FEDERAL RESERVE BANK OF SAN FRANCISCO

WORKING PAPER SERIES

Taking the Fed at its Word: A New Approach to Estimating Central Bank Objectives using Text Analysis

Adam Hale Shapiro and Daniel Wilson
Federal Reserve Bank of San Francisco

June 2019

Working Paper 2019-02

https://www.frbsf.org/economic-research/publications/working-papers/2019/02/

Suggested citation:

Shapiro, Adam Hale, Daniel Wilson. 2019. "Taking the Fed at its Word: A New Approach to Estimating Central Bank Objectives using Text Analysis," Federal Reserve Bank of San Francisco Working Paper 2019-02. https://doi.org/10.24148/wp2019-02

Taking the Fed at its Word: A New Approach to Estimating Central Bank Objectives using Text Analysis*

Adam Hale Shapiro[†] and Daniel J. Wilson[‡]

6/25/19

Abstract

We propose a new approach to estimating central bank objectives, including the implicit inflation target, that requires no priors on the underlying macroeconomic structure nor observation of monetary policy actions. Our approach entails directly estimating the Federal Open Market Committee's (FOMC) objective function from the sentiment expressed by participants at internal meetings. The results challenge two key aspects of conventional wisdom regarding FOMC preferences. First, the FOMC had an implicit inflation target of approximately $1\frac{1}{2}$ percent on average over our baseline 2000 - 2013 sample period, which was below average realized inflation. Second, the FOMC's loss is monotonically decreasing in real economic activity. We show these two results are complementary within a simple New Keynesian model.

*We thank Lily Huang and Ben Shapiro for superb research assistance and we thank the team of FRBSF research assistants who participated in the human audit study for this paper. We are indebted to Moritz Sudhof for his help with parsing the FOMC text data by speaker and general advice on text analysis. We thank Regis Barnichon, Vasco Curdia, Richard Dennis, John Fernald, Matthew Gentzkow, Victoria Nuguer, Glenn Rudebusch, and John Williams for invaluable feedback on the project. The paper benefitted from comments and suggestions by seminar participants at the Federal Reserve Bank of San Francisco, the National Association of Business Economists, and the Central Bank of Brazil Annual Inflation Targeting Conference. The views expressed in this paper are solely those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of San Francisco, or the Board of Governors of the Federal Reserve System.

[†]Federal Reserve Bank of San Francisco, adam.shapiro@sf.frb.org

[‡]Federal Reserve Bank of San Francisco, daniel.wilson@sf.frb.org

I'm bemused by the de facto inflation targeters that we have become here [laughter] with the 1.5 percent goal.

– Ben Bernanke, Chairman of the Federal Reserve
September 2006 FOMC Meeting

...I worry that future researchers are probably going to find evidence that we're acting as if our goal is symmetric around something that's below 2 percent, not 2 percent.

– Charles Evans, President of Federal Reserve Bank of Chicago
June 2012 FOMC Meeting

1 Introduction

What is the central bank's objective function? This is a core question of monetary macroeconomics. The canonical model assumes that the central bank has quadratic preferences over inflation, relative to a known target, and economic slack (see, e.g., Walsh (2017)). Although there is broad consensus on what the central bank objective function *should* look like based on the large literature on optimal monetary policy, there has been very little study of what the central bank objective function actually *is* in practice. The dearth of positive analysis of the central bank objective function is surprising considering it is implicitly the foundation underlying monetary policy rules. Moreover, the sparsity is certainly not due to a belief that the objective function is well understood. For example, even the functional form, much less the parameters, is not widely agreed upon. As Blinder (1997) argued, "academic macroeconomists tend to use quadratic loss functions for reasons of mathematical convenience, without thinking much about their substantive implications. The assumption is not innocuous...practical central bankers and academics would benefit from more serious thinking about the functional form of the loss function."

In this paper, we propose a new approach to estimating central bank objectives. We demonstrate how extracting sentiment through text analysis of central bank deliberations can be used to directly estimate its short-run loss function, including the implicit inflation target. Specifically, we proxy for loss—the left-hand-side variable of the loss function—using a measure of the negativity expressed in the U.S. Federal Open Market Committee's (FOMC) internal discussions. Our negativity measure uses a lexical approach based on the economics/finance-specific dictionaries of positive and negative words developed by Loughran and McDonald (2011) and subsequently refined. These dictionaries contain thousands of words and include both common-language terms and terms that are specific to economics and finance vernacular. For each speaker at each meeting, we construct a measure of the net negativity of their remarks based on their differential use of negative and positive words. To measure the variables potentially entering the FOMC's short-run loss function, we use real-time data on the Federal Reserve's staff (Greenbook) forecasts of near-term core PCE inflation and real economic variables (as in Coibion and Gorodnichenko (2011) and Orphanides (2004)) along with contemporaneous stock market variables.

The results from this exercise challenge two key aspects of the conventional wisdom on FOMC preferences. First, the analysis indicates that the FOMC had an implicit inflation target of approximately $1\frac{1}{2}$ percent on average over the 2000-2013 sample period.[1] This finding is robust to using alternative measures of negativity, including or excluding additional factors in the objective function, and allowing for asymmetric preferences. Our implicit inflation target estimate is significantly below the 2 percent value assumed in many macroeconomic models as well as both average realized inflation and survey measures of longer-run inflation expectations over that period, implying a persistently positive inflation gap.[2] It is also below the explicit 2 percent target that was publicly announced by the FOMC in its January 2012 "Statement on Longer-Run Goals and Monetary Policy Strategy,"[3]

Given this stark divergence between our estimate of an implicit inflation target of $1\frac{1}{2}$ and the conventional prior of 2, we complement our regression analysis with a narrative analysis that identifies and tabulates instances in which FOMC meeting participants stated an explicit inflation target preference. Though stated target preferences are conceptually distinct from the implicit target consistent with the overall tone of the committee's discussion, we do find that the consensus target preference was $1\frac{1}{2}$ percent for most of our baseline sample period. However, we also document a shift toward 2 percent around the end of the Great Recession which became the consensus preference by the time of the January 2012 public declaration of a 2 percent target.[4]

[1] We use 2000 as the start year of our baseline sample because this was the first year in which the Greenbook began forecasting PCE inflation. 2013 is the latest year for which FOMC transcripts are available (as of the time of this writing).

[2] For example, the perceived inflation target rate (PTR) variable used in the Federal Reserve Board's FRB/US model and academic papers (e.g., Fuhrer, Olivei, and Tootell (2012) and Bauer and Rudebusch (2017)) is based on long-run inflation expectations from the Survey of Professional Forecasters, which was slightly above 2 percent over our sample period. The New York Fed's DSGE model, Del Negro, Eusepi, Giannoni, Sbordone, Tambalotti, Cocci, Hasegawa, and Linder (2013), sets a prior on the inflation target centered at 2 percent.

[3] We find evidence that at least some of the FOMC members (e.g., St. Louis Fed President Poole and New York Fed President Geithner), were aware of this discrepancy. We demonstrate theoretically in Section 2 that the loss function we find to be most supported by the data, one in which real output growth linearly reduces loss, has the theoretical implication that actual inflation can run persistently above target as the central bank trades off a positive inflation gap against higher economic growth.

[4] The upward shift after 2008 seen in the narrative analysis begs the question of whether the FOMC's *implicit* inflation target also increased around that time. Though the ability to identify a post-2008 break in the inflation target is somewhat limited by the short time series dimension, we show in Section 6 that there

Second, in contrast to typical formulations of the central bank loss function, we find that the FOMC's loss is monotonically decreasing in real economic activity. Specifically, the results show that loss is decreasing in output growth[5] and financial market performance.[6] Such an objective function, as formulated by Barro and Gordon (1983) and described in Walsh (2017), has an important implication: the central bank is willing to trade off a positive inflation gap in exchange for higher real activity. In other words, a positive inflation gap in the steady state is theoretically consistent with linear preferences over real activity. The empirical results therefore square with the predictions of a simple New Keynesian model with such a loss function.

Direct estimation using text analysis offers a new approach to studying central bank preferences, complementing prior indirect approaches. Prior analyses have relied on indirect inference, deriving central bankers' preferences from either observed interest rate votes[7] or statements about desired interest rates viewed through the lens of an estimated interest-rate rule.[8] Inferring the objective function from estimated interest-rate rules has two main drawbacks. First, as we demonstrate in Section 2 (and has been shown previously), inferring the parameters of the objective function, or even what variables are in it, requires precise knowledge of the structure of the macroeconomic model implicitly underlying the central bank's actions.[9] For instance, if the central bank believes the economy behaves according to the New Keynesian framework, backing out the structural parameters of the objective function requires knowledge of the slopes and persistence parameters of the Phillips and IS curves—parameters for which there is very little consensus in the literature. More broadly, the actual structure of the economy is undoubtedly more complex than any available theo-

is little indication of a post-2008 break in the implicit target.

[5]We find little evidence that the loss function depends on the level of slack or the quadratic of slack. While the finding that the FOMC appears to care more about output growth than slack may seem surprising given that slack is commonly assumed to be part of the FOMC's loss function (while growth in the loss function is somewhat less common), it is consistent with narrative evidence from the FOMC's public communications. Thornton (2011) documents that from 1991 until 2009 the FOMC's policy directive, announced to the public after each FOMC meeting, stated "The Federal Open Market Committee seeks monetary and financial conditions that will foster price stability and promote sustainable *growth in output*" [italics added]. Thornton further notes that neither "maximum sustainable employment nor the unemployment rate" is mentioned in these directives.

[6]We find that both recent S&P gains/losses and volatility (VIX) affects the FOMC's loss. This is consistent with work by Peek, Rosengren, and Tootell (2015) and Wischnewsky, Jansen, and Neuenkirch (2019) who argue that the FOMC responds to financial variables, or at least financial variables that signal instability. It is also consistent with Cieslak and Vissing-Jorgensen (2018) who find that negative mentions of the stock market in FOMC minutes and transcripts have high explanatory power for interest rate policy changes.

[7]See Favero and Rovelli (2003), Dennis (2006), Surico (2007), Ilbas (2012), and Givens (2012)

[8]See Chappell Jr, Havrilesky, and McGregor (1997) and Meade and Stasavage (2008).

[9]This point has been made previously in several studies of optimal monetary policy, such as Rudebusch and Svensson (1999) and Surico (2007).

retical model (Blanchard (2018)). Second, identification of the objective function is limited to periods in which there are changes to the federal funds rate target. There are plausibly many instances when the FOMC is in some way constrained in its ability to change its policy target to perfectly align with its preferences. The zero lower bound, which recently bound between 2008 and 2015, is the most obvious such constraint. Another is the convention of only moving the fed funds target by quarter-point increments.

In the remainder of the paper, we first present a simple three-period New Keynesian model to demonstrate the general relationships between central bank preferences, macroeconomic conditions, and monetary policy. In Section 3, we describe the textual source data we compiled on FOMC meeting transcripts, minutes, and speeches and how we measured the negativity therein. We also show how the negativity in each of these sources has varied over time. Section 4 presents the core results of the paper. Based on the FOMC's private meeting transcripts, we first estimate a standard symmetric, quadratic loss function for the 2000-2013 period and identify the implied inflation target. We then allow for asymmetry. In Section 5, we extend the loss function estimation back to 1986 and allow for a time-varying inflation target. We complement the sentiment regression analysis with a narrative analysis in Section 6, seeking to identify explicit statements of an inflation target preference. In Section 7, we estimate the loss function implied by negativity in the FOMC's *public* communications, namely the meeting minutes and FOMC members' public speeches. We find the loss function implied by minutes and speeches are generally similar to that based on the transcripts and also point to an implicit inflation target around $1\frac{1}{2}$. We offer concluding remarks in Section 8.

2 A Simple Theoretical Framework

The canonical model of central bank preferences and optimal policy is based on an assumed central bank loss function within a standard New Keynesian model of the macroeconomy (see, for example, Clarida, Gali, and Gertler (1999), Giannoni and Woodford (2003), Walsh (2004), and Surico (2007)). Here we present a simple version of the model that conveys the role of the loss function in determining interest rate policy and illustrates the difficulty of identifying the structural parameters of the loss function from estimates of the interest rate rule alone. The key elements of this framework consist of three equations: the central bank loss function in terms of inflation and real economic activity (for example, the unemployment gap), the "Phillips Curve" relating inflation to real economic activity, and the "IS" curve relating real economic activity to the real interest rate chosen by the central bank.

The central bank seeks to minimize the sum of current and expected future per-period losses:

$$\mathcal{L} = \sum_{\tau=0}^{\infty} L_{\tau}. \tag{1}$$

where 1 is referred to as the central bank's loss criterion. Suppose the central bank's (per-period or contemporaneous) loss function is given by:

$$L_{\tau} = \frac{1}{2}(\tilde{\pi}_{\tau}^2 + \phi x_{\tau}^2). \tag{2}$$

where $\tilde{\pi} \equiv \pi - \pi^*$ is the inflation gap, defined as inflation minus the central bank's inflation target, and x represents real economic activity. Typically, x is interpreted as representing the output gap $(y - y^*)$ or the unemployment gap $(u - u^*)$, though x could also be interpreted as a vector of variables capturing real activity.[10]

The Phillips Curve (PC) dictates how inflation is affected by real economic activity and lagged inflation (assuming adaptive expectations):

$$\tilde{\pi}_{\tau} = \psi \tilde{\pi}_{\tau-1} + \gamma x_{\tau-1}, \tag{3}$$

where ψ represents the degree of inflation persistence and γ represents the sensitivity of future inflation to current real economic activity.

The IS curve relates real activity to interest rate policy and lagged real activity:

$$x_{\tau} = \rho x_{\tau-1} + a r_{\tau-1}, \tag{4}$$

where ρ represents the degree of persistence in real activity, r is the real interest rate, and a represents the sensitivity of real activity to interest rates. The central bank chooses the interest rate to minimize equation (1). As is standard in the literature on optimal monetary policy, we assume the central bank seeks a fully optimal commitment policy, which entails choosing in the base period a constant interest rate: $r_{\tau} = r_0$.

As shown in Appendix A.1, substituting the PC and the IS curve into equation (2) under a simple three-period framework, differentiating with respect to r_0, and solving for r_0 yields the following interest rate rule:

$$r_0 = B\tilde{\pi}_0 + Cx_0, \tag{5}$$

[10] For example, empirical Taylor rule specifications often include real output growth and financial market variables.

where B and C are non-negative functions of the structural parameters. This equation says that the optimal interest rate is increasing in the inflation gap and the output gap, with the coefficients B and C determining its responsiveness to the inflation gap and output gap, respectively. B and C are complicated functions of the structural parameters of the loss function, PC, and IS curve:

$$B = \frac{\gamma\psi^2}{a(\gamma^2 + \phi + \phi(1+\rho)^2)}, \tag{6}$$

$$C = \frac{\gamma^2(\psi + \rho) + \phi\rho(1 + \rho + \rho^2)}{a(\gamma^2 + \phi + \phi(1+\rho)^2)}, \tag{7}$$

There are a couple aspects of these coefficients that are important to note. First, notice that even if the central bank only cares about inflation ($\phi = 0$), its interest rate target should still respond to movements in the output gap ($C > 0$). This sensitivity is due to the effect of real activity on future inflation via the Phillips curve ($\gamma > 0$). Thus, empirical findings that the interest rate target responds to x do not necessarily imply that x is part of the central bank's loss function. Second, and most important, estimates of B and C from a Taylor rule regression cannot recover the structural parameters of the loss function without also knowing the values of the IS and Phillips curve parameters.[11] And, of course, more complicated loss functions or economic environments will only introduce more structural parameters into the interest rate rule coefficients.[12] In other words, the only way to back out the structural parameters of the central bank loss function from a Taylor rule estimation is to assume one has full knowledge of the macroeconomic model characterizing the monetary transmission channels. In addition, any instability over time in the structural parameters of the IS or Phillips curves would further complicate efforts to infer the loss function parameters from estimated Taylor rule coefficients. For instance, there has been evidence in recent years that the slope of the Phillips curve has flattened over the past couple of decades (e.g., Leduc and Wilson (2017).

An important alternative loss function – and one for which we find empirical support below – is a more flexible functional form in which real activity (x) also enters linearly:

$$L_\tau = \frac{1}{2}(\tilde{\pi}_\tau^2 + \phi x_\tau^2) - \lambda x_\tau. \tag{8}$$

[11] This point has been made previously in Dennis (2006), Surico (2007), and elsewhere.

[12] For instance, a recent paper by Nakamura and Steinsson (2018) argues that Fed interest rate shocks may have an additional channel beyond the conventional IS curve. Interest rate shocks, because they reflect the Fed's economic forecasts, convey information to private agents about future (potential) output growth which can create actual output growth through investment decisions. This additional Fed information channel introduces even more structural parameters into the economic environment, further complicating the ability to infer the Fed's loss function from estimates of their interest rate rule.

This loss function was suggested in Barro and Gordon (1983) and further analyzed in Walsh (2017). The standard quadratic formulation assumes that policymakers equally dislike real activity below *and* above its sustainable level. As discussed in Walsh (2017), policymakers may instead have a "desire for greater output...motivated by an appeal to political pressure on monetary policy...or distortions due to taxes, monopoly unions, or monopolistic competition [that] may lead [potential output] to be inefficiently low." The quadratic formulation also is at odds with actual statements made by FOMC participants. For example, in a speech on July 25, 2000, Dallas Federal Reserve Bank President Robert McTeer said: "As far as I'm concerned, real growth can't be too fast and unemployment can't be too low."

In Appendix A.1, we derive the optimal interest rate rule obtained from this loss function:

$$r_0 = B\tilde{\pi}_0 + Cx_0 - \lambda D, \tag{9}$$

where B, C, and D are combinations of other structural parameters. The optimal rule has three notable features. First, even though the loss function (8) is decreasing in real activity, optimal policy still prescribes increasing the interest rate target when real activity increases, as in the standard Taylor rule derived from a quadratic loss function. In other words, observing that the central bank tends to raise rates when x is high and lower rates when x is low says very little about what the underlying loss function looks like. Second, as was the case with the standard quadratic loss function, the coefficients on inflation and real activity in the implied interest rate rule are combinations of multiple structural parameters, making it impossible to back out the structural parameters of the loss function without an exact knowledge of PC and IS curves. Third, in contrast to the standard Taylor rule, this rule has a negative constant term (λD). This negative constant has an important implication: the optimal real interest rate will be *below* the real interest rate consistent with a zero inflation gap.

Importantly, this negative constant term also implies that the central bank may tolerate inflation that is persistently above target. Specifically, substituting this optimal interest rate rule above into the IS and Phillips curve, and taking the partial derivative with respect to λ shows that the optimal inflation gap is increasing in λ:

$$\frac{\partial \tilde{\pi}_2}{\partial \lambda} = \frac{\gamma(2+\rho)}{\gamma^2 + \phi(1-\rho)^2} > 0 \tag{10}$$

since γ, ρ, and ϕ are all assumed to be positive. When $\lambda = 0$, the central bank's optimal inflation gap is zero. As λ increases, the central bank is more willing to trade off the loss from a positive inflation gap against the gain from higher real economic activity. The more persistent an increase in real activity (i.e., the larger is ρ) the higher the benefit of the tradeoff. Conversely, the steeper the slope of the Phillips curve (γ), or the more the central bank dislikes variance in real activity (ϕ), the more costly is the tradeoff.

3 Data

We extract a direct measure of the FOMC's loss from publicly available transcripts and speeches. Below we outline the data sources used and describe how we quantified the negativity expressed in FOMC meetings, minutes, and speeches. We then show how our negativity measure has varied over time.

3.1 Data Sources

Our main textual data source is the public archive of FOMC transcripts that can be downloaded directly from the Federal Reserve Board of Governors website: `https://www.federalreserve.gov/monetarypolicy/fomc_historical.htm`. These include all regular FOMC meetings from 1976 to 2013 (as of the time of this writing), though we make no use of pre-1986 transcripts in this paper given other data constraints. We converted these pdf files to text files and then parsed the text to generate separate text files for every utterance (sentence) in the transcript which is tagged with a speaker. There were 637,779 total utterances. We then apply three filters to remove utterances likely to be especially noisy. First, we drop utterances with less than five words. Second, we drop stand-alone utterances, defined as an utterance that is preceded and followed by utterances from different speakers. Third, we used the Oxford Dictionary of Economics (ODE) to filter out remarks that did not contain at least one economics-related term. We define a remark as a set of consecutive utterances by a single speaker (i.e., comments made by a speaker before discussion turned to another speaker). Because the ODE is quite expansive, containing 3,229 terms, and very little of the discussions at FOMC meetings is unrelated to economics, this filter removed just 3.5 percent of the 519,342 utterances remaining after the first two filters, leaving 501,420. As we show in Section 4, our results are very similar whether or not we apply the economic-terms filter. We also provide results based on two alternative filters, one that keeps only remarks containing terms related to inflation and one that keeps only remarks related to slack.[13]

[13]The inflation terms are: price, prices, pricing, inflation, inflationary, cpi, pcepi, core, deflation, deflationary, disinflation, disinflationary. The slack terms are: output gap, unemployment, unemployed, jobless, joblessness, nonemployment, U3, U4, U5, U6, nairu, natural rate, potential output, potential GDP, potential GNP, slack, utilization.

Most speakers will make many remarks during a given meeting/transcript. Using historical lists of Federal Reserve governors and bank presidents, and which presidents were voters versus non-voters at any given meeting, we are also able to perform analyses on particular subsets of remarks, such as those by Fed chairs, governors, presidents, and voters. We exclude remarks from non-FOMC members (mostly Fed research staff members) given that our goal is to estimate the collective loss function of the FOMC. This exclusion also has the benefit of, in effect, filtering out the portion(s) of each FOMC meeting in which the staff presents its assessment of economic and financial conditions to the committee, leaving primarily only the portion of the meeting in which committee members discuss their economic outlooks and policy views.

