be no remaining effect of real-economy PMU on the policy stance, just as we find in column (6). In contrast, inflation PMU consistently predicts a more hawkish policy stance, with its explanatory power not subsumed by any of the controls in Table IV.

IV.A.2. Link to conservatism and activism

The positive relationship between inflation PMU and HD is informative about the channel that could generate the Fed-managed uncertainty about inflation. The prediction of the parameter uncertainty literature originating from Brainard (1967) is that higher uncertainty should moderate the policy reaction to economic conditions. This, however, does not imply a clear directional shift towards tighter policy. Only when the policy rate is below its neutral level does an increase in uncertainty lead to more hawkish behavior, as the policymaker refrains from lowering rates as they would under certainty equivalence. In Söderström (2002)'s extension of this literature, an increase in uncertainty leads to a more aggressive response relative to certainty equivalence, which again has no precise directional prediction.

While we do not rule out that the parameter uncertainty channel operates in our sample, the findings suggest that this channel can explain our results only under specific conditions. Suppose we had a balanced sample of meetings in which the FOMC was considering equally frequently raising and lowering rates (relative to a neutral rate). In this case, under parameter uncertainty, we should not find that inflation PMU predicts a systematically more hawkish stance, contrary to what we document above. We could find such an average hawkishness effect if, instead, our sample was disproportionately comprised of meetings where policymakers leaned toward lowering rates under conservatism (or raising rates under activism).

minutes, they human-code the directional effect of uncertainty on policy and assign an indicator variable (plus or minus one) to meetings where the effect is present, and zero otherwise. They find that this measure predicts the current FFR action beyond macro forecasts. Instead, the frequency of uncertainty mentions (ignoring the directional effect) shows a much weaker link to the policy rate. Our results, especially the opposite effects of *InfPMU* and *EcoPMU* on policy stance, highlight the need to isolate the different types of uncertainty.

Thus, to test whether our result regarding inflation uncertainty aligns with the predictions of conservatism/activism, we split the sample into meetings where the FOMC exhibited a tilt, respectively, towards lowering, raising rates, or neither. We then repeat our baseline estimates separately for these subsets of meetings. We consider two separate but related measures of policy tilt:

1. *The interest rate cycle measure.* We define a period as part of a cutting (hiking) cycle if (i) the meeting involves a cut (hike) in interest rates, or (ii) the last move, within the previous eight meetings, was a cut (hike). Once eight meetings have passed, we assume that the cutting cycle is over even if rates have not yet started to rise; the periods between cutting and hiking cycles form the "neither" subsample.

2. *The Blue/Tealbook measure.* Tealbooks (formerly Bluebooks) contain alternative policy options prepared by the Fed staff before an FOMC meeting. Alternative B is the central policy scenario as viewed by the staff. Using alternative policy options, we define a meeting as having a cutting (hiking) tilt when either (i) the staff's proposed Alternative B involves a cut (hike) or (ii) where Alternative B assumes no change but the staff propose more cut (hike) alternatives than hike (cut) alternatives. The remaining meetings form the "neither" subsample.

The following matrix presents expected signs of the loadings of HD_t on $InfPMU_t$ under uncertainty-induced conservatism or activism, depending on the policy tilt:

	Cutting tilt	Hiking tilt
Conservatism	(+)	(−)
Activism	(−)	(+)

Table V presents the results. Column (1) repeats the baseline estimates from Table IV; columns (2)–(4) split the sample based on approach 1, and columns (5)–(7) based on approach 2. The results show that the predictive power of inflation PMU for policy stance stems from precisely those periods when there is no tendency to cut or hike interest rates (columns (4) and (7)). To the extent that inflation PMU only drives more hawkishness when there is no apparent bias towards raising or lowering rates, these findings are inconsistent with either conservatism or activism. Indeed, when the policy exhibits a cutting policy tilt (columns (2) and (5)), conservatism would imply a positive loading of *HD* on *InfPMU* (as higher uncertainty attenuates the desire to cut), whereas activism would imply a negative loading on *InfPMU* (as higher uncertainty strengthens the desire to cut). When the policy exhibits a hawkish tilt (columns (3) and (6)), the loadings should be reversed. These

Dependent variable: Meeting-level HD_t policy stance score

	Baseline	Approach 1: Int. rate cycle			Approach 2: Blue/Tealbook		
	(1) All	(2) Cut	(3) Hike	(4) Neither	(5) Cut	(6) Hike	(7) Neither
$InfPMU_t$	0.177***	0.101	-0.057	0.387***	0.098	-0.064	0.332***
	(2.79)	(1.15)	(-0.33)	(3.64)	(0.73)	(-0.40)	(4.05)
$EcoPMU_t$	-0.124*	-0.140	0.145	-0.119	0.157	0.032	-0.267**
	(-1.69)	(-1.03)	(0.98)	(-1.13)	(1.45)	(0.32)	(-2.15)
GB controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sentiment	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$\bar{R}^2$	0.43	0.32	0.21	0.34	0.11	0.27	0.31
N	227	98	67	62	44	70	119

Table V. Relationship between PMU and policy stance HD conditional on policy tilt. The table reports the estimates the relationship between PMU and policy stance conditional on policy tilt, defined by recent interest rate moves (columns (2)–(4)) or by Blue/Tealbook alternative strategies (columns (5)–(7)). Column (1) reports the baseline specification corresponding to column (5) in Table IV. The sample period is 1987:08–2015:12. All variables are scaled by their standard deviations. HAC t-statistics with eight lags are reported in parentheses. The regressions are estimated at the frequency of the FOMC meetings.

predictions are not born out in the data. Repeating the regressions without the baseline controls or adding public uncertainty measures gives similar findings.

The statistical properties of PMU indices alone already indicate that it may be challenging to map the way uncertainty manifests in FOMC deliberations directly onto the theoretical models summarized in Section II. First, we observe in Table I that the FOMC spends little time discussing model uncertainty. This is consistent with Blinder (1999)'s view that "while there is some formal literature on this problem [uncertainty over model selection], I think it is safe to say that central bankers neither know nor care much about this literature." Second, we see largely independent variation in the different PMU types. Instead, in general equilibrium models, one would expect that an increase in one source of uncertainty leads to all economic outcomes becoming more uncertain. Finally, while PMU displays substantial, persistent variation, the theory does not have a precise prediction of how parameter or model uncertainty may evolve over time. Taken together with the results in Table V, it is challenging to rationalize our main result on the role of inflation PMU with leading mechanisms in the literature. Before we explore alternative explanations, we present additional evidence to further characterize this relationship.