Using the methodology described below, we calculate a unique negativity score for each speaker-meeting, pooling all remarks by a given speaker at that meeting. This yields 3,933 speaker*meeting observations over all meetings between 1986 and 2013, and 1,932 for our primary sample period of 2000 to 2013.

We also collected speeches of FOMC members—governors of the Federal Reserve Board and the presidents of the twelve regional Federal Reserve banks—from a number of sources. Governor speeches from 1996 to 2017 in digital format were kindly provided by Michael McMahon[14] The majority of bank president speeches were gathered directly from each bank. All banks provide recent speeches on their websites.[15] Some banks only have very recent speeches on their website. In some cases, we were able to obtain early-year speeches from FRASER[16]. Remaining speeches not available on banks' websites or FRASER were obtained in response to email or phone requests to bank libraries. Speeches' text was generally in PDF or HTML format, which we converted to text files. We were able to obtain all bank president speeches from January 1998 to present. Our full data set consists of roughly 3,500 speeches, with 2,200 within our 2000–2013 baseline sample period.

For additional analyses, we also collected the minutes of the FOMC meetings, which are released to the public three weeks after the corresponding meeting. The minutes are a summary of the discussion that took place at the meeting, with no attribution of any specific comments or opinions to individual FOMC members.[17]

[14] A few additional speeches were obtained from the Board of Governors website.

[15] Links to each bank's speech webpage can be found here: `https://www.chicagofed.org/publications/speeches/index`.

[16] See `https://fraser.stlouisfed.org/series/3761`

[17] PDF files for minutes from 1993 onward are available at: `https://www.federalreserve.gov/monetarypolicy/fomc_historical.htm`.

3.2 Quantifying Negativity in FOMC Text

There is a large and growing literature aimed at quantifying sentiment from text. We use a method known as the "Bag of Words" or "lexical" approach, which relies on pre-defined dictionaries of words that are associated with particular sentiments.[18] We employ an updated version of the dictionaries from Loughran and McDonald (2011)(hereafter, LM), who construct lists of negative and positive words curated to be appropriate for financial text. They show that their dictionaries are superior for classifying economic and financial texts to other dictionaries, for example the Harvard Psychosociological Dictionary, which tend to miscategorize words that are neutral in a financial/economic context (e.g., tax, costs, capital, expense, liability, risk, excess, and depreciation).[19] There are 2,355 negative words and 354 positive words in the LM dictionaries. We ignore positive and negative words preceded by "not" or "n't," as recommended by Loughran and McDonald (2016).[20] We show an example of scored text from an FOMC transcript in Appendix B.

The net negativity scores, N_{it}, are calculated as the fraction of negative words by speaker i at a given FOMC meeting in month t minus the fraction of positive words by speaker i at the same meeting (subsequent to any text filtering as described in the previous subsection). Using the difference between the negative and positive fractions – as opposed to one or the other – ensures that our measure is independent of overall emotivity (i.e., use of both negative and positive words). Nonetheless, we show later that the results are consistent using either the negative or positive fractions alone.[21]

To help validate our sentiment measure, we performed a "human audit" as follows. We randomly selected 10% of our nearly 2,000 speaker-by-meeting observations of FOMC meet-

[18] The other approach uses machine learning (ML) techniques. See Liu (2010) for a detailed description of the ML approach to sentiment analysis and Shapiro, Sudhof, and Wilson (2018) for an application of both lexical and ML approaches to measuring news sentiment.

[19] Heston and Sinha (2015) measure negativity in news articles about companies and estimate their impact on those companies' stock returns. They use the Harvard Psychosociological Dictionary along with Loughran and McDonald's dictionary. More closely related to our paper, Jegadeesh and Wu (2017) use a combination of these same two dictionaries to measure the tone (net positivity) of FOMC meeting minutes, with sentences in the minutes separated by topic. Another study using the lexical approach to classify central bank communications is Picault and Renault (2017), which construct a measure of hawkishness/dovishness of ECB press conferences. Lastly, the study of economic policy uncertainty by Baker, Bloom, and Davis (2016) also uses a lexical-based measure as part of its uncertainty index. That measure is a simple count of news articles containing terms such as "uncertain" and "not certain" along with terms related to economic policy.

[20] We first removed stop words and intensifiers, and then searched for positive and negative words preceded by "not" and "n't." For example, "not a very bad reading" would be reduced to "not bad reading." We also ran specifications where we removed the words "unemployed" and "unemployment" from the LM negativity dictionary since higher unemployment can be a positive or a negative event depending on the current unemployment gap. We found no change in our results. We reviewed the LM dictionaries for other such terms and did not find any.

[21] See Appendix Tables A1, A2, and panels (b) and (c) of Figure 5 discussed in Section 4.4.

ing text from 2000 to 2013. We then asked a group of 14 research assistants to read and evaluate the tone of a given observation's text on a 5-point scale (from least to most negative).[22]

The audit results are shown in the scatterplot in Figure 1. Each dot represents a speaker-meeting observation. The negativity score assigned by a research assistant is shown on the x-axis while the LM net negativity fraction is shown on the y-axis. The mean LM fraction, by human score category, is indicated by the red circles. A linear regression fit line also is provided. While there is a good deal of variation in the LM net negativity measure within a category, we find a strong correlation between the human scores and LM net negativity. Specifically, the Spearman's rank correlation is 0.39, which is statistically significant below the 0.01% level.

Figure 2 plots the estimated time (meeting-month) fixed effects from a simple regression of the negativity scores on time and speaker fixed effects, using data from January 1986 through December 2013. The dotted line shows the actual time series of coefficients on the time dummies, while the solid line shows a smoothed version calculated as an 11-month centered moving average. FOMC meeting negativity has a clear countercyclical pattern, rising in recessions and falling in expansions. Negativity rises especially sharply during the 2007-2009 Great Recession. It gradually fell after the Great Recession but was still relatively high by the end of 2013, consistent with the weakness of the recovery during the 2010-2013 period.[23]

It also is interesting that negativity was not relatively higher during the late 1980s, when inflation and unemployment were relatively higher, than in later years, in contrast to the picture one gets from the so-called "misery index" which sums inflation and the unemployment rate. Our results in section 5 suggest this difference can be explained by the late 1980s having a combination of a higher natural rate of unemployment, a higher inflation target, and lower sensitivity to inflation in the FOMC's loss function.

[22]Specifically, they were instructed to: "Assign a score from 1 [very positive] to 5 [very negative] of the sentiment/negativity expressed by the speaker at that meeting. This score should be thought of as your best guess of the score that speaker would give if they were asked, "how negative are you today?" at that meeting. That is, this score should be your assessment of how you think the speaker felt (about economic conditions) as of that meeting date, without imposing how you think he or she should have felt. That is, you should ignore factual statements (e.g., "revenue growth is low", "unemployment rose last month", "inflation has been trending higher") and focus on the speaker's sentimental language (e.g., "I'm not happy about that", "This concerns me", ... "which is a troubling development")."

[23]We similarly plot the net negativity for the minutes from each FOMC meetings and speeches of FOMC members in Appendix Figure A1. Also, it is worth noting that the time series pattern of our FOMC negativity measure appears to be quite consistent with the patterns of the topic-specific time series of net positivity in FOMC minutes constructed by Jegadeesh and Wu (2017), plotted in their Figure 2.

4 Estimating the FOMC's Loss Function

Here we directly estimate the FOMC's loss function based on the negativity expressed in the committee's private meetings. We assume that the negativity expressed by member i at a given point in time, N_{it}, reflects their short-run loss—that is, L_0, in equation 1. The distinction between the short-run (period 0) and the medium- or longer-run is that in the short-run the central bank takes the state of inflation and real economic activity as exogenous. In the medium- and longer-run, the central bank endogenously chooses these variables via interest rate policy in order to minimize its lifetime loss, as in the three-period model in Section 2. Indeed, the FOMC's perceived loss for periods beyond the medium-term is zero in this simple model because the FOMC projects that all gaps eventually close. Hence, an FOMC member's short-run loss includes their perception of current economic states plus their perception of future states *in the hypothetical scenario where the central bank did not act*. This latter perception is referred to as a constant-interest-rate (CIR) forecast—it will capture the FOMC member's perceived (exogenous) persistence of current variables. Unfortunately, the Federal Reserve does not regularly publish CIR forecasts—Greenbook forecasts assume the FOMC follows an interest rate rule—so we cannot directly control for their perceptions of medium- to longer-term perceptions of economic variables.[24] Rather, we use the Greenbook's (Federal Reserve Board staff's) current-quarter and one-quarter-ahead forecasts, averaged. Below, after presenting our baseline results, we discuss how the interpretation of the regression coefficients changes if these near-term forecasts, due to persistence, also reflect information about medium- to long-run CIR forecasts. Importantly, we show that such persistence has no effect on the estimate of the inflation target.

4.1 Symmetric Loss Function

Our baseline estimating equation is derived from the general loss function discussed in section 2:

$$L_t = \tilde{\pi}_t^2 + \phi x_t^2 - \lambda x_t \tag{11}$$

where $\tilde{\pi}_t = \pi_t - \pi^*$, and π_t is current inflation as perceived by the central bank and π^* is its inflation target. Note that this loss function is *symmetric* in the inflation gap – loss increases equally as inflation moves above target and as inflation moves below target. We allow for asymmetry in the following subsection.

[24] Federal Reserve staff occasionally produce CIR forecasts as "alternative simulations," but these are not regularly available for our full sample period.

We proxy for loss using our measure of the tone (net negativity, N) expressed by FOMC members in their meetings: $N = \delta L$. We observe negativity for individual members of the FOMC, N_{it}, and hence we allow for speaker-specific fixed effects. These fixed effects allow for heterogeneity across speakers in their general (time-invariant) style/tone of speaking. Allowing for this heterogeneity could be potentially important because it ensures that changes in the composition of the FOMC over time do not lead one to misinfer changes in negativity over time. Applying these changes to equation 11, and adding an i.i.d. error term to capture measurement error in loss, yields the following regression specification:

$$N_{it} = \alpha_i + \delta \tilde{\pi}_t^2 + \omega x_t^2 + \kappa x_t + \varepsilon_{it}, \tag{12}$$

where $\omega \equiv \phi\delta$ and $\kappa \equiv -\lambda\delta$.

The implicit target, π^*, is a latent variable that is of wide general interest to the public, economists, and other policymakers. The precise value of the π^* guiding monetary policy is unknown, especially prior to 2012 when the FOMC first explicitly announced that their inflation target, measured by PCE inflation, going forward would be 2.0 percent. Hence, rather than imposing an assumed π^* for our 2000-2013 baseline sample to measure $\tilde{\pi}_t$, we directly estimate it. The inflation gap term in equation (12) can be expanded as follows:

$$N_{it} = f_i + \delta \pi_t^2 + \theta \pi_t + \omega x_t^2 + \kappa x_t + \varepsilon_{it}, \tag{13}$$

where $\theta \equiv -2\delta\pi^*$ and $f_i \equiv \alpha_i \delta \pi^{*2}$. Thus, the implied π^* can be backed out from the estimated coefficients on inflation and inflation squared: $\hat{\pi^*} = -\hat{\theta}/2\hat{\delta}$.

Note that the variables on the right-hand side of equation 13, which are those that theoretically enter the FOMC's loss function, should be the FOMC's real-time perceptions of the current/near-term values of those variables. To measure these real-time perceptions, we use the real-time "Greenbook" forecasts prepared by the Federal Reserve's economic staff in advance of each FOMC meeting. We measure current/near-term values using averages of current-quarter and one-quarter-ahead forecasts. Greenbook forecasts are advantageous over current vintage or even other real-time data because they are the actual numbers discussed by FOMC members at the meetings. Moreover, they incorporate all of the higher frequency information available between the data release and the meeting. Importantly, because the Greenbook forecasts are determined before the FOMC members meet, they can be considered exogenous with respect to the committee members' dialogue. By contrast, as noted above, we cannot use longer-run Greenbook *forecasts* of economic variables because these forecasts are conditional on the FOMC following an interest rate rule — they are not constant-interest-rate forecasts, which theoretically are what enter into the FOMC loss function (see Rudebusch and Svensson (1999)).[25] As we show in Appendix A.2, under this assumption the estimated coefficients of (13) represent the total short-term effect of a change in the economic variable—that is, the current period effect plus the effect from its perceived persistence. Also, we do not consider an interest-rate smoothing term in the objective function (for example, as specified by Woodford (2003)) because the interest rate target is chosen by the FOMC at the close of the meeting and is therefore endogenous.[26]

We estimate equation (13) using the 1,811 speaker-meeting observations over the period January 2000 through December 2013. December 2013 is the latest FOMC meeting transcript that is publicly available, as of the time of this writing. We use January 2000 as the sample start date for our baseline analysis for two reasons. First, the Greenbook does not contain forecasts prior to 2000 for PCE inflation, which is the measure that the FOMC publicly stated in 2012 was its preferred measure of inflation (FOMC (2012)).[27] Second, it is widely believed that the inflation target was different (and likely time-varying) prior to the Great Moderation starting in the late 1990s (see Ireland (2007), Cogley, Primiceri, and Sargent (2010), and Coibion and Gorodnichenko (2011)). In Section 5, we expand the sample period to 1986-2013 (which entails splicing in a "PCE-adjusted" core CPI inflation Greenbook forecast) and estimate a version of the loss-function with a time-varying π_t^* and also allowing for the regime change to a constant target period to float freely. The results from this exercise show that the constant-target period begins in 2000, consistent with our baseline sample period.

The results of estimating variants of equation (13) are shown in Table 1. Note that standard errors (shown in parentheses) are robust to heteroskedasticity and clustering by time (i.e., meeting).[28] The first column shows the results of a simple specification that includes only π_t and π_t^2. This estimated quadratic relationship also is plotted visually in Figure 3, overlaid on a bin-scatter plot of the data on inflation against the LM net negativity scores.[29] In the scatter plot, both inflation and negativity have been residualized with respect

[25]For example, the FOMC may be speaking negatively about a current low reading of inflation, which may also cause them to worry (and speak negatively) about very low inflation over the next year. However, the Greenbook forecast would likely show an elevated level of inflation because it includes the effects of a highly accommodative policy path.

[26]That is, the federal funds rate is potentially correlated with unobserved factors that also affect the members' language.

[27]While it is clear from the Greenbook and from the FOMC transcripts that the FOMC shifted from focusing on the CPI to the PCEPI measure in the years around 2000, the exact timing and extent of the shift is somewhat ambiguous. As a robustness exercise, we estimate the loss function using Greenbook CPI forecasts and, as shown in Appendix Tables A9 and A10, found very similar results with the exception of a higher inflation target. Indeed, comparing Tables A9 and A10 to the corresponding columns in Tables 1 and 2, we see that the estimated inflation target based on the CPI is about 30 basis points higher than that based on the PCE, consistent with the fact that CPI inflation averaged about 30 basis points higher than PCE inflation over 2000 to 2013.

[28]Standard errors are essentially unchanged by additionally clustering by speaker.

[29]A bin-scatter plot divides observations into equal bins – 100 in this case – and then plots the mean of x

to speaker fixed effects. The negative sign on π_t and the positive sign on π_t^2 implies that loss has a convex relationship with inflation and that there exists a loss-minimizing inflation rate, π^*.

As indicated in column (1) of the table, the estimated quadratic loss function implies a $\hat{\pi}^*$ of approximately 1.4 percent, with a 95% confidence interval of 1.1 to 1.7. How we arrive at this value of $\hat{\pi}^*$ is clear from Figure 3. Negativity tends to be lowest when inflation is close to 1.4 percent and rises as inflation deviates from 1.4 in either direction.

This estimate is considerably lower than the explicit 2 percent inflation target stated in 2012 as well as survey measures of longer-run inflation expectations, as seen in Figure 4.[30] Moreover, the transcripts reveal that at least some committee members were well aware of the discrepancy between the FOMC's target and market participants' perception of the target. For example, in September 2006 meeting St. Louis Federal Reserve President, William Poole states "I had several conversations at Jackson Hole with Wall Street economists and journalists, and they said, quite frankly, that they really do not believe that our effective inflation target is 1 to 2 percent. They believe we have morphed into $1\frac{1}{2}$ to $2\frac{1}{2}$ percent."[31] The result is also reminiscent of Afrouzi, Kumar, Coibion, and Gorodnichenko (2015) finding that inflation expectations of firms in New Zealand have been persistently higher than the central bank's announced target over the past 25 years. The estimate of π^* is also below the 2000-2013 average of actual year-over-year core PCE inflation, which is 1.8 (measured using either current vintage or real-time data).[32] The possibility that inflation was on average above target over an extended period like 2000–2013 is difficult to reconcile with the FOMC following optimal monetary policy *if* their loss function is the standard quadratic loss function. However, as discussed in Section 2, it is consistent with optimal policy given a loss function in which loss falls linearly with real economic activity, such as output growth.

Hence, we next add various measures of real economic activity, linear and squared, to this symmetric loss function in the remaining columns of Table 1. In column (2), we estimate the standard loss function including the unemployment gap—both a linear and squared term as in equation (13). The unemployment gap is measured by the average of the Greenbook's current-quarter and one-quarter-ahead forecasts of the unemployment rate minus the Greenbook's estimate of the natural rate of unemployment (as of that meeting). The coefficients

against the mean of y for each bin. Bin-scatter plots are frequently used to visualize data when there are a very large number of underlying data points.

[30]Market-based measures of inflation expectations were also above this value. For example, the TIPS-based 5-year-ahead, 5-year-forward break-even inflation rate (based on CPI) averaged 2.4 between 2003-2012.

[31]Timothy Geithner and Eric Rosengren made similar comments at the September 2006 and January 2009 meetings, respectively.

[32]Excluding the zero lower bound period, which began in December 2008 and likely hampered the Fed's ability to boost real activity and inflation, this average is even higher at 1.9

on both the linear and squared unemployment gaps are statistically insignificant.

In column (3), we replace the unemployment gap with output growth. Some prior studies have found a role for output growth in central bank preferences and interest rate policy (e.g., Walsh (2003), Coibion and Gorodnichenko (2011), Orphanides and Williams (2006). We measure output growth, Δy_t, using the average of current-quarter and one-quarter-ahead forecasts of real GDP growth from the Greenbook. We find that negativity falls significantly with both output growth and its squared term—implying loss falls monotonically with output growth. This result is consistent with the prior studies finding a role for output growth in interest rate rules. It is also consistent with the fact, documented (Thornton (2011)), that the FOMC explicitly stated its policy objectives in terms of "economic growth" or "growth in output" from 1991 through 2008, when it changed its policy directive to refer to "maximum employment."[33] Moreover, as discussed in Section 2, the finding that loss falls monotonically with real economic activity, proxied here by output growth, can help reconcile our finding of an inflation target that was below the levels of realized inflation and inflation expectations that prevailed on average over our sample period. If loss falls with output growth, optimal policy trades off a positive inflation gap for faster growth.

Some FOMC members have suggested that financial variables may also enter into the central bank's loss function (Bernanke and Gertler (2001), Kohn (2006), and Peek, Rosengren, and Tootell (2015)). We examine this hypothesis by adding a number of common financial measures to our specification. Specifically, in column (4) we include the trailing 3-month percentage change in the S&P 500 index, the Shiller P/E ratio (a measure of the recent *level* of stock market prices), and the volatility index (VIX), a measure of financial market uncertainty, to our baseline specification with real activity measured by the unemployment gap.[34] We find that all three of these financial variables have a significant effect on the FOMC's negativity. Negativity falls with recent stock market returns, while it rises with increases in the P/E ratio or the VIX.[35] These results are consistent with Peek, Rosengren, and Tootell (2015), who argue that financial variables do enter the FOMC's loss function

[33] In an additional regression, we interacted a post-2008 dummy with output growth to test the hypothesis that the FOMC's language in the transcripts coincided with the change in the language of its stated objectives. The coefficient on the interaction was positive and significant, indicating that movements in output growth changed the FOMC's loss by a smaller amount in the post 2008 period, corroborating the change in the stated objectives.

[34] We assume that financial variables enter the FOMC's loss separately from output growth and in a linear fashion. That is, $N_{it} = f_i + \delta\pi_t^2 + \theta\pi_t + \omega x_t^2 + \kappa x_t + \zeta FIN_t + \varepsilon_{it}$, where FIN represents a vector of financial market variables.

[35] Note that when financial variables are added, the coefficient on linear output growth becomes approximately zero while squared output growth remains negative and significant. Taken literally, this implies that loss falls as growth deviates from zero, even in the negative direction. However, we note that the coefficient on the linear term is imprecisely estimated because negative growth is rarely observed in our sample (10 percent of the sample) and occurs contemporaneously with strong movements in the financial variables.

based on their evidence that references to financial instability in the FOMC transcripts significantly improve the fit of an estimated Taylor Rule. They are also consistent with Cieslak and Vissing-Jorgensen (2018) who find that negative mentions of the stock market in FOMC minutes and transcripts have high explanatory power for interest rate policy changes. In this rich specification, we estimate the implied inflation target to be about 1.5, only slightly larger than the 1.4 obtained when only inflation is used in the specification. This suggests that the $\hat{\pi}^* \approx 1\frac{1}{2}$ result is not sensitive to controlling for real economic activity, measured by output growth, financial conditions, or both. This robustness is important because real economic activity generally is correlated with inflation.

The estimates of $\hat{\pi}^*$ here, however, are based on the assumption of a symmetric loss function. We relax that assumption next.

4.2 Asymmetric Loss Function

Allowing for asymmetry in the relationship between the inflation gap and loss is potentially important both generally for understanding the central bank's preferences but also specifically for estimating the inflation target. Allowing for asymmetry, however, requires a non-linear estimation approach because the ability to solve for π^* as a function of linear least squares coefficients, as we did in Table 1, relied on the symmetric, quadratic specification for the inflation gap. To relax the symmetry constraint in a parsimonious way, we alter the loss function specification to be linear (rather than quadratic) in the inflation gap but with potentially different slopes above and below zero:

$$N_{it} = \delta_1(\pi_t - \pi^*) * \mathbb{1}[\pi_t > \pi^*] + \delta_2(\pi_t - \pi^*) * \mathbb{1}[\pi_t \leq \pi^*] + \mathbf{X}_t\Lambda + \varepsilon_{it}, \tag{14}$$

where $\mathbf{X}_t$ is a vector of non-inflation variables entering the loss function and $\mathbb{1}[]$ denotes an indicator variable equal to one if the condition in the brackets is true and zero otherwise.

We estimate π^* along with the coefficients δ_1, δ_2, and Λ using a simple grid search over all possible values of π^* from 0 to 3.0, with step size of 0.01. At each iteration, we plug in the π^* for that iteration into equation 14 and then estimate the equation via OLS. The final estimates of $\hat{\pi}^*$, $\hat{\gamma}_1$, $\hat{\gamma}_2$, and $\hat{\Lambda}$ are those resulting from the iteration yielding the minimum sum of squared residuals. To obtain the standard error for $\hat{\pi}^*$, we use a block bootstrap procedure that allows for clustering by t (sample-month).[36]

Before allowing for asymmetry, we first estimate this linear specification, equation (14),

[36] The block bootstrap procedure loops over 100 draws, where each draw pulls all observations from a random sample of $T-1$ months (with replacement) and estimates $\hat{\pi}^*$ using the grid search method described above. The standard error is the standard deviation of the $\hat{\pi}^*$ distribution and the 95% confidence interval is given by the 5th and 95th percentiles of this distribution.

constraining $\delta_1 = -\delta_2$ in order to check whether changing from a quadratic to piecewise-linear specification affects the estimated $\hat{\pi}^*$. In other words, we estimate a V-shaped instead of a U-shaped loss function (in terms of inflation) while still maintaining symmetry. The results are shown in columns (1), (2), and (3) of Table 2. The specification underlying column (1) includes only the inflation gap terms (i.e., restricting ω and κ to equal 0). We obtain a $\hat{\pi}^*$ of 1.4, the same obtained using the quadratic specification. Column (2) adds the real activity variable and real activity variable squared, as proxied by output growth. Finally, the specification underlying column (3) includes all additional factors. Adding real activity or all of the additional factors results in an estimate of π^* of 1.50, very similar to that from the analogous quadratic specification in columns (3) and (4) of Table 1.

The results when we allow for asymmetry are shown in columns (4) with only inflation terms included, (5) with real economic activity (proxied by output growth) included, and (6) with all additional factors included. The results in column (4) are also shown visually in panel (a) of Figure 5. As with Figure 3, we overlay this fitted relationship on a bin-scatter plot of negativity against inflation. The negativity data are residualized with respect to speaker fixed effects. Loss appears to increase roughly linearly as inflation moves away from a target around 1.5 percent. The slope by which loss increases away from target is about the same (in absolute value) above and below the target.

When real activity or the full set of additional factors are included, allowing for asymmetry results in a decline in the estimate of $\hat{\pi}^*$ to about 1.3. The coefficients on the inflation gap above and below zero indicate that negativity rises faster as inflation moves further below target than it does when inflation moves further above target. That is, the absolute value of the slope coefficient for the inflation gap below zero is larger than the slope coefficient for the inflation gap above zero. The "Symmetry p-val" row at the bottom of Table 2 shows the p-value on the null hypothesis that $\hat{\delta}_1 = -\hat{\delta}_2$. In the full specification, the difference in slopes is found to be weakly significant, with a p-value of 0.08.

One caution in interpreting these results deserves mention. The asymmetry of the loss function in terms of inflation relative to target can, of course, only be estimated over the range of observed inflation rates during the sample period. Greenbook near-term forecasts of core PCE inflation between 2000 and 2013 rarely fell much below 1 percent and never got very close to zero. FOMC policymakers have frequently spoken about the particular dangers of deflation (especially given the zero lower bound on interest rate policy). It is entirely possible that FOMC preferences are much more asymmetric in the range of inflation close to zero. That is, the loss function slope could sharply steepen (in absolute value) as inflation rates get close to or below zero, which we haven't observed.

4.3 Loss Function Implied by Filtered Transcripts

We next investigate the loss function using the net negativity measures from particular subsets of the full corpus of meeting transcript text. As described in the Section 3, our baseline negativity measure is constructed from transcripts text that filtered out speaker remarks that did not contain at least one word from the Oxford Dictionary of Economics (ODE). This filter was intended to remove remarks in the FOMC meetings that are unrelated to economic discussions. Using similar methodology, we also explored (1) not filtering at all (keeping all remarks), (2) keeping only remarks associated with inflation, and (3) keeping only remarks associated with slack. For inflation and slack, we constructed our own lists as subsets of ODE words and phrases. From these alternative sets of text, we computed the LM net negativity score by speaker-meeting as before (fraction of negative words minus fraction of positive words). Time series plots of the monthly median values of these three alternative measures are provided in Appendix Figure A1. Loss function estimates using these alternative negativity measures are provided in Table 3. The loss function estimates using negativity calculated from the unfiltered text (column (2)) are very similar to the baseline estimates. This is not surprising given that nearly 90% of the transcript remarks contain economic terms. When we filter to include only remarks related to inflation (column (3)) or slack terms (column (4)) the estimates are generally consistent with the baseline estimates but with less precise estimates of the inflation target.

Columns (5)-(8) report results where negativity is calculated from transcript remarks filtered on particular types of speakers (defined by their status at the time of their remarks): (1) FOMC voting participants, (2) FOMC non-voting participants, (3) Governors, and (4) Regional Fed Presidents. Comparing voting and non-voting members (columns (5) and (6), respectively), we find that voters have a somewhat higher implicit inflation target than non-voters, 1.7 versus 1.4 We obtain similar results when comparing the results for governors (including the chair) versus regional Fed presidents, in columns (7) and (8). Moreover, the inflation target estimated from presidents' negativity is more precisely estimated than that from governors. The implied target is 1.5 for presidents and 1.8 for governors.[37]

4.4 Alternative Sentiment Measures

Our baseline results are based on measuring sentiment using the difference between the fraction of negative words and the fraction of positive words (net negativity). In this subsection, we provide results based on alternative, independently-constructed sentiment measures.

[37] We also tried estimating a separate loss function for FOMC chairs, however we found there were too few observations to obtain precise estimates.

First, we estimate the FOMC loss function using the negative and positive fractions separately. Second, we generate a net negativity measure using a popular open-source python tool called VADER (Valence Aware Dictionary and Sentiment Reasoner) (Hutto and Gilbert (2014)). VADER is also a lexical sentiment classifier, based on a combination of available general-english and social media lexicons, but it also applies a number of heuristic rules to take account of certain contextual characteristics of how each word is used in a given sentence. The rules relate to negation (e.g., a word being preceded by "not" reverses its valence), punctuation (e.g., exclamation points), capitalization, degree modification (e.g., being preceded by "very" or "slightly"), and coming before or after the word "but." Such rules can improve the accuracy of a sentiment classifier. However, an important downside of VADER for our application is that the sentiment scores associated with its lexicon and rules are constructed from social media text/language which often will have very different word meanings than those in the economics and finance domain (as shown in Shapiro, Sudhof, and Wilson (2018)).

The results of estimating V-shaped loss functions using these alternative measures are shown in Appendix Tables A1 – A3. In addition, bin-scatter plots in terms of inflation and the estimated V-shaped asymmetric loss function (corresponding to column (3) of the tables) on these alternative sentiment measures are provided in panels (b) through (d) of Figure 5. The results are remarkably consistent across all of the sentiment measures. In particular, like the baseline measure, all three of the alternative measures point to an inflation target—that is, the inflation rate minimizing negativity and maximizing positivity—of approximately $1\frac{1}{2}$. With regards to the other potential factors in the loss function, the results are generally qualitatively similar across the measures, though the statistical significance varies. For instance, GDP growth is more statistically significant when based on either of the negativity measures than using the LM positivity fraction, while the squared unemployment gap significantly reduces positivity but it has no significant effect on the negativity measures. Lastly, we note that the stock market volatility (VIX) significantly affects both measures of negativity, but has no significant effect on positivity.

5 Extended-Sample Analysis of Inflation Target

Our baseline analysis is run during a period when inflation was relatively low and steady. Prior to the 1990s, however, inflation was higher and less stable. Indeed, numerous studies have shown that both trend inflation and inflation persistence dramatically declined (see Stock and Watson (2007), Stock and Watson (2016)) from the high inflation period of the 1970s and 80s to the late 1990s and 2000s. Other studies (for example, Ireland (2007)) have more explicitly linked this decline in trend inflation to a decline in the Federal Reserve's target. Committee members also noted that the implicit inflation target was likely declining over this period. For example in the January 2003 FOMC meeting, Governor Donald Kohn stated "...I do believe that, from 1987 at least into the second part of the 1990s, the Committee surely did not have a constant inflation target." Indeed, a close reading of the transcripts from the mid-1980s and the 1990s suggests that the FOMC was far from agreement on whether they should even have an explicit inflation target, much less what that target should be. An analysis that includes this period should therefore allow for the possibility that the implicit target – that is, the target consistent with the central bank's preferences – was time-varying and different than it was over the 2000–2013 period. Thus, we relax the assumption that π^* is a constant, and estimate the FOMC's symmetric loss function allowing π^*_t to be time varying.

For tractability, we make two assumptions about the path of π^*_t. First, π^*_t is assumed to fit a constant over a "constant-target period"—defined as a time period between s and 2013m12. Second, π^*_t is assumed to fit a quadratic polynomial function of time during a "time-varying-target period"—defined as a period between 1986m1 and s.[38] We imputed the core PCE forecasts back to 1986m1 by splicing adjusted Greenbook forecasts of core CPI—adjusted using the average difference between core CPI and core PCE over pre-2000 period. We let the regime change, s, float freely which allows for the possibility that π^*_t is time-varying or constant for the entire sample period, 1986m1-2013m12.

We perform a grid search over four parameters that govern the path of π^*_t: a constant in the constant-target period, a slope and curvature in the time-varying-target period, and a date, s, of the regime switch between the time-varying and constant-target period. For aid in identification, we estimate π^*_t assuming a symmetric V-shaped loss function, however, we allow the slope of the V-shape to differ in the time-varying- and constant-target periods. Technical details are available in Appendix C.

The results in Figures 6 (without controls) and 7 (with controls)[39] show that the FOMC's implied inflation target did in fact decline over time. Specifically, π^*_t is slightly above 3 percent in 1986m1 and declines to approximately $1\frac{1}{2}$ beginning in 2000, where it remains until the end of the sample period (2013m12). This decline is consistent with Ireland (2007), Cogley, Primiceri, and Sargent (2010), and Coibion and Gorodnichenko (2011), which also found declines in π^* over a similar time period, despite the very different approach.[40] While

[38] 1986m1 is the first month when core CPI inflation forecasts were published in the Greenbook.

[39] Controls include the full set included in column (2) of Table 2. Wa also include the difference between GB headline and core inflation to control for energy price fluctations, which were volatile during this period.

[40] The finding that the FOMC's preferred inflation target fell from the mid-1980s to around 2000 contrasts somewhat with Ball and Mazumder (2018) who argue that the inflation target itself was flat during that

the level of π_t^* declined, the loss function became steeper (results not depicted in Figure).[41] That is, the FOMC's language showed a stronger distaste for inflation deviations in the later period when inflation was in fact more stable and less persistent.

6 Narrative Analysis of Inflation Target

The analysis in the prior two sections estimated, among other things, the implicit inflation target most consistent with the FOMC's preferences, as revealed by the tone of their discussions. Here we complement that analysis with a narrative approach, aiming to identify explicit statements of a preferred inflation target. Specifically, we perform an automated regular expression (regex) search over all FOMC meeting transcripts (including conference calls) from 1986 through 2013 for terms or phrases related to inflation objectives.[42] We then reviewed and analyzed the sections of text corresponding to those matches.

Discussion of explicit inflation targeting did not begin to appear in the FOMC meetings until around 1994. Prior to then, FOMC participants occasionally mentioned an objective of "price stability" but without relating that to an explicit inflation target. One illuminating exception we found was a statement made by Federal Reserve Board Governor David Mullins in the November 1993 meeting that suggests an implicit target moving below 3 percent by that time: "I think there's a real payoff not just from stabilizing inflation in the 3 to 4 percent range but in moving lower".

The first serious consideration of an explicit inflation target, that we could find, comes from St. Louis Fed President Thomas Meltzer in 1994. At the July meeting that year, he said "If we don't make an explicit statement in this FOMC testimony with respect to our long-run expectations on inflation that goes beyond 'we think price stability is good,' and get more specific in terms of a target range, then at the very least I think we have to make it clear that we consider 3 percent inflation to be unacceptable...." A few meetings later, in November 1994, he stated: "...I feel that it may be time for us to consider setting a specific inflation target that looks out into the future. I think, and this point was made as well, that it could make our job considerably easier in circumstances like the present–with upward

period but that the public's inflation expectations shifted from being backward-looking to anchored at the Fed's target.

[41] The coefficient increased from 0.2 in the time-varying period to 0.45 in the stable period.

[42] We performed two separate searches and collected the union of the two results. The first search looked for text containing any of the following strings: inflation target | inflation objective | long-run inflation | long run inflation | longer-run inflation | longer run inflation | inflation goal | objective for inflation | target for inflation | goal for inflation | PCE objective | PCE goal | PCE target | target for PCE inflation | goal for PCE inflation | objective for PCE inflation | objective for core | goal for core | target for core. The second was a regex search that looked for lines of text containing: (inflation | PCE) AND (percent) AND (objective|target|long-run|longer-run|long run|longer run), where "|" represents "or."

cyclical inflationary pressures–if people were willing to look out to a longer-range target and that added to credibility."

There was much debate over the following couple years about whether the FOMC should have an inflation target, even internally. For instance, Atlanta Fed President Robert Forrestal during the Jan. 31/Feb. 1 1995 meeting said "...I would be against an inflation target and I would associate myself entirely with the views of Governor [Janet] Yellen" (who had noted some potential risks to having a target) while other participants expressed being in favor of a target. The question remained unsettled into the late 1990s, as exemplified by this statement from President Melzer at the November 1997 meeting: "What are the FOMC's intentions? Do we like seeing inflation below 2 percent? Does the public know it? I think, as I have said before, that we ought to be more explicit about our longer-term objective. In that event, it would be much less likely that our actions would be misinterpreted as being anti-jobs or anti-growth."

Starting in the early 2000s, however, explicit statements by FOMC participants of their inflation preferences became much more common. Indeed, while the automated regular-expression search described above found only 50 matches over 1986 to 1999 – and only 2 of those mentioned a specific inflation target – the search yielded several hundred matches over the 2000 to 2013 period. Reading through the sections of text corresponding to those matches, we identified and tabulated each instance in which a participant expressed their own preference for a specific numerical inflation target (or range such as between 1.5 and 2). Figure 8 plots the results of this narrative analysis. Each circle represents a stated preference, from the indicated speaker (y-axis) at the indicated FOMC meeting (x-axis), for a specific inflation target. The value of the preferred target is shown within the circle and also indicated by the circle's color. Values go from 1.0 (light blue) to 1.5 (dark blue) to 1.75 (purple) to 2.0 (red).

In total, we identified 58 statements of an inflation target preference. 20 of these expressed a preference for $1\frac{1}{2}$ percent; 9 for either exactly $1\frac{3}{4}$ or between $1\frac{1}{2}$ and 2 percent; 27 for 2 percent; and just two for 1 percent. However, these aggregate counts mask a clear and important pattern over time. Statements in favor of a 2 percent target were non-existent before 2007 and did not become widespread until 2009, late in the Great Recession. In fact, a single participant, Governor Frederic Mishkin accounted for all but one of the pre-2009 2 percent statements.[43] Prior to the Great Recession, $1\frac{1}{2}$ percent was the overwhelming favorite among participants. The transition of the consensus favorite over the course of the

[43] Governor Mishkin alluded to the fact that most other participants preferred $1\frac{1}{2}$ percent at the October 2007 meeting: "People know that I am a 2 percent kind of guy, and I know good people here who are $1\frac{1}{2}$ percent kinds of guys."

Great Recession is book-ended by the March 20-21, 2007 regular meeting and a conference call meeting on January 16, 2009. In the March 2007 meeting, FOMC participants were explicitly asked by the Chair if they thought the Fed should have an explicit numerical inflation target and, if so, what that target should be. Four members expressed a preference for $1\frac{1}{2}$ percent, three for between $1\frac{1}{2}$ and 2 percent, two for 1 percent, and just one (Mishkin) for 2 percent. In the January 2009 meeting, seven out of the ten members that voiced a specific preference desired 2 percent. In fact, most of those seven had themselves previously expressed a lower preferred target.

In sum, our narrative analysis points to $1\frac{1}{2}$ percent being a consensus preference for the FOMC's explicit inflation target over the general period of 2000 to 2007. By 2009, the consensus seems to have shifted up to 2 percent. Of course, in January 2012, the 2 percent explicit target was codified officially by the FOMC in their public announcement of the target. One plausible explanation for this shift was that, at this time, nominal interest rates had hit the zero lower bound, hampering the Fed's ability to raise inflation. In such a low interest rate environment, raising the inflation target can provide a hedge against hitting the zero lower bound in future episodes (see Ball (2014) and Andrade, Galí, Bihan, and Matheron (2018)).

It is important to note that the publicly expressed *explicit* inflation target is conceptually distinct from the FOMC's privately discussed *implicit* inflation target. Specifically, FOMC participants may explicitly state in private or public their preferred rate of inflation, but the tone over all of their remarks (not just when talking about inflation) may indicate that their implicit – i.e., loss-minimizing – target is different. Moreover, their monetary policy actions may be consistent with a different target than what they state explicitly, as suggested in the June 2012 quote by Chicago Fed president Charles Evans provided at the beginning of the paper: "...I worry that future researchers are probably going to find evidence that we're acting as if our goal is symmetric around something that's below 2 percent, not 2 percent."

Nonetheless, this narrative evidence that the explicit/preferred inflation target shifted from 1.5 to 2 percent around January 2009 begs the question of whether the FOMC's implicit target also shifted up around that time. We investigate this question with three extensions to our baseline loss function regressions. First, we estimate the regression over expanding-window samples with the start month fixed at January 2000 and the end month iterating from December 2003 through December 2013. The estimates of pi-star and its 95% confidence interval over the expanding-window end months are shown in Appendix Figure A7. The point estimate is stable around 1.5 for all samples, even as one expands the sample well past January 2009. Second, we test for a known structural break at January 2009, by allowing the coefficients on inflation and inflation squared in our baseline specification (Table A7) to vary before and after January 2009 (i.e., allowing inflation coefficients to differ between 2000m1–2008m12 versus 2009m1–2013m12). The estimated pi-star prior to the break is 1.59 (s.e. = 0.14) and the estimate after the break is 1.44 (0.08); the difference is statistically insignificant. Third, we repeatedly estimate this baseline specification iterating over potential structural breaks from January 2004 through January 2012. The break yielding the minimum SSR is found to be Nov. 2010, with a pre-break pistar of 1.57 (0.12) and a post-break pistar of 1.59 (0.12). The difference is statistically insignificant. In sum, in all three exercises, we find no evidence suggesting a jump in the implicit inflation target after 2008.

It should be noted that these tests are based on a fairly short post-2008 time-series, limiting their statistical power for identifying a structural break, especially if it occurred closer to the end of our sample period. In particular, we are unable at this point to effectively assess whether the implicit target may have shifted up after the FOMC's official announcement of a 2% explicit target in January 2012. The availability of additional transcripts and Greenbook forecasts in future years will allow for such tests.

7 Loss Function Implied by Public Communications

Our estimates above of the FOMC's loss function are based on the negativity expressed by FOMC members during the internal private meetings held 8 times a year in Washington, D.C. These are the meetings at which members discuss their monetary policy votes and the Committee's possible policy actions. Because the meetings are private—and transcripts of the meetings are not released until five years later—it is likely that members express their views in a candid manner (Hansen, McMahon, and Prat (2018)). For these reasons, we consider these meeting transcripts as the best textual source of data reflecting the FOMC's preferences. Nonetheless, we also investigate the negativity expressed in two public communications of the FOMC: (1) the minutes of FOMC meetings, which are released three weeks after each FOMC meeting and (2) the public speeches of individual FOMC members. We estimate the loss function implied by each of the negativity expressed in each of these sets of text.

7.1 FOMC Meeting Minutes

Three weeks after each FOMC meeting, the Federal Reserve releases a summary, known as the minutes, of the discussion at the meeting. The minutes are a general overview of the topics discussed and opinions expressed at the meeting, with no attribution of any comments or opinions to individual FOMC members. While the tone of the minutes is much less emotive than that of the actual spoken remarks made at the meeting, it is nonetheless interesting to see whether the expressed negativity in the minutes relates to inflation, slack, and output growth in a similar fashion to that in the transcripts.

We therefore repeat the same loss function estimations done in subsections 4.1 and 4.2 above but using the net negativity from the minutes. Though minutes are available for meeting from 1993 to present, we restrict the sample period to 2000-2013 both to facilitate comparison to the meetings results above and because the Greenbook forecasts for inflation, output growth, and the unemployment rate are not available past 2013 (as of the time of this writing).