IV.B. FOMC members vs. staff

The analysis so far exploits variation in the PMU indices derived from the economy-round statements made by all meeting participants. However, the staff's and FOMC's views are conceptually distinct. The staff presentations during the economy round largely explain and contextualize the forecasting scenarios underlying the quantitative Greenbook forecasts. As such, one would expect staff's uncertainty language to be mainly relevant to forming economic expectations and thus subsumed by our controls. On the other hand, the FOMC members' language should reflect a broader view of the economy, incorporating any higher-order moments relevant to their decision-making, and specifically Fed-managed uncertainty considerations.

To explore these potential differences, we construct PMU and sentiment indices for the staff and the FOMC separately. We apply the same algorithm as for the meeting-level measures but treat the staff and FOMC texts at each meeting as separate corpora.

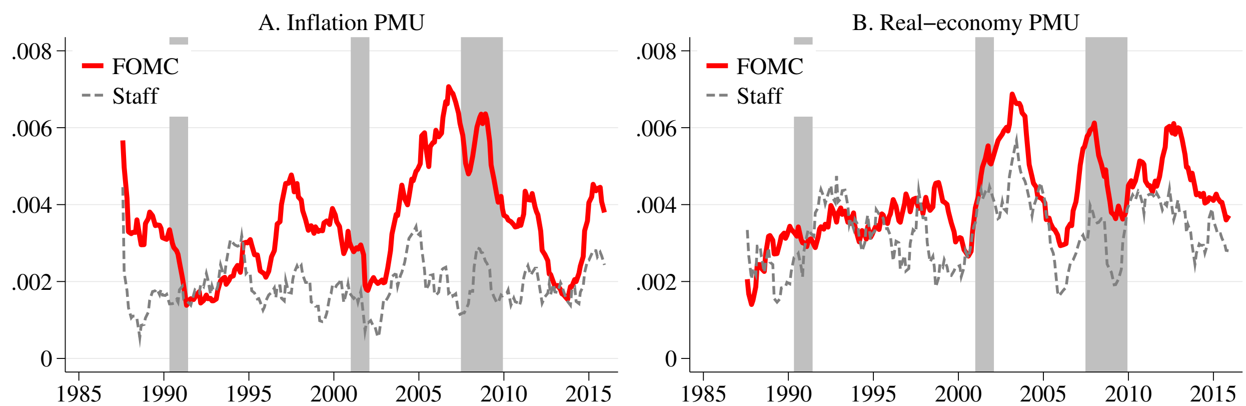

Figure 3. PMU of FOMC members vs. staff. This figure presents inflation and economy PMU indices constructed separately for FOMC members and the staff. Each uncertainty index is scaled relative to the overall length of the statements made by FOMC members or staff, respectively, in the economy round of the meeting. The series are smoothed averages over the last eight FOMC meetings.

Figure 3 disaggregates the meeting-level PMU indices from Figure 1 by FOMC members and the staff. Both groups' real-economy PMUs show a similar cyclical variation. Instead, the FOMC's inflation PMU rises much faster during expansions than the staff's and remains persistently elevated.

Under the hypothesis that the staff's inflation PMU depicts general uncertainty around inflation forecasts at each meeting but not Fed-managed uncertainty, it should not influence the FOMC's policy stance once Greenbook forecasts and sentiment are accounted for. The uncertainty relevant to the policy decisions should instead be encapsulated in FOMC's PMU. Table VI tests this idea by regressing the policy stance *HD* on staff- and FOMC-specific PMU indices and the controls from Table IV, column (5). The results confirm that the effect of inflation uncertainty on policy stems primarily from the FOMC members' views. On a stand-

Dependent variable: Meeting-level HD_t policy stance score

	(1)	(2)	(3)
$InfPMU_t$ (FOMC)	0.180***		0.183***
	(2.84)		(3.18)
$EcoPMU_t$ (FOMC)	-0.093		-0.087
	(-1.48)		(-1.36)
$InfPMU_t$ (Staff)		0.109*	0.011
		(1.81)	(0.23)
$EcoPMU_t$ (Staff)		-0.137*	-0.038
		(-1.93)	(-0.65)
GB controls	Yes	Yes	Yes
Sentiment	Yes	Yes	Yes
$\bar{R}^2$	0.43	0.33	0.43
N	227	227	227

Table VI. Uncertainty of FOMC members vs. staff. The table reports regressions of meeting-level HD_t variable on uncertainty indices of staff and FOMC members. We control for sentiment (*InfSent* and *EcoSent*) specific to FOMC members (column (1)), staff (column (2)), and members and staff (column (3)). HAC t-statistics are reported in parentheses.

alone basis, the staff's inflation PMU is marginally significant and is entirely driven out by the members' PMU in a joint specification.

IV.C. Individual-level results

One consideration in interpreting the meeting-level results is that they could arise from a disagreement among FOMC members as opposed to the common perceptions of the committee as a whole. We thus turn to estimating the language-based reaction functions at the individual FOMC-member level, exploiting the granularity of our textual data. The results show that it is the common perception of uncertainty on the FOMC that affects the policy stance.

In Table VII, the dependent variable is the policy stance of member i in meeting t, HD_{it} (using the policy-round statements), and the explanatory variables are the corresponding PMU and sentiment scores of that member (using their economy-round statements). The goal is to study how a policymaker's own expression of uncertainty predicts their individual policy stance. All regressions include member fixed effects, and so the estimates represent the within-individual reaction functions. Column (1) shows that, similar to the meeting-level results, also within-member inflation PMU is associated with more hawkishness, while the real-economy PMU with more dovishness (although this latter effect is weak). The impact of inflation uncertainty on policy stance is not driven by the member-specific sentiment (column (2)).

To distinguish between the common FOMC's perceptions vis-á-vis member heterogeneity, column (3) additionally includes aggregate meeting-level PMU indices, and column (4) includes time-fixed effects. Both specifications render the member-level PMU insignificant, indicating that the explanatory power of uncertainty for policy stance stems from the time-series variation common to members rather than from the cross-sectional dispersion of views across members.