The main results are shown in Table 4. (Results for additional specifications are provided in Appendix Tables A5 and A6.) Columns (1) and (2) show the results of estimating the symmetric, quadratic loss function in terms of inflation. As was the case for meetings, the data point to a U-shaped (convex) loss function in terms of inflation. In the full specification (column (2)), the implied $\hat{\pi}^*$ is 1.4, the same as found using meeting transcripts (Table 1, column (4)).

Columns (3) and (4) allow for loss asymmetry around the inflation target, as in Table 2.[44] When asymmetry is allowed, the estimated $\hat{\pi}^*$ remains at 1.5 with or without real activity and financial variables included as controls. Thus, the language used in the public minutes of the FOMC meetings appears to point to a similar inflation target as that implied by the verbatim language actually used the meetings. We also find output growth has a much stronger effect on negativity in the minutes than in the transcripts, while stock market returns have a much smaller (and statistically insignificant) effect.

7.2 Speeches

Speeches provide another textual source of data on the preferences of FOMC members, albeit one that could reflect additional considerations. In particular, central bankers may speak less candidly in their public speeches, both out of concern about revealing non-public information regarding likely future policy actions (or views of other members) and about expressing views that may be unpopular with the public or current politicians. For instance, FOMC members may be hesitant to express too little concern about unemployment relative to inflation for fear of sounding insensitive to the plight of the jobless. In addition, members may seek to use their speeches not just to express their own monetary policy views but also to influence the expectations of the public with regard to inflation and/or the future policy

[44] We follow the same non-linear gridsearch estimation procedure described and used in subsection 4.2. Recall the procedure searches over potential inflation targets from 0.00 to 3.00, with step sizes of 0.01, for the estimated loss function yielding the minimum sum of squared residuals.

path.

With these caveats about candidness and strategic communications in mind, we repeat the same loss function estimations as above using the negativity scores for speeches. Note that we have a comprehensive data set of speeches from 1998 through 2017, though we present results here based on the 2000-2013 sample period for the same reasons mentioned above for minutes. The main results are summarized in Table 5, with a full set of results in Appendix Tables A7 and A8. Consistent with the results for transcripts and minutes, the speech results point to a U-shaped loss function in terms of inflation. With only inflation and inflation squared in the regression (columns (1) and (3)), the implied $\hat{\pi}^*$ around 2.1-2.2, though it is imprecisely estimated. When real activity and financial variables are included, $\hat{\pi}^*$ is estimated to be around 1.4-1.5, though it is again imprecisely estimated. Overall, the large degree of noise around the estimates of the inflation target shows that the tone from speeches is less useful for identifying the inflation target than the tone from the transcripts or the minutes.

8 Conclusion

In this study we directly estimate the FOMC's objectives using a measure of loss constructed from meeting transcripts. Our baseline analysis, estimated on the period between 2000 and 2013, shows that the FOMC's implicit inflation target was roughly $1\frac{1}{2}$ percent. This result is robust to alternative functional forms for the loss function and is also obtained when we separately analyze the negativity expressed in the minutes of the FOMC meetings or the speeches made by FOMC members. This estimate of the inflation target is significantly below the explicit 2 percent target contained in the FOMC's 2012 "Statement on Longer-Run Goals and Monetary Policy Strategy" (and subsequent annual updates to this statement) as well as survey measures of longer-run inflation expectations over this period. However, we document that over our 2000-2013 sample period, FOMC members often have explicitly stated their preferred inflation target and $1\frac{1}{2}$ percent seemed to be the consensus choice at least up until 2009.

The divergence between the FOMC's implicit 1.5 percent target with both realized inflation and survey measures of inflation expectations is consistent with our findings concerning the FOMC's preferences over output growth. Specifically, the persistently positive inflation gap squares with the FOMC's linear preferences for output growth. The strong focus by central bankers' on output growth has been suggested in prior theoretical work (e.g., Walsh (2003)) and also found empirically in Taylor Rule estimations (e.g., Coibion and Gorodnichenko (2011)). It is also consistent with prior narrative analysis of FOMC communications by Thornton (2011), who showed that the FOMC routinely cited "growth in output," and not sustainable employment, the unemployment rate, or any concept of slack, as part of their policy directive from 1979 through 2008.

That financial variables may also enter the central bank's loss function is a much more contested issue. For example, Bernanke and Gertler (2001) argue that monetary policymakers *should not* respond to asset prices. Former vice chair Don Kohn (Kohn (2006) and Kohn (2008)) went further, arguing that the Fed *does not* respond to asset prices. On the other side, Peek, Rosengren, and Tootell (2015) augmented an empirical Taylor Rule with a variable measuring references to financial instability and found it to be significantly predictive of Fed interest rate changes. In a similar vein, Cieslak and Vissing-Jorgensen (2018) find that both actual negative stock market returns and references to stock market declines in the FOMC transcripts are predictive of target rate cuts. An interesting avenue of future research would be to better uncover why the FOMC appears to care about stock market returns and volatility, even after accounting for inflation, slack, and growth. One plausible reason is that FOMC members regard these variables as good indicators of the forward trajectory of the economy. That is, they serve as proxies for constant-interest-rate economic projections, measuring where the economy would be headed in the absence of any monetary policy actions.

References

Afrouzi, H., S. Kumar, O. Coibion, and Y. Gorodnichenko (2015): "Inflation Targeting Does Not Anchor Inflation Expectations: Evidence from Firms in New Zealand," *Brookings Papers on Economic Activity*, (1), 151–208.

Andrade, P., J. Galí, H. L. Bihan, and J. Matheron (2018): "The optimal inflation target and the natural rate of interest," Discussion paper, National Bureau of Economic Research.

Baker, S. R., N. Bloom, and S. J. Davis (2016): "Measuring Economic Policy Uncertainty*," *The Quarterly Journal of Economics*, 131(4), 1593–1636.

Ball, L., and S. Mazumder (2018): "A Phillips Curve with Anchored Expectations and Short-Term Unemployment," *Journal of Money, Credit and Banking*.

Ball, L. M. (2014): *The case for a long-run inflation target of four percent*, no. 14-92. International Monetary Fund.

Barro, R. J., and D. B. Gordon (1983): "Rules, discretion and reputation in a model of monetary policy," *Journal of monetary economics*, 12(1), 101–121.

Bauer, M. D., and G. D. Rudebusch (2017): "Interest Rates Under Falling Stars," *FRBSF Working Paper*.

Bernanke, B. S., and M. Gertler (2001): "Should Central Banks Respond to Movements in Asset Prices?," *American Economic Review*, 91(2), 253–257.

Blanchard, O. (2018): "On the future of macroeconomic models," *Oxford Review of Economic Policy*, 34(1-2), 43–54.

Blinder, A. S. (1997): "Distinguished Lecture on Economics in Government: What Central Bankers Could Learn from Academics–and Vice Versa," *The Journal of Economic Perspectives*, 11(2), 3–19.

Chappell Jr, H. W., T. M. Havrilesky, and R. R. McGregor (1997): "Monetary policy preferences of individual FOMC members: a content analysis of the memoranda of discussion," *Review of Economics and Statistics*, 79(3), 454–460.

Cieslak, A., and A. Vissing-Jorgensen (2018): "The Economics of the Fed Put," *working paper.*

Clarida, R., J. Gali, and M. Gertler (1999): "The science of monetary policy: a new Keynesian perspective," *Journal of economic literature*, 37(4), 1661–1707.

Cogley, T., G. E. Primiceri, and T. J. Sargent (2010): "Inflation-gap persistence in the US," *American Economic Journal: Macroeconomics*, 2(1), 43–69.

Coibion, O., and Y. Gorodnichenko (2011): "Monetary Policy, Trend Inflation, and the Great Moderation: An Alternative Interpretation," *American Economic Review*, 101(1), 341–70.

Del Negro, M., S. Eusepi, M. P. Giannoni, A. M. Sbordone, A. Tambalotti, M. Cocci, R. Hasegawa, and M. H. Linder (2013): "The FRBNY DSGE Model," .

Dennis, R. (2006): "The policy preferences of the US Federal Reserve," *Journal of Applied Econometrics*, 21(1), 55–77.

Favero, C. A., and R. Rovelli (2003): "Macroeconomic stability and the preferences of the Fed: A formal analysis, 1961-98," *Journal of Money, Credit and Banking*, pp. 545–556.

FOMC (2012): "Statement on Longer-Run Goals and Monetary Policy Strategy," [Online; posted 25-January-2012].

Fuhrer, J. C., G. P. Olivei, and G. M. Tootell (2012): "Inflation dynamics when inflation is near zero," *Journal of Money, Credit and Banking*, 44, 83–122.

Giannoni, M. P., and M. Woodford (2003): "Optimal Interest-Rate Rules: I. General Theory," NBER Working Papers 9419, National Bureau of Economic Research, Inc.

Givens, G. E. (2012): "Estimating central bank preferences under commitment and discretion," *Journal of Money, credit and Banking*, 44(6), 1033–1061.

Hansen, S., M. McMahon, and A. Prat (2018): "Transparency and Deliberation Within the FOMC: A Computational Linguistics Approach*," *The Quarterly Journal of Economics*, 133(2), 801–870.

Heston, S. L., and N. R. Sinha (2015): "News versus sentiment: Predicting stock returns from news stories," *Robert H. Smith School Research Paper.*

Hutto, C., and E. Gilbert (2014): “VADER: A Parsimonious Rule-based Model for Sentiment Analysis of Social Media Text,” Eighth International Conference on Weblogs and Social Media (ICWSM-14).

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

Ireland, P. N. (2007): “Changes in the Federal Reserve's inflation target: Causes and consequences,” *Journal of Money, credit and Banking*, 39(8), 1851–1882.

Jegadeesh, N., and D. A. Wu (2017): “Deciphering fedspeak: The information content of fomc meetings,” .

Kohn, D. L. (2006): “Monetary policy and asset prices,” European Central Bank.

——— (2008): “Monetary Policy and Asset Prices Revisited,” Cato Institute.

Leduc, S., and D. J. Wilson (2017): “Has the Wage Phillips Curve Gone Dormant?,” *FRBSF Economic Letter*.

Liu, B. (2010): “Sentiment Analysis and Subjectivity.,” *Handbook of natural language processing*, 2, 627–666.

Loughran, T., and B. McDonald (2011): “When is a liability not a liability? Textual analysis, dictionaries, and 10-Ks,” *The Journal of Finance*, 66(1), 35–65.

——— (2016): “Textual analysis in accounting and finance: A survey,” *Journal of Accounting Research*, 54(4), 1187–1230.

Meade, E. E., and D. Stasavage (2008): “Publicity of debate and the incentive to dissent: evidence from the US Federal Reserve,” *The Economic Journal*, 118(528), 695–717.

Nakamura, E., and J. Steinsson (2018): “High-Frequency Identification of Monetary Non-Neutrality: The Information Effect*,” *The Quarterly Journal of Economics*, 133(3), 1283–1330.

Orphanides, A. (2004): “Monetary policy rules, macroeconomic stability, and inflation: A view from the trenches,” *Journal of Money, Credit and Banking*, pp. 151–175.

Orphanides, A., and J. C. Williams (2006): “Monetary policy with imperfect knowledge,” *Journal of the European Economic Association*, 4(2-3), 366–375.

Peek, J., E. S. Rosengren, and G. M. Tootell (2015): "Should US Monetary Policy Have a Ternary Mandate?," in *Federal Reserve Bank of Boston 59 th Economic Conference: Macroprudential Monetary Policy.*

Picault, M., and T. Renault (2017): "Words are not all created equal: A new measure of ECB communication," *Journal of International Money and Finance*, 79, 136–156.

Rudebusch, G., and L. E. Svensson (1999): *Policy Rules for Inflation Targeting*pp. 203–262. University of Chicago Press.

Shapiro, A. H., M. Sudhof, and D. Wilson (2018): "Measuring news sentiment," Working paper, Federal Reserve Bank of San Francisco.

Stock, J. H., and M. W. Watson (2007): "Why has US inflation become harder to forecast?," *Journal of Money, Credit and banking*, 39, 3–33.

——— (2016): "Core inflation and trend inflation," *Review of Economics and Statistics*, 98(4), 770–784.

Surico, P. (2007): "The Fed's Monetary Policy Rule and U.S. Inflation: The Case of Asymmetric Preferences," *Journal of Economic Dynamics and Control*, 31, 305–324.

Thornton, D. L. (2011): "What Does the Change in the FOMC's Statement of Objectives Mean?," *Economic Synopses*, (1).

Walsh, C. (2003): "Speed limit policies: the output gap and optimal monetary policy," *American Economic Review*, 93(1), 265–278.

Walsh, C. E. (2004): "Robustly Optimal Instrument Rules and Robust Control: An Equivalence Result," *Journal of Money, Credit and Banking*, 36(6), 1105–1113.

Walsh, C. E. (2017): *Monetary theory and policy.* MIT press.

Wischnewsky, A., D.-J. Jansen, and M. Neuenkirch (2019): "Financial Stability and the Fed: Evidence from Congressional Hearings," *De Nederlandsche Bank Working Paper.*

Woodford, M. (2003): "Optimal Interest-Rate Smoothing," *The Review of Economic Studies*, 70(4), 861–886.

Table 1: Estimated U-shaped Loss Function
FOMC Meetings: 2000 - 2013

	(1)	(2)	(3)	(4)
π_t, GB	-1.602**	-0.990	-1.571***	-1.532***
	(0.693)	(0.709)	(0.598)	(0.479)
π_t^2, GB	0.582***	0.472**	0.514***	0.496***
	(0.194)	(0.193)	(0.168)	(0.135)
$(u_t - u_t^*)$, GB		0.113		-0.00114
		(0.0695)		(0.0771)
$(u_t - u_t^*)^2$, GB		0.00152		0.0147
		(0.0135)		(0.0123)
Δy_t , GB			-0.103***	-0.000690
			(0.0157)	(0.0248)
Δy_t^2 , GB			-0.0244***	-0.0367***
			(0.00491)	(0.00526)
S&P Return, 3m				-2.527***
				(0.543)
Shiller PE Ratio				0.0210**
				(0.00923)
VIX Uncertainty				0.0158***
				(0.00574)
Constant	1.926***	1.078*	2.535***	1.486***
	(0.586)	(0.643)	(0.502)	(0.496)
Observations	1932	1932	1932	1932
Adjusted R^2	0.168	0.181	0.262	0.336
Type	meeting	meeting	meeting	meeting
Sample	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12
$\hat{\pi}^*$	1.375	1.048	1.527	1.545
SE	(0.155)	(0.335)	(0.108)	(0.102)
95% C.I.	[1.071 - 1.678]	[.391 - 1.704]	[1.315 - 1.738]	[1.345 - 1.744]

The variables y and y* denote log GDP and log potential GDP, respectively.
Standard errors (in parentheses) are robust to heteroskedasticity and clustering by sample-month.
Regressions include speaker fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2: Estimated V-shaped Loss Function, Allowing for Asymmetry
FOMC Meetings: 2000 - 2013

	(1) Symmetric V	(2) Symmetric V	(3) Symmetric V	(4) Asymmetric V	(5) Asymmetric V	(6) Asymmetric V
$\mid \pi_t - \pi^* \mid$, GB	0.768***	0.592***	0.541***			
	(0.130)	(0.115)	(0.108)			
$(\pi_t > \pi^*)$=0 × $(\pi_t - \pi^*)$, GB				-0.578**	-1.221***	-0.945***
				(0.276)	(0.300)	(0.271)
$(\pi_t > \pi^*)$=1 × $(\pi_t - \pi^*)$, GB				0.817***	0.482***	0.457***
				(0.138)	(0.0926)	(0.0944)
Δy_t , GB		-0.101***	0.000364		-0.110***	-0.00414
		(0.0143)	(0.0235)		(0.0136)	(0.0232)
Δy_t^2 , GB		-0.0244***	-0.0365***		-0.0236***	-0.0354***
		(0.00455)	(0.00487)		(0.00466)	(0.00487)
$(u_t - u_t^*)$, GB			0.0437			0.0428
			(0.0768)			(0.0763)
$(u_t - u_t^*)^2$, GB			0.00629			0.00552
			(0.0130)			(0.0125)
S&P Return, 3m			-2.486***			-2.418***
			(0.547)			(0.559)
Shiller PE Ratio			0.0216**			0.0201**
			(0.00934)			(0.00885)
VIX Uncertainty			0.0151**			0.0159**
			(0.00592)			(0.00630)
Constant	0.686***	1.216***	0.177	0.702***	1.209***	0.187
	(0.0593)	(0.0785)	(0.317)	(0.0644)	(0.0761)	(0.317)
Observations	1932	1932	1932	1932	1932	1932
Adjusted R^2	0.176	0.271	0.338	0.176	0.272	0.338
Type	meeting	meeting	meeting	meeting	meeting	meeting
Sample	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12
Symmetry p-val				0.352	0.01	0.077
$\hat{\pi^*}$	1.43	1.5	1.5	1.49	1.33	1.34
SE	(0.15)	(0.09)	(0.09)	(0.29)	(0.27)	(0.22)
95% C.I.	[1.25, 1.5]	[1.3, 1.57]	[1.34, 1.67]	[1, 1.87]	[1.02, 1.55]	[1.05, 1.71]

The variables y and y* denote log GDP and log potential GDP, respectively.
Standard errors (in parentheses) are robust to heteroskedasticity and clustering by sample-month.
Regressions include speaker fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Negativity using Filtered Subsets of Transcript Text
FOMC Meetings: 2000 - 2013

	(1) Baseline	(2) All Text	(3) Inflation Text	(4) Slack Text	(5) Voters	(6) Non-Voters	(7) Governors	(8) Presidents
π_t, GB	-1.532***	-1.547***	-1.255**	-1.595**	-1.508***	-1.547***	-0.818	-1.721***
	(0.479)	(0.478)	(0.511)	(0.695)	(0.533)	(0.546)	(0.636)	(0.510)
π_t^2, GB	0.496***	0.499***	0.406***	0.499**	0.442***	0.564***	0.226	0.583***
	(0.135)	(0.135)	(0.144)	(0.192)	(0.146)	(0.158)	(0.170)	(0.143)
$(u_t - u_t^*)$, GB	-0.00114	-0.00426	-0.0443	-0.00587	-0.0113	0.0654	0.0803	0.0237
	(0.0771)	(0.0762)	(0.0894)	(0.103)	(0.0853)	(0.0878)	(0.109)	(0.0854)
$(u_t - u_t^*)^2$, GB	0.0147	0.0151	0.0247*	0.0206	0.0174	0.00601	-0.00136	0.0129
	(0.0123)	(0.0122)	(0.0144)	(0.0167)	(0.0137)	(0.0141)	(0.0172)	(0.0131)
Δy_t , GB	-0.000690	-0.000973	-0.0137	-0.0608	0.0230	-0.0350	0.0475	-0.0193
	(0.0248)	(0.0244)	(0.0300)	(0.0396)	(0.0234)	(0.0386)	(0.0292)	(0.0286)
Δy_t^2 , GB	-0.0367***	-0.0368***	-0.0458***	-0.0358***	-0.0357***	-0.0405***	-0.0303***	-0.0405***
	(0.00526)	(0.00520)	(0.00625)	(0.00744)	(0.00485)	(0.00797)	(0.00652)	(0.00596)
S&P Return, 3m	-2.527***	-2.505***	-2.885***	-3.125***	-2.916***	-2.003***	-3.353***	-2.164***
	(0.543)	(0.541)	(0.604)	(0.654)	(0.597)	(0.645)	(0.715)	(0.595)
Shiller PE Ratio	0.0210**	0.0211**	0.0220**	0.0276*	0.0171	0.0315***	0.0224	0.0252**
	(0.00923)	(0.00918)	(0.0110)	(0.0142)	(0.0109)	(0.0100)	(0.0147)	(0.0104)
VIX Uncertainty	0.0158***	0.0158***	0.0168***	0.0188**	0.0134*	0.0180***	0.00773	0.0188***
	(0.00574)	(0.00574)	(0.00601)	(0.00737)	(0.00702)	(0.00626)	(0.00791)	(0.00624)
Constant	1.486***	1.505***	1.419**	1.671**	1.712***	1.033*	1.143	1.364**
	(0.496)	(0.495)	(0.557)	(0.759)	(0.565)	(0.621)	(0.771)	(0.567)
Observations	1932	1932	1857	1352	1173	759	630	1302
Adjusted R^2	0.336	0.337	0.330	0.305	0.288	0.422	0.242	0.392
Type	meeting	meeting	meeting	meeting	meeting	meeting	meeting	meeting
Sample	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12
Speaker	Chair-Gov-Pres.	Chair-Gov-Pres.	Chair-Gov-Pres.	Chair-Gov-Pres.	Voters	Non-Voters	Governors	Regional Pres.
$\hat{\pi^*}$	1.545	1.549	1.546	1.597	1.705	1.371	1.813	1.476
SE	(0.102)	(0.1)	(0.14)	(0.153)	(0.111)	(0.133)	(0.269)	(0.107)
95% C.I.	[1.345 - 1.744]	[1.353 - 1.744]	[1.271 - 1.82]	[1.297 - 1.896]	[1.487 - 1.922]	[1.11 - 1.631]	[1.285 - 2.34]	[1.266 - 1.685]

The variables y and y* denote log GDP and log potential GDP, respectively.