Dependent variable: Individual meeting-level HD_{it} policy stance score

	(1)	(2)	(3)	(4)	(5)	(6)
$InfPMU_{it}$ (ind)	0.12***	0.12***	0.00014	-0.011	0.11**	-0.0097
	(2.86)	(2.82)	(0.00)	(-0.30)	(2.62)	(-0.25)
$EcoPMU_{it}$ (ind)	-0.074	-0.058	0.018	0.012	-0.041	0.011
	(-1.65)	(-1.43)	(0.45)	(0.30)	(-1.03)	(0.29)
$InfPMU_t$ (agg)			0.93***			
			(4.97)			
$EcoPMU_t$ (agg)			-0.74***			
			(-3.63)			
$MktPMU_{it}$ (ind)					-0.16***	0.011
					(-2.70)	(0.25)
$ModPMU_{it}$ (ind)					-0.071	-0.15
					(-0.64)	(-1.38)
$OthPMU_{it}$ (ind)					-0.19***	-0.11**
					(-4.20)	(-2.40)
Sentiment	No	Yes	Yes	Yes	Yes	Yes
Meeting FE	No	No	No	Yes	No	Yes
Member FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.028	0.048	0.070	0.26	0.059	0.26
N	3925	3925	3925	3925	3925	3925

Table VII. Uncertainty of FOMC members: individual member-level regressions. The table reports regressions of individual FOMC member's i policy stance at meeting t, HD_{it}, on individual PMU indices at that meeting (denoted with "(ind)"). Column (4) controls for aggregate PMU indices (denoted with "(agg)") calculated at the meeting level. Standard errors are double-clustered at the meeting and member level.

Finally, the last two columns include the full set of individual-level PMU indices, including financial markets, model, and the unclassified other PMU, without and with meeting fixed effects in columns (5) and (6), respectively. Individual member policy views are sensitive to the financial market uncertainty, with increased $MktPMU_{it}$ associated with an easier stance, supporting the demand-shock interpretation of market uncertainty. However, this effect reflects common rather than member-specific variation and is subsumed by the meeting fixed effects in column (6). Model PMU ($ModPMU_{it}$) is not significant at the individual level, suggesting that model misspecification is not a primary concern of policymakers driving our results. The residual uncertainty component ($OthPMU_{it}$) predicts an easier policy stance even with time-fixed effects, indicating that idiosyncratic uncertainty perceptions do influence individual policy views, but their effect on the overall policy stance of the committee is weak, given results in Table IV column (7).

IV.D. Policy rate effect of policymakers' uncertainty

The results so far relate inflation PMU to a textual measure policy stance, HD, which we show to encapsulate forward-looking FOMC's views beyond the current policy action. We now quantify the extent to which PMU affects the FOMC's actual policy choices.

To this end, we regress changes in the policy rate between meetings t and $t+h$ for $h = 1, \ldots, 8$ on time-t PMU indices and controls. We focus specifically on the dynamic effects of the FOMC members' PMU, as motivated by Table VI. The controls include variables from column (5) of Table IV, and additionally, the EPU index Baker et al. (2016) to account for the demand channel of uncertainty, and two lags of the policy rate to account for its inertia. We present the estimates for the FFR target using the 1987:08–2008:12 sample as well as for the shadow rate constructed by Wu and Xia (2016) using the 1987:08–2015:12 sample, to account for the zero-lower bound period.

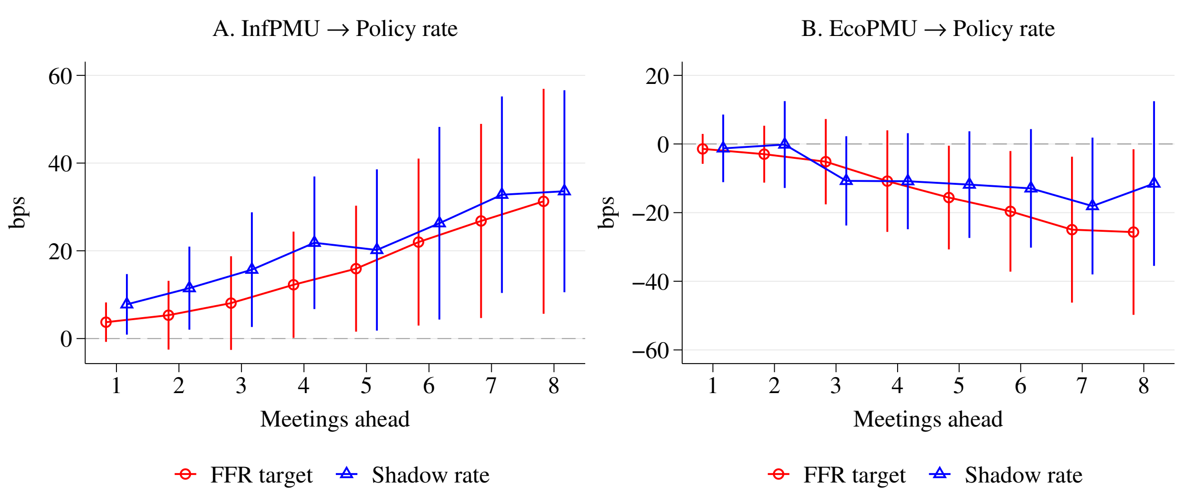

Figure 4. Cumulative effects of PMU on the policy rate. The figure presents the response of the policy rate (in basis points) to a one-standard deviation change in the PMU. Two measures of the policy rate are considered: the FFR target (circles) and the shadow rate of Wu and Xia (2016) (triangles). The coefficients are obtained from regressing cumulative changes in policy rate ($\Delta FFR_{t+h} = FFR_{t+h} - FFR_t$ and analogously for the shadow rate), on the PMU indices, and controls including GB forecasts, trend inflation τ_t, two lags of policy rate (t and $t-1$), the BBD EPU index and inflation and real-economy sentiment ($InfSent_t$, $EcoSent_t$). The textual measures are obtained from statements of FOMC members in the economy round of the meeting. The spikes mark the 95% confidence intervals obtained with HAC standard errors. The maximum sample for the eight-meeting-ahead forecast is 1987:08–2008:12 using the FFR target and 1987:08–2015:12 using the shadow rate.