Standard errors (in parentheses) are robust to heteroskedasticity and clustering by sample-month. Regressions include speaker fixed effects.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Estimated Loss Function Based on FOMC Minutes
2000 - 2013

	(1) Symmetric U	(2) Symmetric U	(3) Asymmetric V	(4) Asymmetric V
π_t, GB	-1.123	-0.966		
	(0.915)	(0.621)		
π_t^2, GB	0.433	0.338*		
	(0.272)	(0.176)		
$(\pi_t > \pi^*)$=0 $\times$ $(\pi_t - \pi^*)$, GB			-0.281	-0.355
			(0.427)	(0.265)
$(\pi_t > \pi^*)$=1 $\times$ $(\pi_t - \pi^*)$, GB			0.667***	0.472***
			(0.221)	(0.163)
$(u_t - u_t^*)$, GB		0.137		0.172*
		(0.119)		(0.102)
$(u_t - u_t^*)^2$, GB		-0.0137		-0.0210
		(0.0178)		(0.0179)
Δy_t , GB		-0.163***		-0.162***
		(0.0331)		(0.0325)
Δy_t^2 , GB		-0.0343***		-0.0344***
		(0.00650)		(0.00689)
S&P Return, 3m		-1.083*		-1.023
		(0.627)		(0.708)
Shiller PE Ratio		0.0326**		0.0335***
		(0.0131)		(0.0123)
VIX Uncertainty		0.0211***		0.0210***
		(0.00665)		(0.00728)
Constant	1.588**	0.899	0.797***	0.0927
	(0.726)	(0.761)	(0.117)	(0.429)
Observations	111	111	111	111
Adjusted R^2	0.066	0.734	0.070	0.739
Type	minutes	minutes	minutes	minutes
Sample	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12
Symmetry p-val			0.29	0.686
$\hat{\pi^*}$	1.294	1.429	1.51	1.5
SE	(0.278)	(0.261)	(0.51)	(0.51)
95% C.I.	[.749 - 1.838]	[.917 - 1.94]	[1.4, 2.72]	[1.25, 2.72]

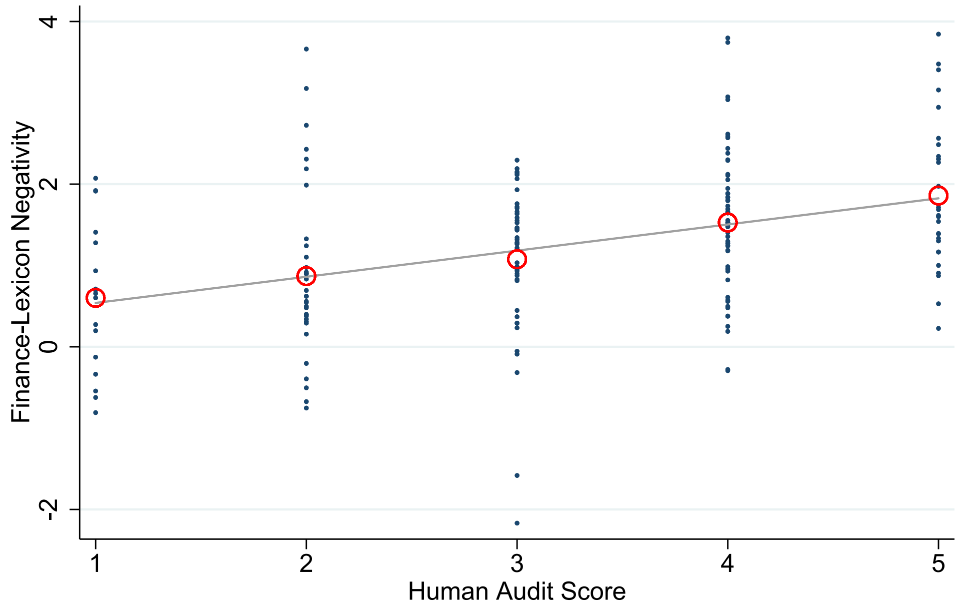
The variables y and y* denote log GDP and log potential GDP, respectively.
Standard errors (in parentheses) are robust to heteroskedasticity.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Estimated Loss Function Based on FOMC Speeches
2000 - 2013

	(1) Symmetric U	(2) Symmetric U	(3) Asymmetric V	(4) Asymmetric V
π_t, GB	-1.410***	-0.529		
	(0.520)	(0.450)		
π_t^2, GB	0.321**	0.172		
	(0.152)	(0.127)		
$(\pi_t > \pi^*)$=0 $\times$ $(\pi_t - \pi^*)$, GB			-0.452***	-0.325
			(0.106)	(0.240)
$(\pi_t > \pi^*)$=1 $\times$ $(\pi_t - \pi^*)$, GB			0.575	0.196
			(0.387)	(0.141)
$(u_t - u_t^*)$, GB		0.141		0.168*
		(0.0891)		(0.0922)
$(u_t - u_t^*)^2$, GB		0.00432		-0.00132
		(0.0140)		(0.0146)
Δy_t , GB		-0.0904***		-0.0917***
		(0.0252)		(0.0255)
Δy_t^2 , GB		0.00274		0.00280
		(0.00468)		(0.00466)
S&P Return, 3m		0.361		0.414
		(0.568)		(0.563)
Shiller PE Ratio		-0.0104		-0.00995
		(0.0111)		(0.0112)
VIX Uncertainty		0.00929		0.00920
		(0.00571)		(0.00565)
Constant	2.295***	1.276**	0.647***	0.798**
	(0.427)	(0.558)	(0.0736)	(0.361)
Observations	2277	2277	2277	2277
Adjusted R^2	0.201	0.252	0.202	0.253
Type	speech	speech	speech	speech
Sample	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12
Symmetry p-val			0.731	0.618
$\hat{\pi^*}$	2.198	1.538	2.15	1.41
SE	(0.274)	(0.356)	(0.47)	(0.49)
95% C.I.	[1.66 - 2.735]	[.84 - 2.235]	[.99, 2.5]	[.88, 2.4]

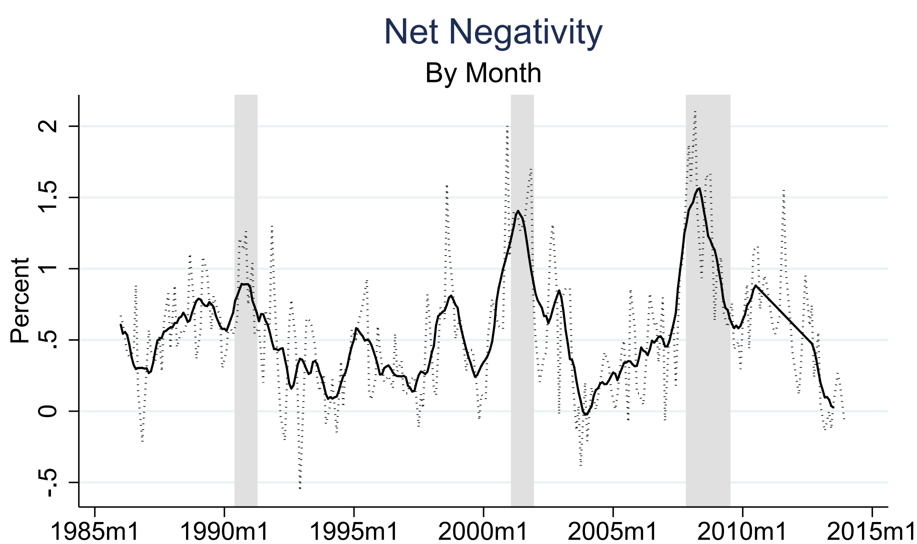
The variables y and y* denote log GDP and log potential GDP, respectively.
Standard errors (in parentheses) are robust to heteroskedasticity and clustering by sample-month.
Regressions include speaker fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 1: LM Net Negativity vs. Human Scores



Spearman Rank Correlation = 0.397 ; N = 182
Notes: Blue dots are raw data points, solid line is linear regression fit line, and red circles are within-score means of raw data points.

Figure 2: Transcripts of FOMC Meetings



Dotted line plots coefficients on time dummies from regression with speaker fixed effects.
Solid line is 11-month centered moving average.
Gray shaded areas indicate recessions.

Figure 3: Estimated U-shaped Loss Function for Inflation
FOMC Meetings: 2000 - 2013

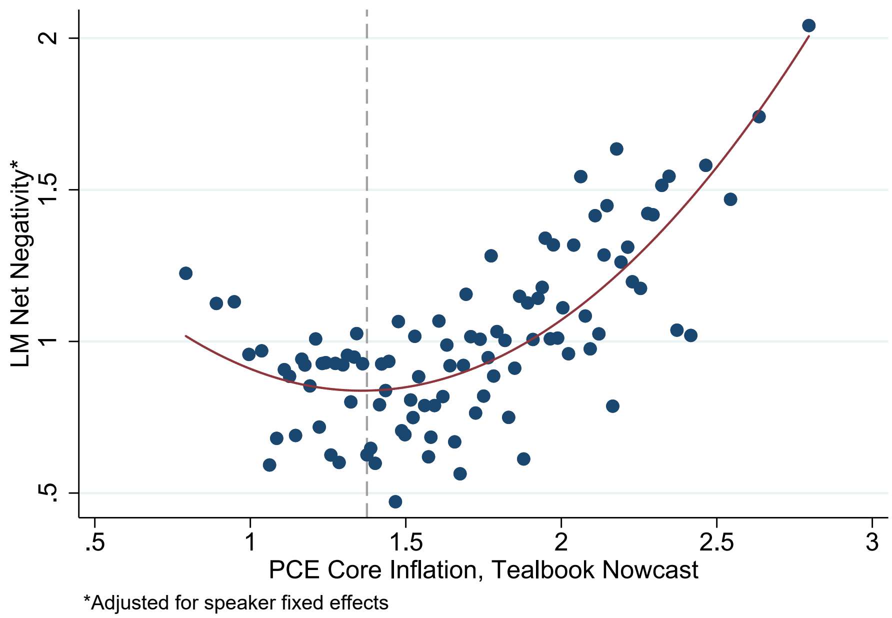


Figure 4: $\hat{\pi}^*$ Compared with SPF Inflation Expectations

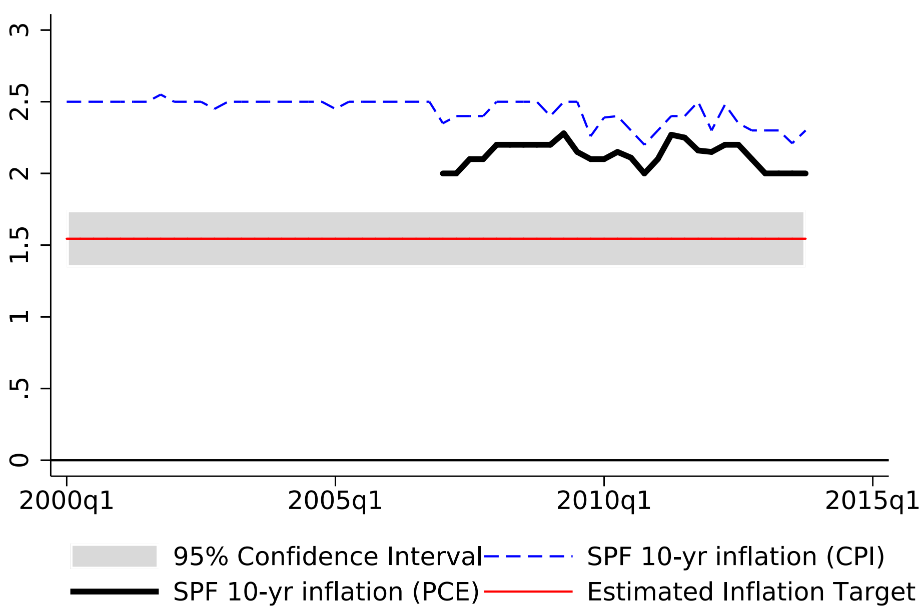
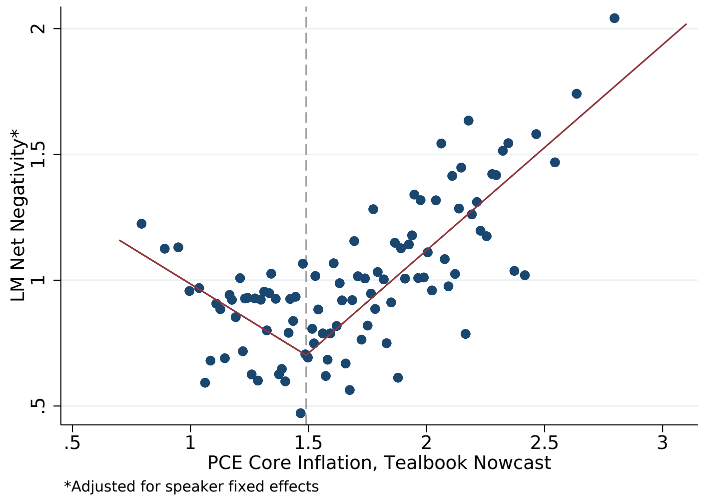
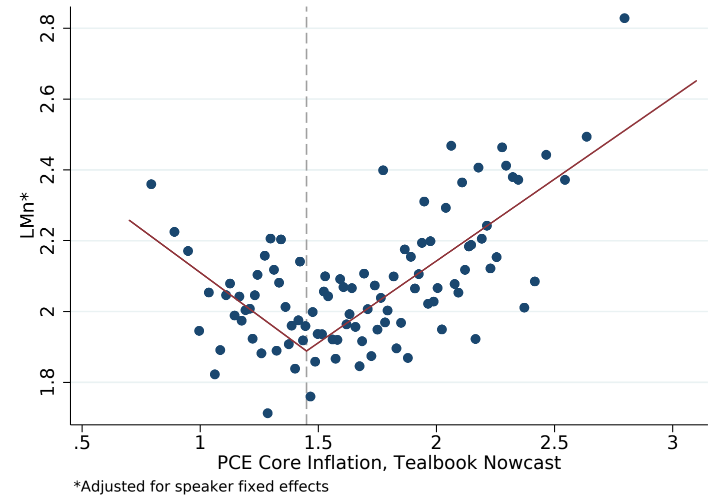


Figure 5: Estimated V-shaped loss function for inflation
FOMC Meetings: 2000 - 2013

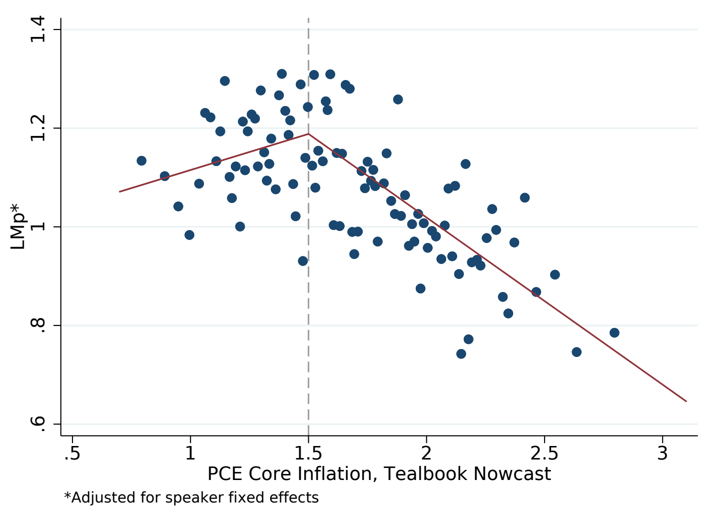
(a) Baseline, LM Net Negativity



(b) LM Negative Fraction



(c) LM Positive Fraction



(d) VADER Net Negativity Score

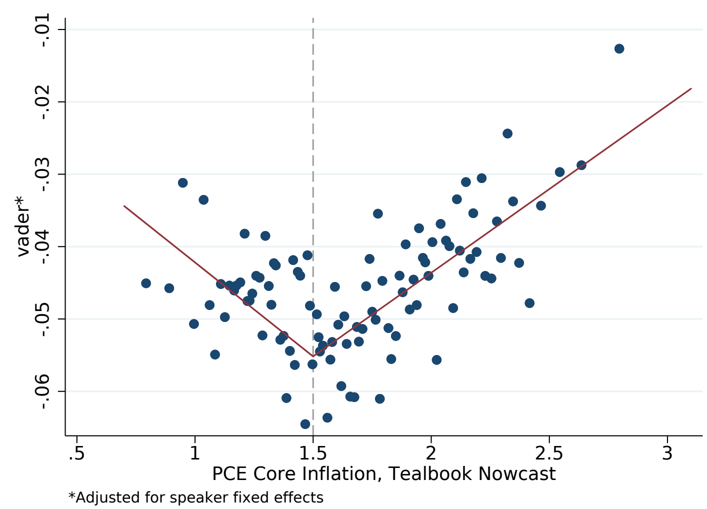


Figure 6: Estimated time-varying π^*
FOMC Meetings: 1986 - 2013
No Additional Factors

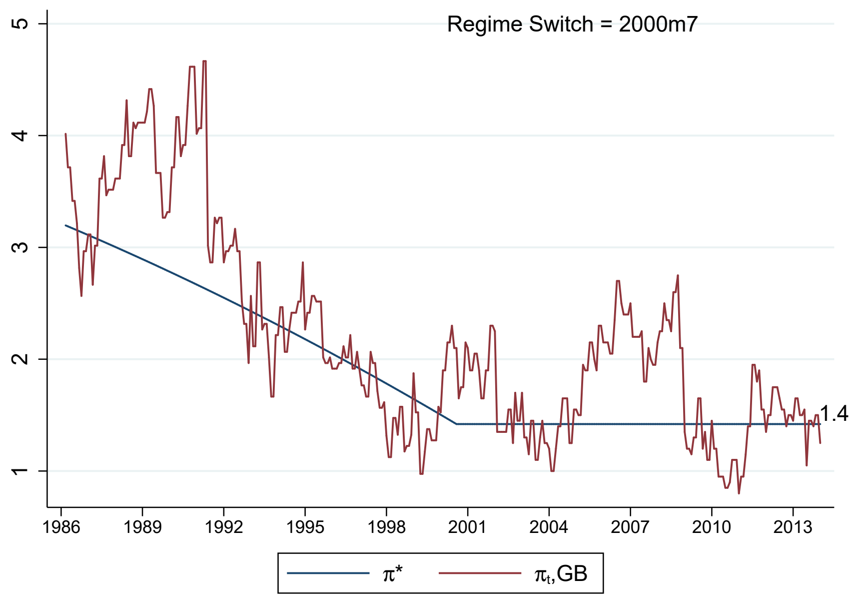


Figure 7: Estimated time-varying π^*
FOMC Meetings: 1986 - 2013
With Additional Factors

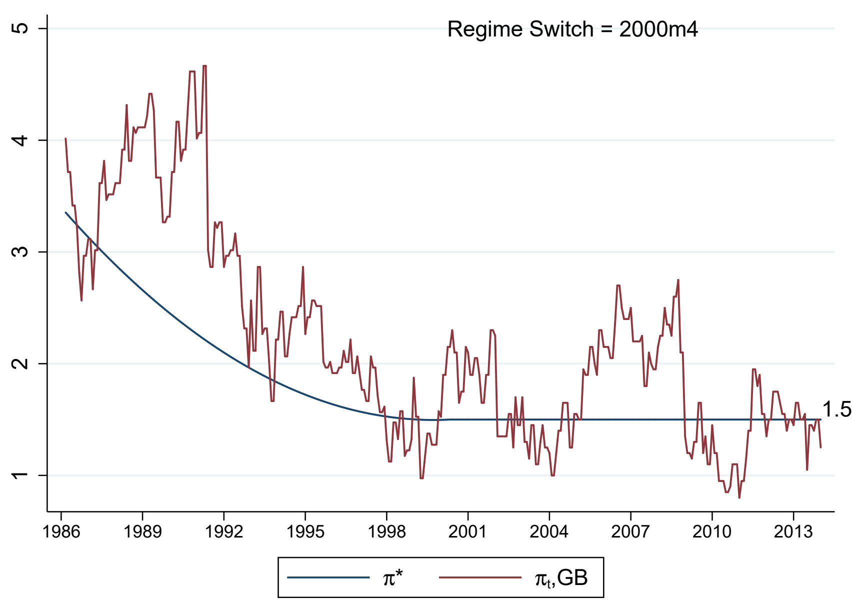
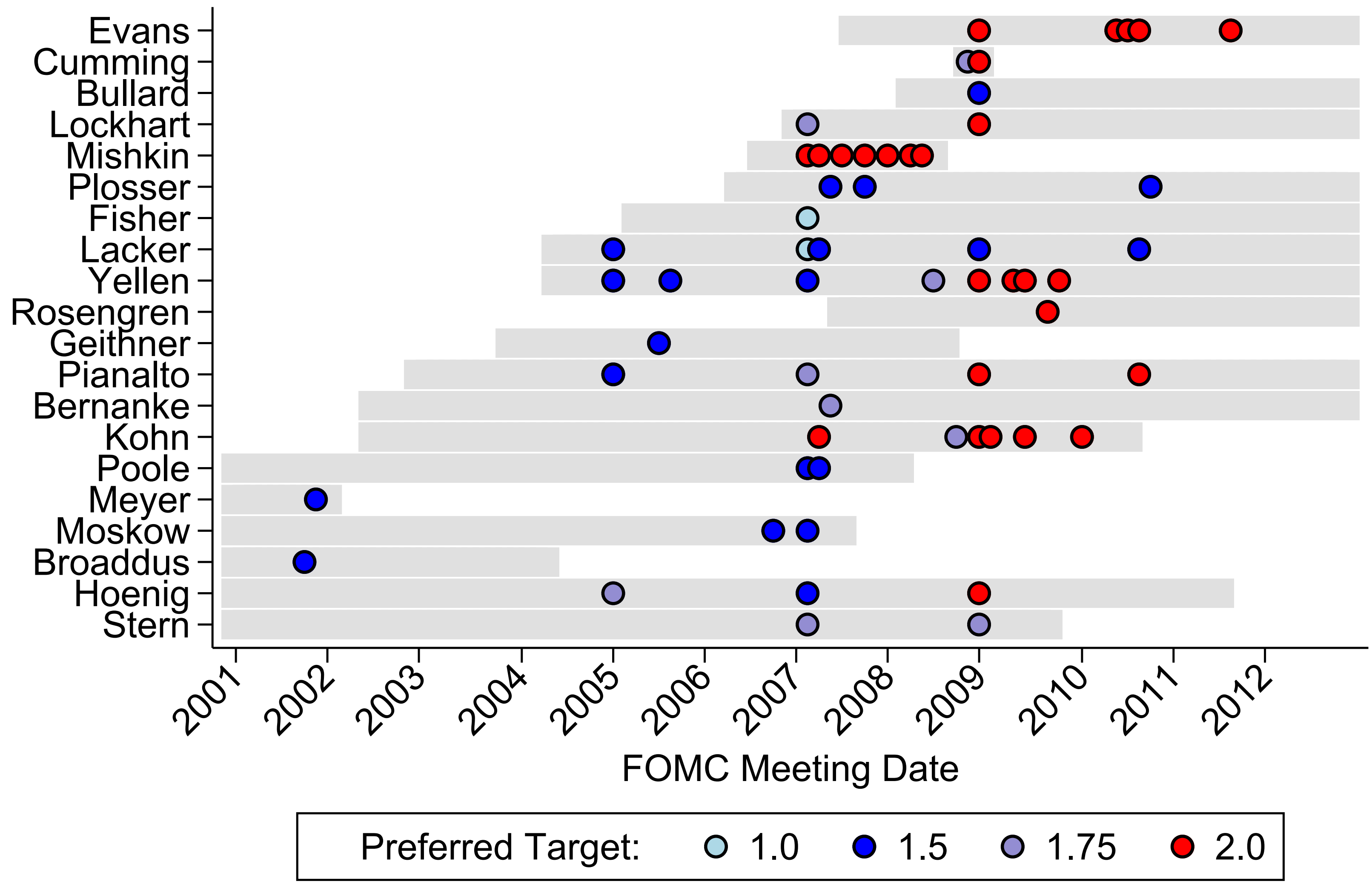


Figure 8: Explicit Statements of Inflation Target Preferences in FOMC Meetings
By Speaker, Over Time



Note: Only speakers with at least one stated preference are shown. Each circle represents a stated inflation target preference from the indicated speaker (y-axis) at the indicated FOMC meeting (x-axis). Gray shading indicates speaker's FOMC tenure.