Figure 4 presents the effect of a one-standard-deviation change in the inflation and real-economy PMU on the cumulative change in the policy rate up to eight meetings ahead. We superimpose the estimates for the FFR target in the pre-zero lower bound period (marked as circles) and the shadow rate in the full sample (marked as triangles). The effect of uncertainty accumulates with the horizon. At eight meetings ahead, inflation PMU induces a 31 basis point FFR target increase. In economic terms, this magnitude is the largest among the covariates we consider and is slightly larger than that of a one-standard-deviation increase in the real GDP growth nowcast (which equals 28 basis points at eight meetings ahead). The extended analysis with the shadow rate confirms a large cumulative impact of inflation PMU (34 basis points at the eight-meeting horizon). In contrast, the longer-run effect of the real-economy PMU is less robust, with statistical and economic magnitudes weakening further in the full sample.

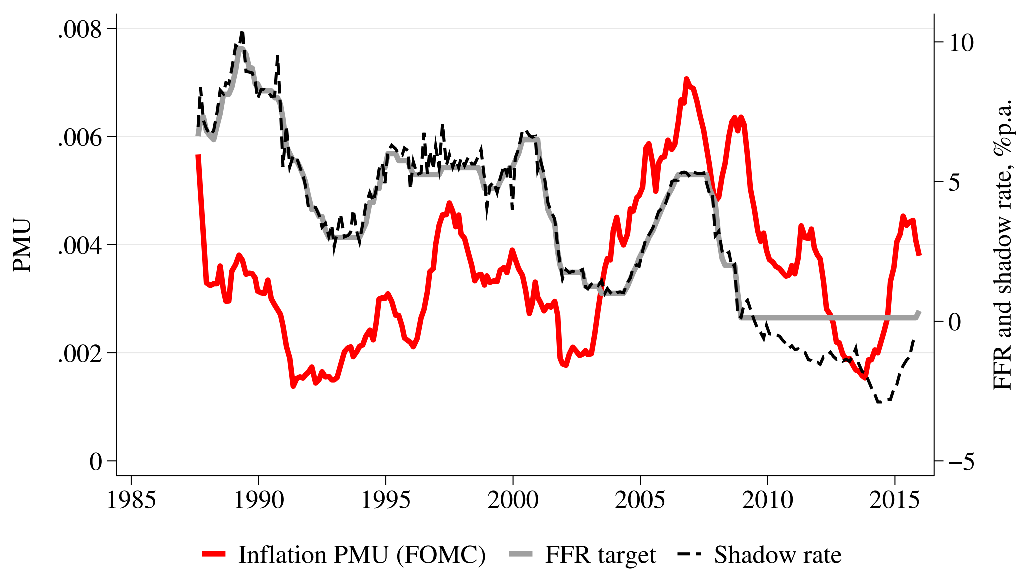

Figure 5. Inflation PMU and policy rate. The figure superimposes the inflation PMU of FOMC members measured in the economy round of the meeting against the policy rate: FFR target and the shadow rate from Wu and Xia (2016). The PMU is smoothed over the last eight meetings.

One might be concerned that the effects of inflation PMU are due to a particular episode in our sample. Therefore, to visualize the predictive content of inflation PMU for future policy, Figure 5 superimposes the FFR target and the shadow rate against the FOMC members' inflation PMU (smoothed over the last eight meetings). The figure illustrates a systematic relationship whereby policy tightenings (easings) tend to be preceded by rising (declining) policymakers' perceptions of inflation uncertainty.

V. Inflation Tail Risk

Our empirical results connect the FOMC's perceptions of inflation uncertainty to a more hawkish policy stance. We have argued that such a directional effect of uncertainty is difficult to explain within classic models of uncertainty in monetary policymaking based on parameter uncertainty. In this section, we entertain an alternative interpretation of the empirical findings: that the FOMC is particularly sensitive to upper-tail inflation risks, i.e., small probabilities of large inflation outcomes.

We present a specific case of the general framework from Section II, in which Fed-managed inflation uncertainty arises because policy affects the probability of inflation tail risks. The model delivers two testable predictions. First, inflation PMU should be positively related to expected inflation. Second, the relationship between inflation PMU and policy stance should be the strongest when expected inflation is above the target. We verify both predictions in the data. We then provide narrative evidence from the FOMC transcripts consistent with the tail risk considerations. The policymakers emphasize the need to maintain credibility to avoid tail risks that could arise from unanchored inflation expectations. Proofs for formal results are in Appendix D.

V.A. Setting

To introduce inflation tail risks into the framework of Section II, we assume that the distribution of inflation can be described by the following two-state mixture model:

$$\pi_t \sim \begin{cases} \mathcal{N}(\overline{\pi}_t - a_\pi r_t, s^2_{\pi,t}) & \text{w.p.} \quad 1 - p_t(r_t) \\ \mathcal{N}(\overline{\pi}_t + \Delta_t - a_\pi r_t, s^2_{\pi,t}) & \text{w.p.} \quad p_t(r_t). \end{cases} \tag{7}$$

In each state, inflation is drawn from a Gaussian distribution, as is typical in macro models. The two states differ, however, in their expected level of baseline inflation because $\Delta_t > 0$. The high-inflation state is realized with probability $p_t(r_t)$. Crucially, the probability depends on the policy choice r_t. To contrast this case with a situation where such policy dependence is absent, we also consider an alternative distribution in which the high-inflation state is realized with probability $p_{0,t}$ that does not depend on the policy.

We make the following assumptions about the tail-risk probability:

Assumption 1. ***Inflation tail risk***

1. $0 \leq p_t(r_t) < 0.5$ *for all* r_t.

2. $p'(r_t) := \frac{\partial p_t(r_t)}{\partial r_t} < 0$ *for all* r_t.

3. $p'(r_t)$ *is continuous and bounded.*

The first assumption implies that the high-inflation state is the rarer event, consistent with the notion of tail risks. The second assumption stipulates that inflation tail risk declines when the policy becomes more hawkish. The third assumption is technical and ensures the loss function is well-behaved in r_t.