Online Appendix

A Details of Theoretical Framework

A.1 Deriving Interest Rate Rule from Generalized Loss Function

Here we provide details for deriving the optimal interest rate rule based on the generalized loss function given by equation 8 in Section 2:

$$L_\tau = \frac{1}{2}(\tilde{\pi}_\tau^2 + \phi x_\tau^2) - \lambda x_\tau. \tag{15}$$

In that loss function, the central bank's contemporaneous loss includes a term, x, that decreases linearly with real economic activity. This loss function nests the more standard quadratic loss function shown in equation 2.

The central bank at time 0 chooses the real interest rate, r_0, to minimize its lifetime loss function:

$$\mathcal{L} = \sum_{\tau=0}^{2} L_\tau, \tag{16}$$

More accurately, r_0 is the interest rate gap relative to the neutral interest rate, r^*. In the 3-period version of the model, with the double-lag structure described in Section 2, at time 0 the central bank can only affect x_1, x_2, and π_2 with its interest rate choice, r_0; it has no effect on x_0, π_0, or π_1, which are predetermined. x_1 and x_2 are determined by the IS curve:

$$x_1 = \rho x_0 - a r_0, x_2 = \rho^2 x_0 - (1+\rho) a r_0 \tag{17}$$

where ρ represents the degree of persistence in real activity. $\tilde{\pi}_2$ is determined by the Phillips curve (PC):

$$\tilde{\pi}_2 = \psi \tilde{\pi}_1 + \gamma x_1 = \psi^2 \tilde{\pi}_0 + (\psi + \rho)\gamma x_0 - \gamma a r_0, \tag{18}$$

where ψ represents the degree of inflation persistence and we have substituted in the IS equation for x_1.

The first-order condition for the central banks interest rate choice is:

$$\frac{\delta \mathcal{L}}{\delta r_0} = \frac{\delta \tilde{\pi}_2}{\delta r_0}\tilde{\pi}_2 + \phi \frac{\delta x_1}{\delta r_0} x_1 + \phi \frac{\delta x_2}{\delta r_0} x_2 - \lambda \frac{\delta x_1}{\delta r_0} - \lambda \frac{\delta x_2}{\delta r_0} = 0 \tag{19}$$

Taking these derivatives and solving for r_0 yields the following loss-minimizing interest rate rule chosen in period 0:

$$r_0 = B\tilde{\pi}_0 + Cx_0 - \lambda D, \tag{20}$$

where B, C, and D are complex functions of the structural parameters of the loss function, PC, and IS curve:

$$B = \frac{\gamma\psi^2}{a(\gamma^2 + \phi + \phi(1+\rho)^2)}, \tag{21}$$

$$C = \frac{\gamma^2(\psi + \rho) + \phi\rho(1 + \rho + \rho^2)}{a(\gamma^2 + \phi + \phi(1+\rho)^2)}, \tag{22}$$

$$D = \frac{2 + \rho}{a(\gamma^2 + \phi + \phi(1+\rho)^2)}. \tag{23}$$

This rule demonstrates three key results. First, even if the central bank was a pure inflation targeter ($\phi = \lambda = 0$), the optimal interest rate would still react to real activity (x) because real activity signals future inflation via the Phillips curve (so long as the PC is not flat – i.e., $\gamma \neq 0$). Thus, observing that the central bank tends to raise rates when x is high and lower rates when x is low says very little about whether and how x enters the central bank's loss function. Second, even in the pure inflation targeting case, the coefficient on the inflation gap in the interest rate rule is a combination of multiple structural parameters, making it impossible to back out the structural parameters of the loss function without an exact knowledge of PC and IS curves. Adding real activity to the loss function – quadratically, linearly, or both – only exacerbates the problem. Third, if the central bank likes real economic activity all else equal ($\lambda > 0$), then the optimal interest rate rule has a negative constant term, indicating that the more that real activity is viewed as a positive by the central bank, the lower (more stimulative) is the steady-state interest rate (relative to the neutral rate). In other words, the central bank will choose an interest rate that is below the interest rate consistent with a zero inflation gap because it is trading off the cost of a positive inflation gap against the gain of higher real activity.

In the case of the standard quadratic loss function, where $\lambda = 0$, the constant term drops out and one is left with a conventional Taylor rule shown in equation 5 of the main text:

$$r_0 = B\tilde{\pi}_0 + Cx_0. \tag{24}$$

A.2 Deriving Reduced-Form Estimating Equation

In Section 2 of the main text, we argued that the tone expressed by the FOMC in their meetings, minutes, and speeches proxies for their short-run loss as opposed to their lifetime loss, which is the sum of short-run loss and the present discounted value of expected future loss. Of course, if the FOMC believes long-run objectives can be fully achieved via monetary policy, the expected future losses are zero, in which case the short-run loss and lifetime loss are equivalent.

We interpret short-run as the interval of time within which inflation and real economic activity are unaffected by the current interest rate choice of the central bank. More specifically, the short-run is defined by the lag length of the IS curve, the monetary transmission mechanism. For instance, real activity (such as the unemployment gap and GDP growth) is generally thought to respond to interest rates with a lag of around 1 to 2 years. Thus, the short-run loss could be considered to be the sum of L_t and L_{t+l}, where l is less than the lag length of the IS curve. With the general per-period loss discussed in Section 2, this would translate into a short-run loss of:

$$\mathcal{L}_t = \tilde{\pi}_t^2 + \phi x_t^2 - \lambda x_t + \tilde{\pi}_{t+l}^2 + \phi x_{t+l}^2 - \lambda x_{t+l} \tag{25}$$

As discussed in Section 4, we use Greenbook near-term forecasts of macroeconomic variables to measure the FOMC perceptions of the time t variables. Unfortunately, the Greenbook does not provide constant-interest-rate (CIR) forecasts which would to the time $t + l$ variables. Of course, if the near-term forecasts and the longer-term unobserved CIR forecasts are uncorrelated, the coefficients above can be estimated without need to include the CIR forecasts. If we allow for the possibility that the near-term forecast are correlated with the unobserved longer-run CIR forecasts due to the auto-correlation of these macroeconomic variables, the interpretation of the estimated coefficients changes as we detail below. Importantly, we also show below that the estimated inflation target is unaffected by the degree of persistence in inflation (or real activity).

To see these points, suppose that $\tilde{\pi}$ and x are each auto-correlated:

$$\begin{aligned} \tilde{\pi}_{t+l} &= \psi \tilde{\pi}_t + \gamma x_t \\ x_{t+l} &= \rho x_t. \end{aligned}$$

Note that the equation for $\tilde{\pi}_{t+l}$ allows for possibility that real activity in period t can affect inflation within the lag length l.

Substituting these expressions into (25) yields the following:

$$\begin{aligned}\mathcal{L}_t &= \tilde{\pi}_t^2 + \phi x_t^2 - \lambda x_t + \psi^2\tilde{\pi}_t^2 + 2\psi\gamma\tilde{\pi}_t x_t) + \gamma^2 x_t^2 + \phi\rho^2 x_t^2 - \lambda\rho x_t \\ &= (1+\psi^2)\tilde{\pi}_t^2 + (\phi(1+\rho^2)+\gamma^2)x_t^2 - \lambda(1+\rho)x_t + 2\psi\gamma\tilde{\pi}_t x_t\end{aligned}$$

As in Section 4, if we assume that FOMC's expressed negativity proxies for their short-run loss, $N_t = \delta\mathcal{L}_t$, then we obtain an estimating equation (ignoring speaker fixed effects and the error term for exposition) of the form in equation (12):

$$\begin{aligned}N_t &= \hat{\delta}\tilde{\pi}_t^2 + \hat{\omega}x_t^2 + \hat{\kappa}x_t + \hat{\alpha}\tilde{\pi}_t x_t \\ &= \hat{\delta}\pi_t^2 + \hat{\theta}\pi_t + \hat{\omega}x_t^2 + \hat{\kappa}x_t + \hat{\alpha}\tilde{\pi}_t x_t\end{aligned}$$

where

$$\begin{aligned}\hat{\delta} &= \delta(1+\psi^2) \\ \hat{\theta} &= -2\hat{\delta}\pi^* \\ \hat{\omega} &= \delta(\phi(1+\rho^2)+\gamma^2) = \omega + \omega\rho^2 + \gamma^2 \\ \hat{\kappa} &= -\lambda\delta(1+\rho) = \kappa + \kappa\rho \\ \hat{\alpha} &= 2\psi\gamma\end{aligned}$$

One can compare these coefficient expressions to their analogs in equation (13) to see how allowing persistence affects the interpretation of our regression coefficients. The coefficient on inflation squared, $\hat{\delta}$, includes the the current-period component, δ, plus the FOMC member's view of how the inflation shock will persist in the short-run, $\delta\psi^2$. As in Section 4, the implied inflation target can still be estimated by -2 times the ratio of the coefficient on inflation squared to the coefficient on inflation. In other words, the degree of persistence in inflation (and/or real activity) has no effect on the estimated inflation target.

Similarly, the coefficient on the linear term of real activity is simply the current-period component, κ, amplified to the degree of persistence in real activity (ρ). The coefficient on the squared term of real activity, $\hat{\omega}$, includes the current-period component, ω, plus the FOMC's view of how the real activity shock will persist in the short-run $\omega\rho^2$. In addition, $\hat{\omega}$ includes a third term, γ^2, which captures the effect of real activity on future inflation via the Phillips curve. Thus, $\hat{\omega}$ measures the net effect of changes in x^2 on loss, net of its effects on future inflation.

Lastly, we note that, with persistence, there is an additional interaction term at the end of equation (26) that was not part of our baseline estimating equation. The coefficient on the interaction term, $2\psi\gamma$, is the product of two fractions and therefore likely to be close to zero. Nonetheless, we tried including this term as a control in our main specifications and the coefficient was small and statistically insignificant.

B Example of Scored Text

Below we provide a sample of text from the transcript of the January 28-29, 2008 FOMC meeting. Terms that are scored as negative or positive according to the Loughran and McDonald (2011) dictionaries are shown in green while the negative terms shown in red. We also italicize the instances of term preceded by "not." Our sentiment scoring algorithm does not count negative or positive terms that are preceded by "not."

...

CHAIRMAN BERNANKE. If it is okay with everybody, we can start the economic go-around at this point. President Poole, you are up.

MR. POOLE. Thank you, Mr. Chairman. I am not sure how I got to be first here, but I guess I was being unusually agreeable when Debbie asked me. [Laughter] The general tenor of comments that I hear from our directors and people around the Eighth Federal Reserve District – these are the community bankers and smaller firms–is that things are **slow** but *not disastrously slow*. The comments that I hear from a series of phone calls to much larger national companies are decidedly more **pessimistic**, with one exception that I will talk about in a moment. My contact at a large national trucking firm says that they are in a 20-month **recession** in transportation. They are cutting their capacity, cutting the number of trucks, and I think the numbers on their cap-ex illustrate the situation: for 2006, $410 million; for 2007, $336 million; and their plan for 2008 is $200 million. That is down a little more than 50 percent in two years, so they are really cutting back. I also called friends at UPS and FedEx, and generally things are not a whole lot different but a little **weaker** than they have been. Neither firm has any particular issues with labor supply. Domestic express business is flat, and customers are switching to the lower-priced services instead of overnight delivery at the end of the afternoon, shifting to ground services, and that sort of thing. On international business, U.S.-outbound volume for FedEx is up 6 percent. That would be consistent with the export increases that we have seen. Reports are that Asia is a bit **slower** but is still growing very rapidly. Asia to the United States is up 80 percent, 20 percent to Europe and Latin America. The freight market is dead – that is the way my contact put it – down 5 percent year over year. That is consistent with my trucking industry contact – and pretty much the same with UPS. My contact with the fast food industry – the quick-serve restaurant, or QSR, business – says the demand there is definitely **weak**. They are coming in roughly flat, I guess, or actually down so far this year. Prices are up because of the increase in food costs. The casual dining industry is in **worse** shape than the fast food industry.

My contact also follows retail in general pretty closely and finds that retail business in general is **weak**. That is consistent with a lot of the reports that we have been receiving. A major exception is in the IT area – software. I have contact with a large software company, and the contact noted that, as announced, Microsoft had a **fantastic** quarter. The earnings were up **sharply**. PC hardware sales are growing at a rate of 11 to 13 percent expected in the first half of this year, so we see **strong** growth in the PC market. Consumer demand is **stronger** than business demand. Both, however, are pretty **strong**. The international business is doing **better**, in part because the industry is having some **success** in reducing the amount of software piracy. The biggest **problem** is finding software engineers. This particular company is running 8 percent behind its hiring forecast and cannot find software engineers. **Positive** for us old guys; some of the retirees are coming back to write code. [Laughter] Thank you. That is all I have.

...

C Technical details: Time-Varying Inflation Target

The estimation of the optimal time-varying π_t^* over the extended sample, 1986m1-2013m12, is performed under two assumptions:

- π_t^* is assumed constant over an "constant-target period" defined as $t \in (s, 2013\text{m}12]$.
- π_t^* is assumed a quadratic polynomial "time-varying-target period" defined as $t \in [1986\text{m}1, s]$.

The optimization takes the following path:

1. For a given s,
   - Find optimal $\hat{\alpha}_0^s$ assuming $\pi_t^{*,s} = \alpha_0^s$, over sample period $t \in (s, 2013\text{m}12]$.
   - Given $\hat{\alpha}_0^s$, find optimal $\hat{\alpha}_2^s$ and $\hat{\alpha}_2^s$, assuming $\pi_t^{*,s} = \hat{\alpha}_0^s + \alpha_1^s(s-t) + \alpha_2^s(s-t)^2$, over sample period $t \in [1986\text{m}1, s]$
2. Given $\hat{\pi}_t^{*,s} = \hat{\alpha}_0^s + \hat{\alpha}_1^s(s-t) + \hat{\alpha}_2^s(s-t)^2$, perform grid search over $\hat{\pi}_t^{*,s}$ across $s \in [1993\text{m}1, 2006\text{m}1]$ to find optimal $\hat{\pi}_t^*$.

Constant-target period estimation

For a given α_0^s and $t = s$, the regression:

$$N_{it} = \delta^s|\pi_t - \alpha_0^s| + \mathbf{X}_t\Lambda + \varepsilon_{it} \tag{26}$$

is run over the sample period $t \in (s, \text{2013m12}]$.

A grid search is performed over α_0^s with step size 0.01, whereby $\hat{\alpha}_0^s$ is the value $\alpha_0^s \in [0, 4]$ that produces the largest R^2.

Time-varying-target period estimation

First, to speed up the optimization routine, we find the window, $[\alpha_{1,L}^s, \alpha_{1,H}^s]$, where slope parameter, α_1^s likely resides. We do so by assuming π_t^* is linear in the time-varying-target period.

Let $LIN_t^s = \hat{\alpha}_0^s + \alpha_1^s(s - t)$, where $\hat{\alpha}_0^s$ was found from (26). For a given α_1^s and a given $t = s$, the regression:

$$N_{it} = \delta^s|\pi_t - LIN_t^s| + \mathbf{X}_t\Lambda + \varepsilon_{it}^s \tag{27}$$

is run over the sample period $t \in [\text{1986m1}, s]$. A grid search is performed over α_1^s with step size 0.001, whereby $\hat{\alpha}_1^s$ is the value $\alpha_1^s \in [-1, 1]$ that produces the largest R^2. The step size and window size is shrunk by a factor of 10 if the optimal $\hat{\alpha}_1^s$ is zero. This is repeated until a nonzero $\hat{\alpha}_1^s$ is found. The likely window $[\alpha_{1,L}^s, \alpha_{1,H}^s]$ is assumed to be $\hat{\alpha}_1^s \pm 10\hat{\alpha}_1^s$, with step size $d^s = (\alpha_{1,H}^s - \alpha_{1,L}^s)/100$

Next, we perform a joint grid search over α_1^s and α_2^s assuming $\pi_t^{*,s}$ can be approximated by a quadratic polynomial in the time-varying-target period. Let $QUAD_t^s = \hat{\alpha}_0^s + \alpha_1^s(s - t) + \alpha_2^s(s - t)^2$, where $\hat{\alpha}_0^s$ was found from (26). For a given α_1^s, α_2^s, and $t = s$ the regression:

$$N_{it} = \delta^s|\pi_t - QUAD_t^s| + \mathbf{X}_t\Lambda + \varepsilon_{it}^s \tag{28}$$

is run over the sample period $t \in [\text{1986m1}, s]$. A joint grid search is performed over α_1^s and α_2^s with step sizes d^s and 0.00001, and grid intervals $[\alpha_{1,L}^s, \alpha_{1,H}^s]$ and [-0.0001, 0.0001], respectively, that produces the largest R^2. This produces $\widehat{QUAD}_t^s = \hat{\alpha}_0^s + \hat{\alpha}_1^s(s-t) + \hat{\alpha}_2^s(s-t)^2$.

Full-period estimation

Finally, the optimal s is found. For a given $\widehat{QUAD}_t^s$ the regression:

$$L_{it} = \gamma^{pre}|\pi_t - \widehat{QUAD}_t^s| * \mathbb{1}(t \leq s) + \gamma^{post}|\pi_t - \widehat{QUAD}_t^s| * \mathbb{1}(t > s) + \mathbf{X}_t\Lambda + \varepsilon_{it}^s \tag{29}$$

is run over the sample period $t \in [\text{1986m1}, \text{2013m12}]$. Here we allow for different parameters, γ_1 and γ_2, in the constant-target and time-varying-target periods. A grid search is performed over s over the entire sample that produces the largest R^2 . To speed to optimization, an exhaustive grid search is first performed over 12 month intervals. The search is than narrowed to 4, and then 1 month intervals until the optimal $\hat{\pi}_t^* = \widehat{QUAD}_t$ is found. The results are shown in Figures 6 (without controls) and 7 (with controls).

D Preferred Inflation Target Statements in FOMC Meetings

Below are the quotes we found in the FOMC meeting transcripts over the 2000 to 2013 period in which an FOMC participant stated an explicit preference for the inflation target. If the speaker provides a separate preferred target for PCE inflation and CPI inflation, we take the one for PCE inflation. The target preferences are plotted by speaker and over time in Figure 8 and discussed in Section 6 of the paper.

Nov. 6, 2001

Broaddus: 1.5

Of course, the core PCE inflation rate, which is the measure I think most of us now focus on, is currently about 1 $\frac{1}{2}$ percent. I think that's pretty close to the inflation target we should be aiming for at this stage, for the reasons I just noted.

Dec. 11, 2001

Meyer: 1.5

The Committee does not have an explicit long-run inflation objective, so I do the exercise in terms of my own long-run objective for inflation, which is 1 $\frac{1}{2}$ percent for the PCE core inflation rate.

Feb. 2, 2005

Hoenig: 1.75

Given its general acceptance by the public, I would choose CPI inflation because it's better known. And I would have an objective somewhere in the range of 1 to 2 percent or 1 $\frac{1}{2}$ to 2$\frac{1}{2}$ percent.

Lacker: 1.5

I agree with the recommendation that the objective should be a consumer price index–either the CPI with a 2 percent midpoint or the PCE price index with a 1 $\frac{1}{2}$ percent midpoint.

Yellen: 1.5

Taking measurement bias between the two indexes into account, my preference would now be for a long-run inflation objective of 1 $\frac{1}{2}$ percent for core PCE inflation.

Pianalto: 1.5

My price stability objective is for price expectations to be consistent with the PCE index increasing at an average rate of $1\frac{1}{2}$ percent per year, which I expect to achieve by having the PCE index itself increasing at that average rate over periods of five to ten years.

Aug. 9, 2005

Geithner: 1.5

However, even this relatively modest path leaves us some margin above the $1\frac{1}{2}$ percent pace for the core PCE that we believe should be our objective over time.

Sept. 20, 2005

Yellen: 1.5

Core PCE prices have risen at a $1\frac{1}{2}$ percent rate over the six months through July, right in the middle of my preferred range, and core CPI inflation has also been well behaved.

Oct. 25, 2006

Moskow: 1.5

My preference is for core inflation to be $1\frac{1}{2}$ percent, in the center of that zone.

Mar. 21, 2007

Poole: 1.5

I think that there's a lot to be said for stating that our inflation objective is $1\frac{1}{2}$ percent, plus or minus $\frac{1}{2}$.

Fisher: 1

I would argue for a 1 percent target based on the CPI—if you put a gun to my head, which I hope you don't—over a longer time frame.

Lacker: 1

Taking all of this on board, I believe 1 percent would be our best choice for a numerical inflation objective.

Mishkin: 2

The actual number is less important so long as it is a reasonable number, consistent with the Greenspan definition of price stability–that is, it's sort of like pornography; you know it when you see it. A number of 2 is certainly consistent with that.

Hoenig: 1.5

Now, I would prefer a point goal of 2 percent for the core CPI and $1\frac{1}{2}$ percent for the core PCE, and I would specify a flexible time horizon.

Stern: 1.75

I think a little less than 2 percent is fully consistent with an objective of low, stable inflation, which is what we're really talking about here. Moreover, the fact that it doesn't have a bottom to the range means that, if we get lucky or if there's an opportunity to bring inflation down below 2 percent, we could take advantage of that, and that would be all to the *good. I have some concerns with a range or a target that focuses on $1\frac{1}{2}$ or something even lower....*

Lockhart: 1.75

Regarding exact numbers, I've not settled on a specific number, but I would think that something in the range of $1\frac{1}{2}$ to 2 percent, depending upon the index that's chosen, is a reasonable guide to policy and compatible with the dual mandate.

Pianalto: 1.75

If the majority of the Committee prefers the PCE, I would choose a midpoint of $1\frac{3}{4}$ percent.

Yellen: 1.5

I remain comfortable with the goal that I enunciated some time ago–a long-run inflation objective of $1\frac{1}{2}$ percent for the core PCE inflation rate.

Moskow: 1.5

I've talked publicly about a comfort zone of 1 to 2 percent core PCE....

May 9, 2007

Mishkin: 2

My view of where the number should be is that I lean toward 2 percent because I do think the transition costs are important, although I am concerned about the issue that President Lacker mentioned.

Lacker: 1.5

Under what, in my judgment, would be an appropriate monetary policy, we use the Chairman's July testimony to announce that the FOMC's objective is for PCE inflation to average $1\frac{1}{2}$ percent and that the Committee intends to reduce inflation to that level within two years.

Kohn: 2

I did this in the context of what I would have as an interim inflation target of 2 percent. I think 2 percent is achievable without significant output loss.

Poole: 1.5

I think that we ought to continue with a comfort zone of 1 to 2, and we ought to think about the inflation target as being $1\frac{1}{2}$ plus or minus a half.

June 28, 2007

Plosser: 1.5

In any event, the bottom line for my forecast is that I anticipate that the economy will grow just below trend of 3 percent in 2008 and at trend of 3 percent in 2009, and we achieve an inflation goal of 1.5 percent by the end of the period. Of course, this forecast is based on my desired inflation objective, which may not be representative of other members of the Committee.

Bernanke: 1.75

I simply take note of the fact that the latest projections show the central tendency of the Committee's inflation objectives to be 1.5 to 2 percent on the core PCE deflator. I actually–and I'm speaking entirely for myself–would be not at all displeased if that became known as the Federal Reserve's comfort zone or informal definition of price stability.

Aug. 7, 2007

Mishkin: 2

I believe that a 2 percent goal is reasonable for reasons that I have discussed before.

Oct. 31, 2007

Mishkin: 2

People know that I am a 2 percent kind of guy, and I know good people here who are $1\frac{1}{2}$ percent kinds of guys.

Plosser: 1.5

Core PCE inflation remains slightly below 2 percent next year and moderates toward my goal of $1\frac{1}{2}$ percent by 2010.

Jan. 30, 2008

Mishkin: 2

The key here is that I think that inflation expectations are grounded–in fact, are grounded at a level that is consistent with my inflation objective, around 2 percent on PCE, which might be different from others' views, but that's where I am right now.

Apr. 30, 2008

Mishkin: 2

About where I think inflation is going to be–I have been a 2 percent guy for a long time. I am not changing that.

June 25, 2008

Mishkin: 2

I'm a 2 percent kind of guy on PCE, and I'm still a 2 percent guy–that even though headline inflation is very elevated, we're going to see over the forecast period that inflation will come back down to around the 2 percent level both on the headline and on the core.

Aug. 5, 2008

Yellen: 1.75

Given my preference for an inflation target of around $1\frac{3}{4}$ percent and equal welfare weights on the inflation and unemployment gaps, I view the Greenbook policy path and forecast as a roughly optimal trajectory to the attainment of our goals.

Oct. 29, 2008

Kohn: 1.75

In my forecast for inflation from next year on, inflation was at or below the $1\frac{1}{2}$ to 2 percent rate I would like to see as a steady state consistent with avoiding the zero bound when *adverse shocks hit.*

Dec. 16, 2008

Cumming: 1.75

So more fundamentally we need to communicate what we want to accomplish, and that importantly involves our commitment to price stability, as many have said here in the sense of keeping prices in the medium term rising in line with our $1\frac{1}{2}$ to 2 percent preference, and our commitment to a resumption of sustainable economic activity.

Jan. 16, 2009 (FOMC conference call)

Bullard: 1.5

I would suggest 1.5 percent as the target.

Lacker: 1.5

About these other questions, a single number to me seems obviously preferable. Total PCE and $1\frac{1}{2}$ percent would be my choices.

Stern: 1.75

I have long favored something like the European Central Bank target of 2 percent or a little under. That gives us some room on the downside.

Yellen: 2

All in all I have concluded that a long-term numerical inflation objective of 2 percent for the PCE price index would be preferable.

Evans: 2

On the particular numbers, I would favor using the total PCE index at 2 percent. That seems to be more likely to avoid zero lower bound issues.

Pianalto: 2

But in light of our recent experience, I am now leaning toward an objective for total PCE inflation of 2 percent to provide a larger buffer against zero lower bound events.

Hoenig: 2

I would prefer overall CPI but certainly can live with PCE as we have been doing at this time, with an explicit statement that we are targeting the midpoint of 2 percent.

Kohn: 2

On the specific points, I would go for a point rather than a range. I would go for something around 2 percent on the PCE index.

Lockhart: 2

On balance, I favor a point forecast of 2 percent, a round number.

Cumming: 2

I believe it would be very helpful under the current circumstances to adopt an explicit *numerical objective for medium-term inflation of 2 percent for PCE inflation, given the real risk of deflation and the likelihood that deflation fears will become an important part of the public's concerns about the steep global downturn that we are now in.*

Jan. 28, 2009

Kohn: 2

With that slack, inflation continues to drop, and even with long-run inflation expectations well anchored, I had total and core PCE in the 1 to $1\frac{1}{4}$ percent range in 2010–11, well below my objective of 2 percent.

Apr. 29, 2009

Yellen: 2

I expect at best a gradual recovery starting late this year, with core inflation remaining below my preferred 2 percent rate for the next few years.

June 24, 2009

Yellen: 2

I expect core inflation to drift lower over the next few years, falling below the 2 percent rate that seems best to me.

Kohn: 2

So, on balance, I see persistent output gaps and inflation falling below my 2 percent objective over the next few years.

Sept. 23, 2009

Rosengren: 2

Thus, like the Greenbook, I expect that lower labor costs and the substantial slack in the economy will continue to generate disinflation, and, thus, over the next two years, we will likely be moving further below my inflation target of 2 percent.

Nov. 4, 2009

Yellen: 2

It is because I expect resource utilization–namely, unemployment–to remain far above the NAIRU for a long time, for core inflation to be below my preferred 2 percent objective, and inflation expectations to remain anchored that my own policy expectations accord with the assumptions in the Greenbook and the constrained optimal policy path in the Bluebook.

Jan. 29, 2010

Kohn: 2

Continued large slack keeps inflation subdued, well below my 2 percent objective for the next three years, on the assumptions that commodity prices rise in line with futures markets and that longer-term inflation expectations remain anchored.

June 23, 2010

Evans: 2

Because inflation is projected to underrun my 2 percent inflation goal over the medium term, according to FOMC central tendencies, it's difficult for me to imagine altering our current accommodative policy stance over the next six months or so, and certainly not in a material fashion.

Aug. 10, 2010

Evans: 2

Nevertheless, by my reckoning, with the Tealbook's core PCE inflation projection of 1 percent in 2012, we're failing by a full percentage point; that is, I have 2 percent as my price stability goal.

Sept. 21, 2010

Lacker: 1.5

Inflation remains pretty steady at 1.5 percent overall on a year-over-year basis. That lines up with my own inflation objective.

Pianalto: 2

Although these are encouraging signs, at this point inflation expectations are still well below my longer-run objective of 2 percent.

Evans: 2

If markets understand our explicit commitment to exit this policy, future inflation expectations will converge to our ultimate price stability objective, which I put at 2 percent.

Nov. 3, 2010

Plosser: 1.5

Inflation is now running between 1 and $1\frac{1}{2}$ percent measured year over year, which is very near my inflation objective.

Sept. 21, 2011

Evans: 2

After reviewing the analyses, I continue to feel that a reasonable and aggressive set of triggers, if it was a decision today, would be 7 percent for unemployment and 3 percent for medium-term inflation. With an inflation objective of 2 percent, I think that 3 percent inflation is a reasonable statement of symmetric preferences around our objective.

E APPENDIX TABLES AND FIGURES

Table A1: Estimated V-shaped loss function with unknown π^*
FOMC Meetings: 2000 - 2013
LM Fraction Negative

	(1) Symmetric V	(2) Symmetric V	(3) Asymmetric V	(4) Asymmetric V
$\mid \pi_t - \pi^* \mid$, GB	0.462***	0.329***		
	(0.118)	(0.0988)		
$(\pi_t > \pi^*)$=0 × $(\pi_t - \pi^*)$, GB			-0.492*	-0.578***
			(0.249)	(0.180)
$(\pi_t > \pi^*)$=1 × $(\pi_t - \pi^*)$, GB			0.462***	0.237**
			(0.118)	(0.0942)
$(u_t - u_t^*)$, GB		0.100		0.0708
		(0.0616)		(0.0660)
$(u_t - u_t^*)^2$, GB		-0.0101		-0.00857
		(0.0103)		(0.0106)
Δy_t , GB		0.0169		0.0141
		(0.0209)		(0.0209)
Δy_t^2 , GB		-0.0371***		-0.0382***
		(0.00392)		(0.00399)
S&P Return, 3m		-1.652***		-1.682***
		(0.400)		(0.401)
Shiller PE Ratio		0.0230***		0.0208**
		(0.00820)		(0.00820)
VIX Uncertainty		0.0140***		0.0135***
		(0.00479)		(0.00479)
Constant	1.891***	1.283***	1.889***	1.398***
	(0.0513)	(0.261)	(0.0546)	(0.268)
Observations	1932	1932	1932	1932
Adjusted R^2	0.206	0.377	0.206	0.378
Type	meeting	meeting	meeting	meeting
Sample	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12
Symmetry p-val			0.895	0.06
$\hat{\pi^*}$	1.45	1.57	1.45	1.48
SE	(0.16)	(0.17)	(0.31)	(0.25)
95% C.I.	[1.24, 1.53]	[1.45, 1.87]	[.98, 1.77]	[1.03, 1.75]

The variables y and y* denote log GDP and log potential GDP, respectively.
Standard errors (in parentheses) are robust to heteroskedasticity and clustering by sample-month.
Regressions include speaker fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A2: Estimated V-shaped loss function with unknown π^*
FOMC Meetings: 2000 - 2013
LM Fraction Positive

	(1) Symmetric V	(2) Symmetric V	(3) Asymmetric V	(4) Asymmetric V
$\mid \pi_t - \pi^* \mid$, GB	-0.295***	-0.260***		
	(0.0426)	(0.0467)		
$(\pi_t > \pi^*)$=0 × $(\pi_t - \pi^*)$, GB			0.146	0.140
			(0.0890)	(0.112)
$(\pi_t > \pi^*)$=1 × $(\pi_t - \pi^*)$, GB			-0.339***	-0.269***
			(0.0472)	(0.0482)
$(u_t - u_t^*)$, GB		0.0376		0.0308
		(0.0363)		(0.0385)
$(u_t - u_t^*)^2$, GB		-0.0150**		-0.0149**
		(0.00634)		(0.00635)
Δy_t , GB		0.0159*		0.0156*
		(0.00847)		(0.00851)
Δy_t^2 , GB		-0.00174		-0.00198
		(0.00207)		(0.00216)
S&P Return, 3m		0.743***		0.753***
		(0.282)		(0.285)
Shiller PE Ratio		0.000403		-0.000184
		(0.00426)		(0.00435)
VIX Uncertainty		-0.00207		-0.00193
		(0.00266)		(0.00267)
Constant	1.205***	1.216***	1.188***	1.235***
	(0.0264)	(0.145)	(0.0267)	(0.149)
Observations	1932	1932	1932	1932
Adjusted R^2	0.211	0.249	0.212	0.249
Type	meeting	meeting	meeting	meeting
Sample	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12
Symmetry p-val	0.	0.	0.015	0.258
$\hat{\pi^*}$	1.35	1.3	1.5	1.32
SE	(0.11)	(0.2)	(0.23)	(0.4)
95% C.I.	[1.25, 1.51]	[1.05, 1.54]	[1.25, 1.7]	[1.05, 2.49]

The variables y and y* denote log GDP and log potential GDP, respectively.
Standard errors (in parentheses) are robust to heteroskedasticity and clustering by sample-month.
Regressions include speaker fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3: Estimated V-shaped loss function with unknown π^*
FOMC Meetings: 2000 - 2013
VADER Net Negativity Score

	(1) Symmetric V	(2) Symmetric V	(3) Asymmetric V	(4) Asymmetric V
$\mid \pi_t - \pi^* \mid$, GB	0.0235***	0.0198***		
	(0.00520)	(0.00530)		
$(\pi_t > \pi^*)$=0 × $(\pi_t - \pi^*)$, GB			-0.0260**	-0.0264***
			(0.0107)	(0.0100)
$(\pi_t > \pi^*)$=1 × $(\pi_t - \pi^*)$, GB			0.0231***	0.0165***
			(0.00513)	(0.00520)
$(u_t - u_t^*)$, GB		-0.00412		-0.00463
		(0.00338)		(0.00368)
$(u_t - u_t^*)^2$, GB		0.000511		0.000512
		(0.000588)		(0.000604)
Δy_t , GB		0.00193*		0.00183*
		(0.00106)		(0.00107)
Δy_t^2 , GB		-0.00104***		-0.00106***
		(0.000166)		(0.000188)
S&P Return, 3m		-0.0264		-0.0271
		(0.0200)		(0.0201)
Shiller PE Ratio		-0.000819*		-0.000873*
		(0.000455)		(0.000456)
VIX Uncertainty		0.000949***		0.000927***
		(0.000318)		(0.000318)
Constant	-0.0550***	-0.0450***	-0.0552***	-0.0420***
	(0.00268)	(0.0132)	(0.00290)	(0.0135)
Observations	1932	1932	1932	1932
Adjusted R^2	0.156	0.268	0.155	0.269
Type	meeting	meeting	meeting	meeting
Sample	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12
Symmetry p-val	0.	0.	0.754	0.344
$\hat{\pi^*}$	1.51	1.6	1.5	1.53
SE	(0.14)	(0.18)	(0.3)	(0.23)
95% C.I.	[1.4, 1.62]	[1.37, 1.73]	[1.04, 2.15]	[1.05, 1.7]

The variables y and y* denote log GDP and log potential GDP, respectively.
Standard errors (in parentheses) are robust to heteroskedasticity and clustering by sample-month.
Regressions include speaker fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A4: Estimated U-shaped loss function with unknown π^*
FOMC Meetings: 2000 - 2013
Weighted

	(1)	(2)	(3)	(4)
π_t, GB	-1.191*	-0.721	-1.356**	-1.323***
	(0.670)	(0.667)	(0.592)	(0.465)
π_t^2, GB	0.436**	0.370*	0.434**	0.426***
	(0.191)	(0.187)	(0.167)	(0.134)
$(u_t - u_t^*)$, GB		0.122*		0.0515
		(0.0711)		(0.0776)
$(u_t - u_t^*)^2$, GB		-0.00253		0.00453
		(0.0126)		(0.0123)
Δy_t , GB			-0.0868***	0.0171
			(0.0121)	(0.0213)
Δy_t^2 , GB			-0.0234***	-0.0364***
			(0.00398)	(0.00456)
S&P Return, 3m				-2.151***
				(0.381)
Shiller PE Ratio				0.0277***
				(0.00921)
VIX Uncertainty				0.0187***
				(0.00485)
Constant	1.675***	0.908	2.325***	1.027**
	(0.558)	(0.596)	(0.503)	(0.460)
Observations	1932	1932	1932	1932
Adjusted R^2	0.129	0.147	0.218	0.315
Type	meeting	meeting	meeting	meeting
Sample	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12
$\hat{\pi}^*$	1.365	.974	1.561	1.551
SE	(0.195)	(0.426)	(0.118)	(0.114)
95% C.I.	[.982 - 1.747]	[.139 - 1.808]	[1.329 - 1.792]	[1.327 - 1.774]

The variables y and y* denote log GDP and log potential GDP, respectively.
Standard errors (in parentheses) are robust to heteroskedasticity and clustering by sample-month.
Regressions include speaker fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A5: Estimated U-shaped Loss Function
FOMC Minutes: 2000 - 2013

	(1)	(2)	(3)	(4)	(5)
π_t, GB	-1.123	0.0912	-0.681	-0.667	-0.966
	(0.915)	(0.846)	(0.634)	(0.778)	(0.621)
π_t^2, GB	0.433	0.215	0.236	0.214	0.338*
	(0.272)	(0.247)	(0.191)	(0.217)	(0.176)
$(u_t - u_t^*)$, GB		0.275***		-0.0889	0.137
		(0.0828)		(0.0813)	(0.119)
$(u_t - u_t^*)^2$, GB		-0.0250		0.0201	-0.0137
		(0.0172)		(0.0138)	(0.0178)
Δy_t , GB			-0.247***	-0.254***	-0.163***
			(0.0235)	(0.0266)	(0.0331)
Δy_t^2 , GB			-0.0249***	-0.0263***	-0.0343***
			(0.00562)	(0.00610)	(0.00650)
S&P Return, 3m					-1.083*
					(0.627)
Shiller PE Ratio					0.0326**
					(0.0131)
VIX Uncertainty					0.0211***
					(0.00665)
Constant	1.588**	-0.0446	2.234***	2.331***	0.899
	(0.726)	(0.720)	(0.499)	(0.746)	(0.761)
Observations	111	111	111	111	111
Adjusted R^2	0.066	0.155	0.649	0.649	0.734
Type	minutes	minutes	minutes	minutes	minutes
Sample	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12
$\hat{\pi^*}$	1.294	-.211	1.443	1.555	1.429
SE	(0.278)	(02.205)	(0.246)	(0.445)	(0.261)
95% C.I.	[.749 - 1.838]	[-4.532 - 4.11]	[.96 - 1.925]	[.682 - 2.427]	[.917 - 1.94]

The variables y and y* denote log GDP and log potential GDP, respectively.
Standard errors (in parentheses) are robust to heteroskedasticity.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A6: Estimated V-shaped Loss Function, Allowing for Asymmetry in Inflation Gap Loss
FOMC Minutes: 2000 - 2013

	(1) Symmetric V	(2) Asymmetric V	(3) Symmetric V	(4) Asymmetric V
$\mid \pi_t - \pi^* \mid$, GB	0.615***		0.444***	
	(0.197)		(0.148)	
$(\pi_t > \pi^*)$=0 × $(\pi_t - \pi^*)$, GB		-0.281		-0.355
		(0.427)		(0.265)
$(\pi_t > \pi^*)$=1 × $(\pi_t - \pi^*)$, GB		0.667***		0.472***
		(0.221)		(0.163)
$(u_t - u_t^*)$, GB			0.155*	0.172*
			(0.0923)	(0.102)
$(u_t - u_t^*)^2$, GB			-0.0195	-0.0210
			(0.0175)	(0.0179)
Δy_t , GB			-0.162***	-0.162***
			(0.0323)	(0.0325)
Δy_t^2 , GB			-0.0353***	-0.0344***
			(0.00647)	(0.00689)
S&P Return, 3m			-1.052	-1.023
			(0.701)	(0.708)
Shiller PE Ratio			0.0323***	0.0335***
			(0.0119)	(0.0123)
VIX Uncertainty			0.0207***	0.0210***
			(0.00722)	(0.00728)
Constant	0.761***	0.797***	0.154	0.0927
	(0.105)	(0.117)	(0.400)	(0.429)
Observations	111	111	111	111
Adjusted R^2	0.073	0.070	0.741	0.739
Type	minutes	minutes	minutes	minutes
Sample	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12
Symmetry p-val		0.29		0.686
$\hat{\pi^*}$	1.42	1.51	1.5	1.5
SE	(0.28)	(0.51)	(0.2)	(0.51)
95% C.I.	[1.13, 1.95]	[1.4, 2.72]	[1.22, 1.66]	[1.25, 2.72]

The variables y and y* denote log GDP and log potential GDP, respectively.