The negative dependence of the tail risk probability on the policy rate is critical for subsequent discussion and is motivated by the idea of "inflation scares" from Goodfriend (1993).[25] A policy that is not sufficiently hawkish against inflation raises the chance that the central bank loses its credibility, which in turn leads to a large inflation realization. A tighter monetary policy reduces the chance of losing the nominal anchor. Throughout, we maintain the standard assumption of a quadratic loss function as in equation (2). Even if policymakers' preferences are symmetric, they may nevertheless have motives to act on inflation uncertainty. Maintaining credibility to avoid costly scenarios in which inflation expectations become unanchored is one such motive.

The baseline inflation uncertainty, denoted by $s^2_{\pi,t}$ in equation (7), is the same in both states. Since our empirical results suggest that Fed-managed uncertainty arises only for inflation, we assume that the output distribution is $y_t \sim \mathcal{N}(\overline{y}_t - a_y r_t, s^2_{y,t})$ where $s^2_{y,t}$ is exogenously given.

V.A.1. Prediction I: Policy-dependent tail risk generates co-movement between inflation mean and variance

Given the expected loss function (2), the mean and variance of macroeconomic outcomes are the key moments for determining policy choice.

Lemma 1. *Under the distribution of inflation in equation* (7), *expected inflation and inflation variance are*

1. $\overline{\Pi}_t(r_t) = \overline{\pi}_t - a_\pi r_t + p_t(r_t)\Delta_t$
2. $\sigma^2_{\pi,t}(r_t) = s^2_{\pi,t} + p_t(r_t)[1 - p_t(r_t)]\Delta^2_t$.

Expected inflation combines the common component $\overline{\pi}_t - a_\pi r_t$ in both states with a term due to the tail risk $p_t(r_t)\Delta_t$. The variance of inflation $\sigma^2_{\pi,t}$ is given by the baseline inflation

[25] See also Goodfriend and King (2005), Orphanides and Williams (2005), King and Lu (2022). Orphanides and Williams (2022) discuss how Goodfriend's insight has influenced policymakers' thinking in the decades following his 1993 paper, covering a major part of our sample.

uncertainty ($s^2_{\pi,t}$), and the tail risk component that is increasing in the tail event probability (on the domain $p_t(r_t) < 0.5$) as well as in the size of the jump in inflation Δ_t if the tail event occurs. We also consider a benchmark where tail risks are fixed, in the sense that they do not depend on policy. In the fixed tail risks model, denoted with subscript F, the mean and variance become $\overline{\Pi}_{t,F}(r_t) = \overline{\pi}_t - a_\pi r_t + p_{0,t}\Delta_t$ and $\sigma^2_{\pi,t,F} = s^2_{\pi,t} + p_{0,t}[1 - p_{0,t}]\Delta^2_t$, where the latter is independent of r_t.

The tail risk assumption introduces the link between expected inflation and inflation uncertainty. Since both the mean and variance of inflation are increasing in the objects that generate tail risk, i.e., Δ_t and $p_t(r_t)$, the model's first prediction is that inflation uncertainty is positively correlated with measures of expected inflation.

To illustrate this prediction in the data, Figure 6 plots FOMC members' inflation PMU against two proxies for expected inflation. In Panel A, we use Greenbook inflation forecasts. To focus on the cyclical variation in expected inflation, we orthogonalize the four-quarters-ahead inflation forecast $F_t(\pi_4)$ with respect to the trend inflation, τ_t, and graph the residual, which we denote with $F_t(\pi_4)^\perp$. In Panel B, we consider inflation sentiment $\mathit{InfSent}_t$ as an alternative proxy for policymakers' inflation beliefs.

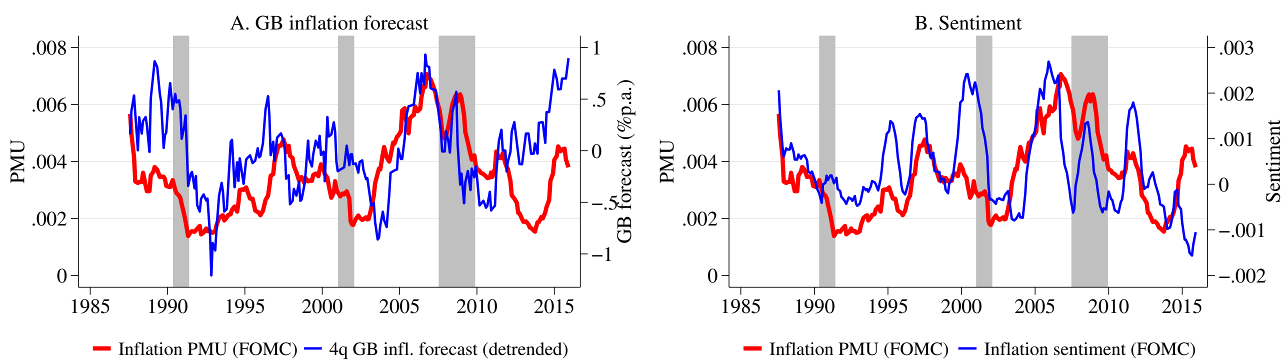

Figure 6. Inflation PMU and expected inflation. Panel A superimposes inflation PMU against $F_t(\pi_4)^\perp$, which proxies for the deviation of expected inflation from the target. $F_t(\pi_4)^\perp$ is constructed by orthogonalizing the four-quarter Greenbook CPI inflation forecast residualized with respect to the trend inflation, τ_t. Panel B superimposes inflation PMU against inflation sentiment, constructed from FOMC members' statements. Increasing inflation sentiment indicates the balance of views toward rising inflation. The text-based series are smoothed averages over the last eight FOMC meetings.

A positive relationship with inflation PMU is evident for both expected inflation measures. The correlation is 0.31 for $F_t(\pi_4)^\perp$ and 0.30 for sentiment (based on unmoothed series). Further decomposing inflation sentiment into separate positive and negative components, we find that the co-movement with PMU is driven primarily by the positive sentiment, i.e., the language associated with increasing inflation (as shown in Appendix Figure C.2).[26] This evidence aligns with the prediction that inflation PMU increases with beliefs about rising inflation, as implied by the tail risks model.

V.A.2. Prediction II: Effect of tail risk on policy depends on expected inflation deviation from the target

To illustrate the effects of Fed-managed uncertainty in this framework, consider first the setting in which tail risks do not depend on policy. The first-order condition for determining optimal policy, $\hat{r}_{0,t}$, obtained from differentiating the expected loss function (2) with respect to r_t, is

$$\overline{\Pi}'_{t,F}(\hat{r}_{0,t}) \left[\overline{\Pi}_{t,F}(\hat{r}_{0,t}) - \pi^*\right] = -\lambda \overline{Y}'_t(\hat{r}_{0,t}) \left[\overline{Y}_t(\hat{r}_{0,t}) - y^*\right], \tag{8}$$

where $\overline{Y}_t(r_t) = \overline{y}_t - a_y r_t$ is expected output under policy r_t. Expression (8) equates the marginal cost of increasing r_t on the left-hand side (i.e., the marginal increase in the inflation loss) with the marginal benefit of increasing r_t on the right-hand side (i.e., the marginal decrease in the output loss). Solving equation (8) yields the certainty-equivalence policy rule from Section II, albeit with expected inflation now given by Lemma 1.

On the other hand, the optimal policy with policy-dependent tail risks $\hat{r}_{1,t}$ is defined by:

$$\overline{\Pi}'_t(\hat{r}_{1,t}) \left[\overline{\Pi}_t(\hat{r}_{1,t}) - \pi^*\right] + \left[\frac{\partial \sigma^2_{\pi,t}}{\partial r_t}\right]_{r_t = \hat{r}_{1,t}} = -\lambda \overline{Y}'_t(\hat{r}_{1,t}) \left[\overline{Y}_t(\hat{r}_{1,t}) - y^*\right]. \tag{9}$$

The first important difference between policymakers' decision in (9) versus (8) is that raising r_t now reduces inflation variance by shrinking the probability of an inflation tail event as $p'_t(r_t) < 0$. This, in turn, creates an additional incentive to increase r_t. This effect is the manifestation of Fed-managed uncertainty in this framework, and is depicted by $\frac{\partial \sigma^2_{\pi,t}}{\partial r_t}$ in equation (9).

Second, the policy-dependent tail risks generate an additional effect via the expected inflation. A tightening reduces expected inflation in each state through the usual mean effect, but now also diminishes the tail-risk probability, which lowers expected inflation even further.[27] When expected inflation under the fixed-risk baseline is above target, $\overline{\Pi}_{t,F}(\hat{r}_{0,t}) - \pi^* > 0$, the amplification due to inflation tail risk reduces the (marginal) cost of raising rates since inflation is brought back to target faster. When expected inflation is below target, instead,

[26] Appendix Table C.14 reports regressions of expected inflation and sentiment on inflation PMU, showing that the relationship is economically and statistically significant. The loading of $InfPMU_t$ on positive sentiment ($InfPos_t$) is about twice as strong as that on negative sentiment ($InfNeg_t$).

[27] As such, expected inflation declines more in response to a given policy tightening, i.e., $\overline{\Pi}'_t(r_t) < \overline{\Pi}'_{t,F}(r_t)$. This can be seen from Lemma 1 and Assumption 1 with $p'(r_t) < 0$: $\overline{\Pi}'_t(r_t) = p'(r_t)\Delta_t - a_\pi < -a_\pi = \overline{\Pi}'_{t,F}(r_t)$.

the marginal cost of raising rates is strengthened. In sum, while the model generates an incentive to raise rates via Fed-managed uncertainty, $\frac{\partial \sigma^2_{\pi,t}}{\partial r_t}$, it also predicts an additional effect through inflation mean, which can either enhance or dampen the incentive to raise rates. Only when expected inflation is above target can one unambiguously assert that tail risks induce more hawkishness.

Proposition 1. *Let $\hat{r}_{0,t}$ be the optimal policy under policy-invariant tail risk, and $\hat{r}_{1,t}$ the optimal policy when the tail risk probability depends on policy via the relationship $p_t(r_t)$.*

Then $\hat{r}_{1,t} > \hat{r}_{0,t}$ if $\overline{\Pi}_{t,F}(\hat{r}_{0,t}) - \pi^* > 0$ and $p_t(\hat{r}_{0,t}) = p_{0,t}$.[28]

As a testable prediction, the impact of inflation PMU on policy stance should be particularly strong when expected inflation is above target. Table VIII explores this hypothesis empirically, by analyzing whether the relationship between inflation PMU and HD depends on the directional deviation of expected inflation from the target. As a proxy for such deviation, we again use the $F_t(\pi_4)^{\perp}$ residual as depicted in Figure 6, Panel A. To the extent that Greenbook forecasts do not internalize policy-dependent inflation tails, by Proposition 1, it is appropriate to condition the analysis on the deviation of Greenbook forecasts from the target.

For reference, column (1) of Table VIII presents the baseline specification using all meetings. We then divide the sample according to whether $F_t(\pi_4)^{\perp}$ is negative (column (2)) or positive (column (3)). Importantly, the relationship between inflation PMU and HD is only statistically significant for meetings with a positive $F_t(\pi_4)^{\perp}$, indicating above-target expected inflation. The point estimate on PMU in those meetings is 2.5 times larger than in other meetings. To directly test the difference between coefficients in low and high expected inflation regimes, column (4) interacts inflation PMU with a dummy variable equal to one when $F_t(\pi_4)^{\perp}$ is positive. The estimated coefficient on this interaction is significant, indicating that inflation uncertainty indeed leads to a more hawkish policy stance during episodes with above-target expected inflation.

To test whether the results are specific to inflation or simply reflect a business cycle variation in PMU, columns (5)–(7) repeat the analysis, splitting the sample by whether the Greenbook real GDP growth nowcast $F_t(g_0)$ is above or below the sample mean. Here, we find much weaker evidence for an asymmetric association between inflation PMU and HD. As such, the state-dependent relationship between uncertainty and stance is specific to policymakers' inflation concerns.

[28]The condition $p_t(\hat{r}_{0,t}) = p_{0,t}$ in Proposition 1 implies that expected inflation under policy-invariant and policy-dependent tail risks is the same when $r_t = \hat{r}_{0,t}$. This normalization ensures that tail risks do not change optimal policy simply because expected inflation changes relative to a fixed-risks setting.

Dependent variable: Meeting-level policy stance score, HD_t

		Split by CPI inflation			Split by RGDP growth		
	(1) All	(2) Low	(3) High	(4) Interact	(5) Low	(6) High	(7) Interact
$InfPMU_t$ (FOMC)	0.185***	0.105	0.250***	0.108	0.207**	0.141*	0.220***
	(2.97)	(1.61)	(3.36)	(1.48)	(2.30)	(1.84)	(2.62)
$EcoPMU_t$ (FOMC)	-0.100	-0.132	-0.052	-0.108	-0.164*	-0.104	-0.092
	(-1.48)	(-1.51)	(-0.42)	(-1.56)	(-1.71)	(-0.83)	(-1.40)
$InfPMU_t$(FOMC) $\times$ $1_{\pi \text{ high}}$				0.202**			
				(2.52)			
$InfPMU_t$(FOMC) $\times$ $1_{g \text{ high}}$							-0.107
							(-0.94)
GB controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sentiment	Yes	Yes	Yes	Yes	Yes	Yes	Yes
$\bar{R}^2$	0.43	0.32	0.51	0.43	0.44	0.24	0.43
N	227	122	105	227	106	121	227

Table VIII. Test of prediction II. The table reports regressions of meeting-level policy stance, HD_t on inflation PMU and sentiment, conditioning on the level of inflation expectations and real GDP growth. Column (1) presents the baseline estimate from Table IV, column (6). Columns (2)–(4) condition on the level of Greenbook four-quarter ahead CPI inflation forecasts. Column (2) runs the baseline regression on observations when $F_t(\pi_4)$ is below trend ("Low"), and column (3) runs it when $F_t(\pi_4)$ is above trend ("High"). To test the difference in coefficients, column (4) estimates the regression with an interaction of $InfPMU_t$ with a dummy variable equal to one when $F_t(\pi_4)$ is above trend. We define low (high) inflation environment when the residual from regressing $F_t(\pi_4)$ on trend inflation τ_t is negative (positive). Column (5) presents analogous results but splits the sample based on whether nowcast of real GDP growth, $F_t(g_0)$ is above or below the sample mean (2.1%). The text-based measures of PMU are constructed from statements of FOMC members in the economy round of the meeting. Coefficients are standardized. HAC t-statistics are reported in parentheses.

V.B. Policy credibility and inflation tail risk perceptions: Narrative evidence

Equation (7) represents a reduced-form assumption linking policy choices to inflation tail events. While developing a theory of why that dependence arises is outside the scope of the paper, the Fed's credibility considerations are one candidate explanation. Goodfriend (1993) emphasized the importance of "the acquisition and maintenance of credibility for [Fed's] commitment to low inflation" during the Volcker and the early Greenspan Fed. Building on Goodfriend (1993) inflation scares idea, fluctuations in the PMU could thus be interpreted as reflecting the time-varying FOMC's concern about maintaining credibility.[29] To assess the plausibility of the tail-risk credibility channel, we use narrative evidence from the FOMC transcripts. Below, we highlight representative episodes of how credibility matters in policy decisions. Appendix E contains a systematic chronological discussion of this issue throughout our sample.

[29] One source of potential credibility loss is that the market worries the FOMC will deviate to loose policy to boost output as in Barro and Gordon (1983). A credibility loss could also result from the FOMC's misjudgement of the neutral rate, r^*. With the true r^* being higher than policymakers assumed, their policy would become too easy and overstimulate the economy, opening a positive output gap. The probability of such a policy mistake, as well as the associated PMU, and the associated credibility concern, are plausibly time-varying.

Figure 5 suggests that policymakers' perceptions of inflation uncertainty fluctuate significantly and can remain persistently elevated for an extended time. Two episodes that feature rapidly rising inflation PMU are the mid-to-late 1990s and 2004 until the global financial crisis. In the second half of the 1990s, when inflation remained relatively low and stable, transcripts show the FOMC members nonetheless worried about their credibility. The rapid increase in inflation PMU in mid-2004 was accompanied by concerns about rising inflation (e.g., the May 2004 meeting). Even more recently, after a brief focus on deflation during the global financial crisis, by 2012, the FOMC quite quickly returned to worrying about the inflationary impact of the unconventional policies they pursued.

Janet Yellen's statements illustrate policymakers' thinking about inflation uncertainty and credibility. Indeed, Yellen regularly expressed credibility concerns. In the September 1996 meeting, she said *"...the risk of an increase in inflation has definitely risen, and I would characterize the economy as operating in an inflationary danger zone"* and this warranted a small policy response because *"a failure to shift policy just modestly in response to shifting inflationary risks could undermine the assumptions on which the markets' own stabilizing responses are based."*

In November 2005, she was more sanguine about the risks but wary of the need to protect credibility: *"Overall, I judge our credibility to be very much intact. Of course, our credibility going forward does depend on continued vigilance. The economy now appears to be close to full employment, with a good deal of momentum. And annual core inflation, at least as judged by the core PCE measure, remains near the upper end of my comfort zone and, arguably, inflation risks are tilted somewhat to the upside. So with respect to policy, I support at a minimum the removal of any remaining policy accommodation...So a few more increases, including one today, seem to me likely to be required."*

Ben Bernanke, in the May 2004 meeting, worried about adverse inflation movements: *"From a risk-management perspective, as we begin to raise rates we should weigh the risk of significantly impeding the labor market recovery against the risk of having to scramble to adjust to unexpectedly adverse inflation developments."* He too paid attention to credibility concerns. In March 2006, he summarized the deliberations of the policy round as: *"I took from the group some sense of at least a slight upside risk to inflation, reflecting the increasing resource utilization; the fact that inflation is somewhat on the high side of what many people describe as their comfort zone; and the fact that, if inflation does rise, there will be costs to bringing it back down and maintaining our credibility."*

Other FOMC members also focused on credibility. President Melzer (St. Louis) spoke of credibility risks in 1997: *"My reading of the economy supports the conclusion that we are at risk of losing the hard-won credibility of our commitment to hold inflation at 3 percent."*

In that same year, President Guynn (Atlanta) thought that, with the economy around full employment, the FOMC had *"a unique opportunity with little downside risk to lean a bit more against the expected upward creep in inflation that most of us are forecasting and, in doing so, to underscore our resolve and credibility in the minds of financial market participants, business decisionmakers, and the general public."*

Vice Chair, Ferguson, said in December 1999 that the FOMC *"should not be afraid to act in a well-modulated fashion in order to maintain our hard fought victory over inflation and also our credibility."* In March 2005, towards the end of his term, he was still focused on the FOMC's credibility and how policy actions could affect it: *"given the stage of the cycle, the skew in the general risk assessment that I outlined, and the need to manage market expectations, I think we should use our statement to signal our awareness that inflation pressures may have picked up. The incoming data are indicative of that. If we are wrong on the upside risks, both we and the market will adjust. On the other hand, if we fail to reflect the existence of these upside risks, we could easily be perceived as being behind the curve, with negative consequences in terms of inflation dynamics and, potentially, our own credibility."*

V.C. Discussion

Our interpretation that inflation uncertainty significantly affects policy on the basis of credibility concerns has important implications for the modeling of monetary policy decisions. Standard New Keynesian models usually assume full information and rational expectations and are solved under the assumption that the central bank can, and must, commit to its policy reaction function. In such models, credibility is established by the once-and-for-all announcement of the reaction function. Period-by-period discretion is an alternative extreme assumption.

More recently, Bianchi and Melosi (2018) study constrained discretion in monetary policy, in which the central bank is able to deviate from active inflation stabilization temporarily, but at the cost of unanchoring inflation expectations.[30] In support of this idea, our results suggest the need for considering the central bank's fighting continually to establish and maintain credibility and then using that credibility to counter recessions when faced with adverse shocks. Carvalho et al. (2022) and Gáti (2022) find that optimal policy responds aggressively to movements in the long-run inflation expectations. We find that over the 1987–2015 sample, the FOMC has been preemptively hawkish to prevent the *feared* changes

[30] Schaumburg and Tambalotti (2007) analyze a continuum of monetary policy rules with differing degrees of credibility, with full commitment and discretion being the special cases of such quasi or loose commitment. Palomino (2012) explores bond pricing implications of monetary policy under full commitment vis-a-vis discretion, while Lakdawala and Wu (2017) study the implications of loose committment.

in inflation expectations that, indeed, do not materialize in our sample. The signaling aspect of monetary policy to maintain credibility is central to long-standing literature such as Cukierman and Meltzer (1986), Backus and Driffill (1985a,b), and Hansen and McMahon (2016).

Our evidence has additional implications for the empirical analysis of monetary policy rules. A stable Taylor-type reaction function has been shown to provide an inadequate description of the historical FOMC experience. Clarida et al. (2000) estimate monetary policy reaction functions for the US before and after Volcker's tenure, concluding that the Fed was much more sensitive to expected inflation in the post-Volcker era (see also, e.g., Coibion and Gorodnichenko (2011)). Complementing this work, our quantification of policymakers' uncertainty in their internal deliberations suggests that the FOMC's concerns about credibility can lead it to endogenously vary the degree of policy tightness over time.

Our interpretation of the empirical results based on the FOMC perceived inflation tails risk can be motivated by the risk-management approach in policymaking. Greenspan (2004) characterizes risk management of the FOMC as setting policy to reflect "a judgment about the probabilities, costs, and benefits of the various possible outcomes under alternative choices for policy." Accordingly, Kilian and Manganelli (2008) argue that the policy decisions under Greenspan were better described in terms of the Fed weighing upside and downside risks to its objectives rather than simply responding via a Taylor rule to the conditional means of inflation and the output gap.

While the framework of Section II and its tail risk application in Section V, emphasizes uncertainty-driven wedges in the policy reaction function relative to the Taylor rule, it maintains the assumption of the Fed's quadratic and symmetric loss function. A straightforward argument behind this assumption is that, over the 1987–2015 period we study, asymmetry of preferences would be inconsistent with the Fed's mandate. The empirical evidence on the asymmetry in the Fed's inflation preferences is mixed. Surico (2007) finds evidence for asymmetric preferences only during the pre-Volcker regime, with the interest rate response to the output gap being the dominant type of nonlinearity. He fails to establish asymmetry in inflation preferences. Shapiro and Wilson (2022) consider both symmetric and asymmetric objective functions and, again, find mixed results. In their baseline specification, inflation losses increase in a similar way when inflation is above or below the target. More importantly, Shapiro and Wilson (2022) argue that the FOMC had an implicit inflation target of approximately 1.5% on average over the 2000–2011 sample, significantly below the commonly assumed value of 2%. We show that an increased policymakers' inflation uncertainty in this sample was associated with hawkishness, especially in episodes of the

Fed's above-target inflation expectations. This finding is consistent with a low implicit inflation target and, therefore, the FOMC's concern with inflation upper tails in this period.

VI. Conclusions

We contribute to the literature by quantifying otherwise hard-to-measure factors driving monetary policymaking from the transcripts of the FOMC deliberations during the 1987–2015 sample. We develop textual measures for the policymakers' perceptions of different types of uncertainty, directional views on the path of the economy, as well as forward-looking policy stances. We show that uncertainty perceptions drive a wedge between the actual decision-making of the FOMC and standard policy rules estimated using the Fed's economic forecasts from Greenbooks.

Our main new results pertain to the effects of inflation uncertainty. Heightened inflation uncertainty leads to more hawkish views of the entire committee and individual members and predicts a tighter policy path up to eight meetings ahead. The economic magnitude of the uncertainty effect on the policy path is comparable to that of the real GDP growth. The FOMC's expressed uncertainty about inflation relevant to their decision-making is distinct from the public perceptions of uncertainty, objective measures of macroeconomic volatility, and also the uncertainty discussed by the Fed staff. We rationalize these findings with a model of upper inflation tail risks, which are endogenous to policy decisions. Narrative evidence links FOMC's inflation uncertainty perceptions to their concerns about maintaining credibility for fighting inflation.

The issue of central bank efforts to maintain credibility is timely. Chair Powell (2022), in opening remarks at the 2022 Jackson Hole Symposium, spoke forcefully about the Fed's determination to control inflation. The concern with credibility is also warranted. Credibility allows the FOMC to better manage economic expectations, as "achieving through word and deed" well-anchored inflation expectations can lead to better policy outcomes (Bernanke, 2022). Our results suggest that policymakers' inflation uncertainty has reflected their continued vigilance for inflation over the past three decades, shaping policy deliberations and choices in a way not captured by standard reaction function estimates. Understanding the implications of that vigilance for macroeconomic and financial stability is an important next step for future research.

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