Standard errors (in parentheses) are robust to heteroskedasticity.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A7: Estimated U-shaped Loss Function
FOMC Speeches: 2000 - 2013

	(1)	(2)	(3)	(4)
π_t, GB	-1.410***	-0.287	-1.515***	-0.529
	(0.520)	(0.481)	(0.457)	(0.450)
π_t^2, GB	0.321**	0.167	0.322**	0.172
	(0.152)	(0.140)	(0.131)	(0.127)
$(u_t - u_t^*)$, GB		0.330***		0.141
		(0.0612)		(0.0891)
$(u_t - u_t^*)^2$, GB		-0.0165		0.00432
		(0.0117)		(0.0140)
Δy_t , GB			-0.147***	-0.0904***
			(0.0166)	(0.0252)
Δy_t^2 , GB			-0.00122	0.00274
			(0.00423)	(0.00468)
S&P Return, 3m				0.361
				(0.568)
Shiller PE Ratio				-0.0104
				(0.0111)
VIX Uncertainty				0.00929
				(0.00571)
Constant	2.295***	0.471	2.817***	1.276**
	(0.427)	(0.417)	(0.391)	(0.558)
Observations	2277	2277	2277	2277
Adjusted R^2	0.201	0.232	0.235	0.252
Type	speech	speech	speech	speech
Sample	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12
$\hat{\pi}^*$	2.198	.86	2.352	1.538
SE	(0.274)	(0.746)	(0.28)	(0.356)
95% C.I.	[1.66 - 2.735]	[-.602 - 2.322]	[1.803 - 2.9]	[.84 - 2.235]

The variables y and y* denote log GDP and log potential GDP, respectively.

Standard errors (in parentheses) are robust to heteroskedasticity and clustering by sample-month.

Regressions include speaker fixed effects.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A8: Estimated V-shaped Loss Function, Allowing for Asymmetry in Inflation Gap Loss
FOMC Speeches: 2000 - 2013

	(1) Symmetric V	(2) Symmetric V	(3) Asymmetric V	(4) Asymmetric V
$\mid \pi_t - \pi^* \mid$, GB	0.445***	0.221*		
	(0.105)	(0.129)		
$(\pi_t > \pi^*)$=0 × $(\pi_t - \pi^*)$, GB			-0.452***	-0.325
			(0.106)	(0.240)
$(\pi_t > \pi^*)$=1 × $(\pi_t - \pi^*)$, GB			0.575	0.196
			(0.387)	(0.141)
$(u_t - u_t^*)$, GB		0.177**		0.168*
		(0.0825)		(0.0922)
$(u_t - u_t^*)^2$, GB		-0.00175		-0.00132
		(0.0143)		(0.0146)
Δy_t , GB		-0.0907***		-0.0917***
		(0.0254)		(0.0255)
Δy_t^2 , GB		0.00317		0.00280
		(0.00378)		(0.00466)
S&P Return, 3m		0.433		0.414
		(0.551)		(0.563)
Shiller PE Ratio		-0.00938		-0.00995
		(0.0109)		(0.0112)
VIX Uncertainty		0.00934		0.00920
		(0.00565)		(0.00565)
Constant	0.655***	0.766**	0.647***	0.798**
	(0.0709)	(0.338)	(0.0736)	(0.361)
Observations	2277	2277	2277	2277
Adjusted R^2	0.202	0.253	0.202	0.253
Type	speech	speech	speech	speech
Sample	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12
Symmetry p-val	0.	0.	0.731	0.618
$\hat{\pi^*}$	2.15	1.45	2.15	1.41
SE	(0.34)	(0.43)	(0.47)	(0.5)
95% C.I.	[1.16, 2.43]	[1.1, 2.55]	[.99, 2.5]	[.91, 2.4]

The variables y and y* denote log GDP and log potential GDP, respectively.

Standard errors (in parentheses) are robust to heteroskedasticity and clustering by sample-month.

Regressions include speaker fixed effects.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A9: Core CPI inflation instead of core PCE inflation
FOMC Meetings: 2000 - 2013

	(1)	(2)	(3)	(4)
π_t, GB	-0.786***	-0.667***	-0.873***	-0.691***
	(0.244)	(0.240)	(0.193)	(0.156)
π_t^2, GB	0.270***	0.259***	0.261***	0.185***
	(0.0726)	(0.0751)	(0.0535)	(0.0428)
$(u_t - u_t^*)$, GB		0.0471		-0.0892
		(0.0753)		(0.0741)
$(u_t - u_t^*)^2$, GB		0.00359		0.0241**
		(0.0147)		(0.0119)
Δy_t , GB			-0.105***	-0.00361
			(0.0207)	(0.0296)
Δy_t^2 , GB			-0.0272***	-0.0410***
			(0.00563)	(0.00611)
S&P Return, 3m				-2.573***
				(0.567)
Shiller PE Ratio				0.0102
				(0.00952)
VIX Uncertainty				0.0135**
				(0.00573)
Constant	1.385***	1.114***	2.082***	1.428***
	(0.198)	(0.211)	(0.183)	(0.343)
Observations	1932	1932	1932	1932
Adjusted R^2	0.157	0.161	0.269	0.331
Type	meeting	meeting	meeting	meeting
Sample	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12
Speaker	Chair-Gov-Pres.	Chair-Gov-Pres.	Chair-Gov-Pres.	Chair-Gov-Pres.
$\hat{\pi}^*$	1.457	1.286	1.671	1.863
SE	(0.127)	(0.155)	(0.108)	(0.142)
95% C.I.	[1.208 - 1.705]	[.982 - 1.589]	[1.459 - 1.882]	[1.584 - 2.141]

The variables y and y* denote log GDP and log potential GDP, respectively.

Standard errors (in parentheses) are robust to heteroskedasticity and clustering by sample-month.

Regressions include speaker fixed effects.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

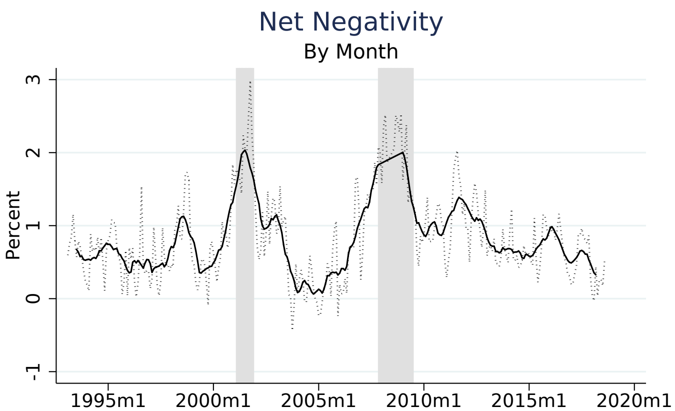
Table A10: Core CPI inflation instead of core PCE inflation
V-Shaped Loss

	(1) Symmetric V	(2) Asymmetric V	(3) Symmetric V	(4) Asymmetric V
$\mid \pi_t - \pi^* \mid$, GB	0.545***		0.313***	
	(0.113)		(0.0690)	
$(\pi_t > \pi^*)$=0 × $(\pi_t - \pi^*)$, GB		-0.349***		-0.349***
		(0.101)		(0.0776)
$(\pi_t > \pi^*)$=1 × $(\pi_t - \pi^*)$, GB		0.651***		0.282***
		(0.137)		(0.0865)
$(u_t - u_t^*)$, GB			-0.0633	-0.0680
			(0.0680)	(0.0746)
$(u_t - u_t^*)^2$, GB			0.0184	0.0183
			(0.0119)	(0.0121)
Δy_t , GB			0.00402	0.00530
			(0.0296)	(0.0298)
Δy_t^2 , GB			-0.0407***	-0.0414***
			(0.00609)	(0.00618)
S&P Return, 3m			-2.469***	-2.493***
			(0.570)	(0.564)
Shiller PE Ratio			0.00949	0.00950
			(0.00936)	(0.00938)
VIX Uncertainty			0.0137**	0.0137**
			(0.00561)	(0.00567)
Constant	0.676***	0.712***	0.684**	0.698**
	(0.0752)	(0.0678)	(0.285)	(0.291)
Observations	1932	1932	1932	1932
Adjusted R^2	0.168	0.174	0.334	0.334
Type	meeting	meeting	meeting	meeting
Sample	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12	2000m1-2013m12
Speaker	Chair-Gov-Pres.	Chair-Gov-Pres.	Chair-Gov-Pres.	Chair-Gov-Pres.
Symmetry p-val	0.	0.026	0.	0.508
$\hat{\pi^*}$	1.63	1.8	1.84	1.81
SE	(0.14)	(0.08)	(0.21)	(0.27)
95% C.I.	[1.38, 1.8]	[1.78, 1.87]	[1.76, 2.04]	[1.08, 2.13]

The variables y and y* denote log GDP and log potential GDP, respectively.
Standard errors (in parentheses) are robust to heteroskedasticity and clustering by sample-month.
Regressions include speaker fixed effects.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

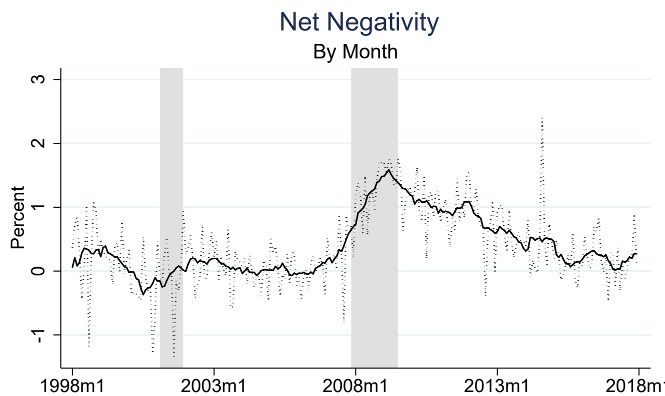
Figure A1: Public Communications

(a) Minutes of FOMC Meetings



Dotted line is raw monthly time series. Solid line is 11-month centered moving average.
Gray shaded areas indicate recessions.

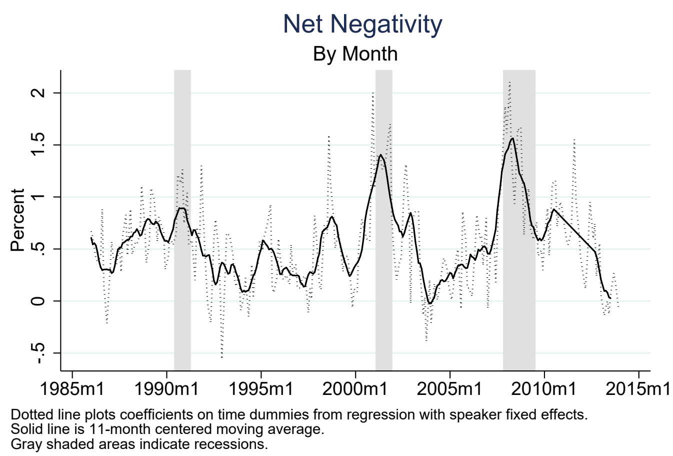
(b) Public Speeches of FOMC Members



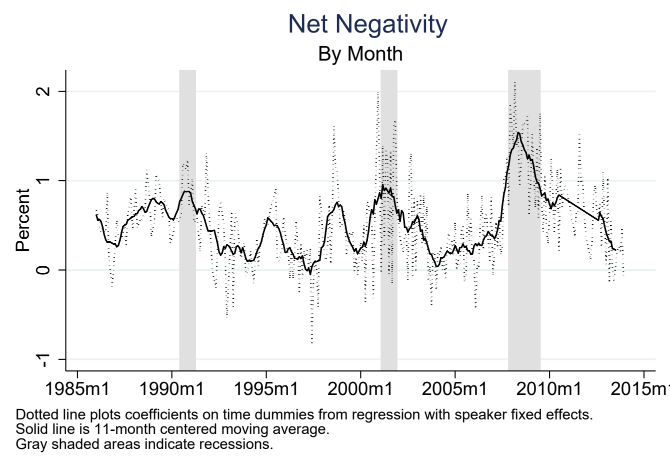
Dotted line plots coefficients on time dummies from regression with speaker fixed effects.
Solid line is 11-month centered moving average.
Gray shaded areas indicate recessions.

Figure A2: Transcripts of FOMC Meetings

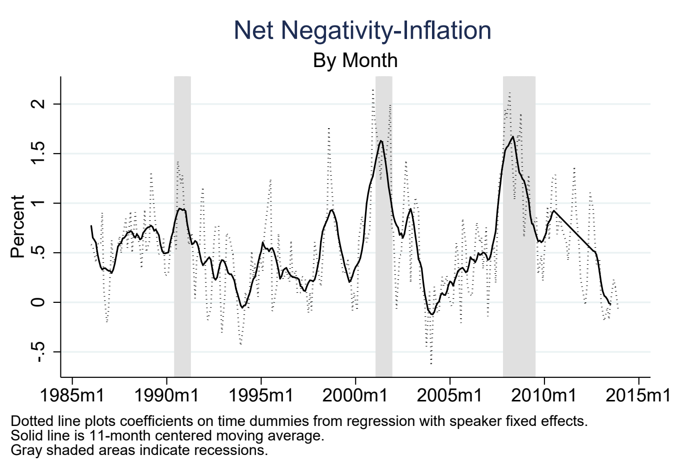
(a) Baseline, Econ-Filtered Text



(b) All Text



(c) Inflation-Filtered Text



(d) Slack-Filtered Text

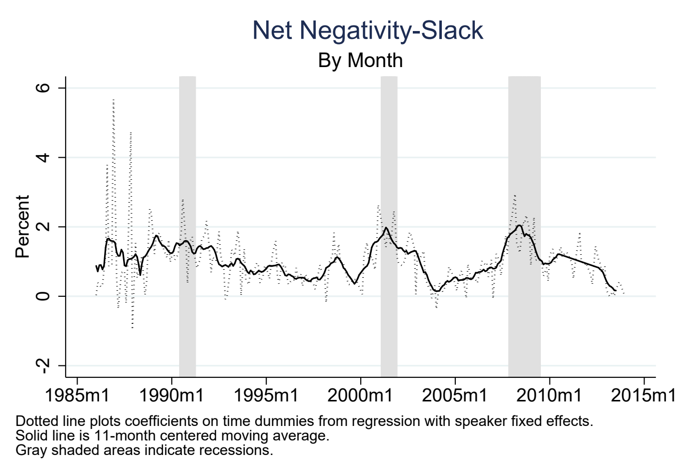


Figure A3: Estimated U-shaped loss function for inflation
FOMC Minutes: 2000 - 2013
No Additional Factors

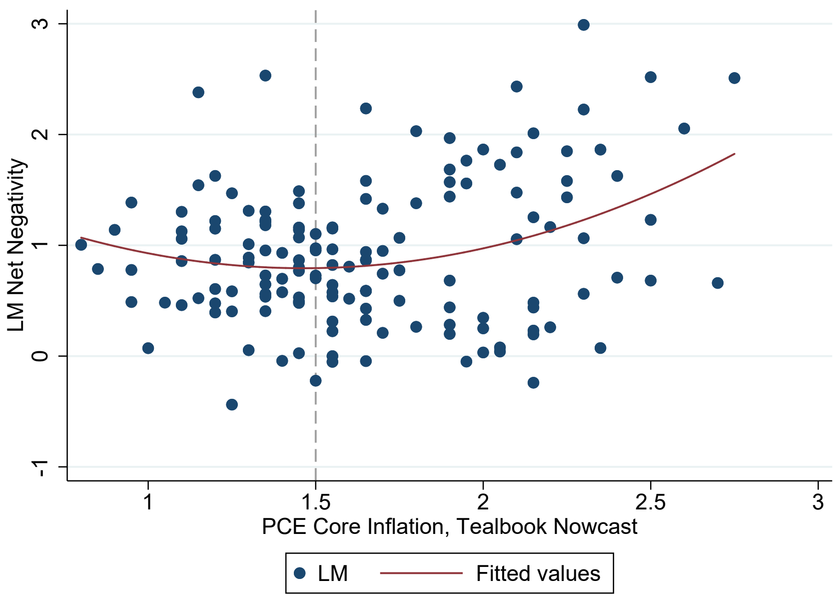


Figure A4: Estimated V-shaped loss function for inflation
FOMC Minutes: 2000 - 2013
No Additional Factors

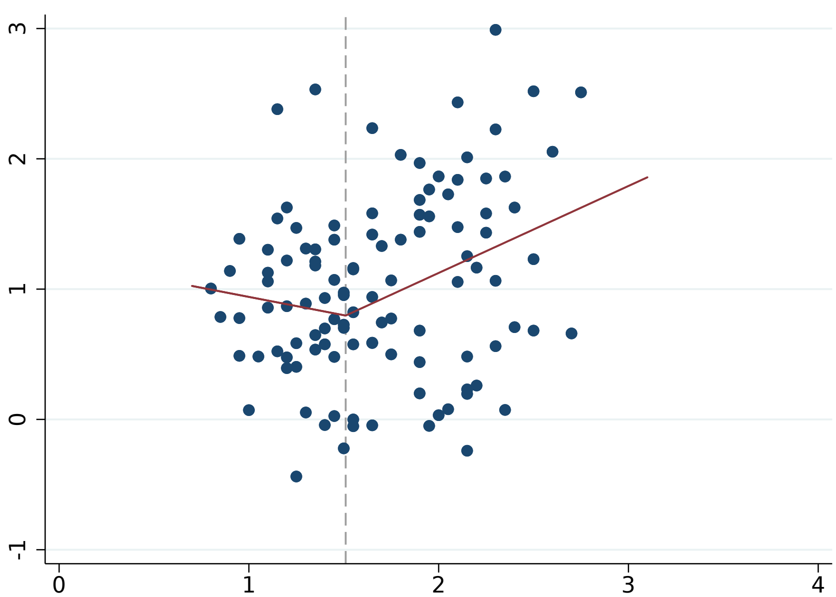


Figure A5: Estimated U-shaped loss function for inflation
FOMC Speeches: 2000 - 2013
No Additional Factors

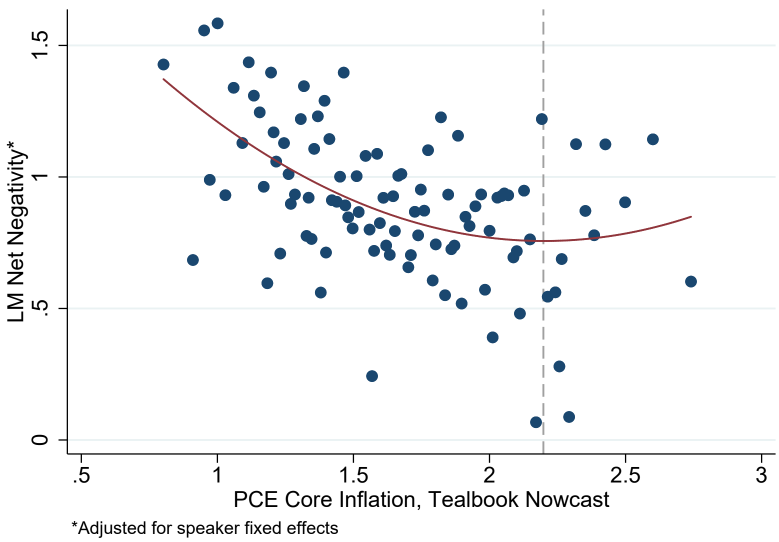


Figure A6: Estimated V-shaped loss function for inflation
FOMC Speeches: 2000 - 2013
No Additional Factors

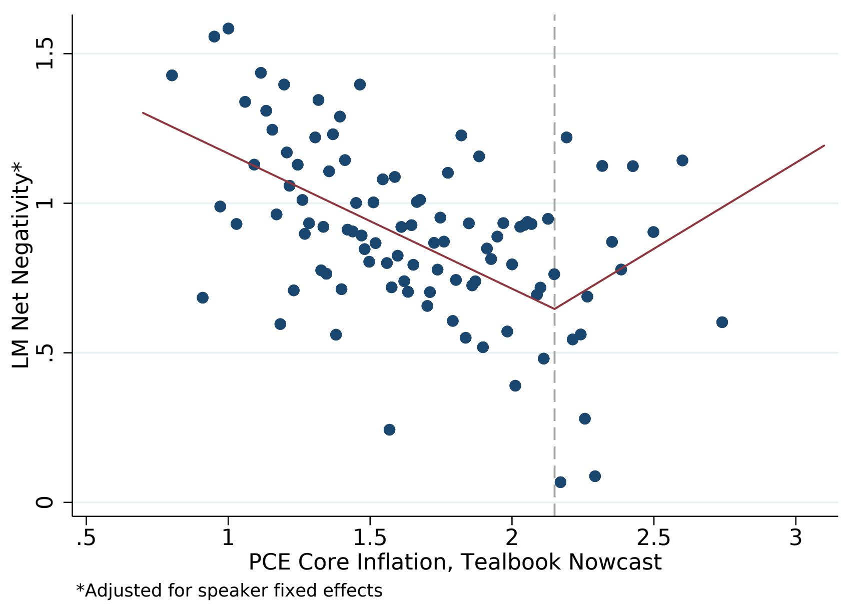
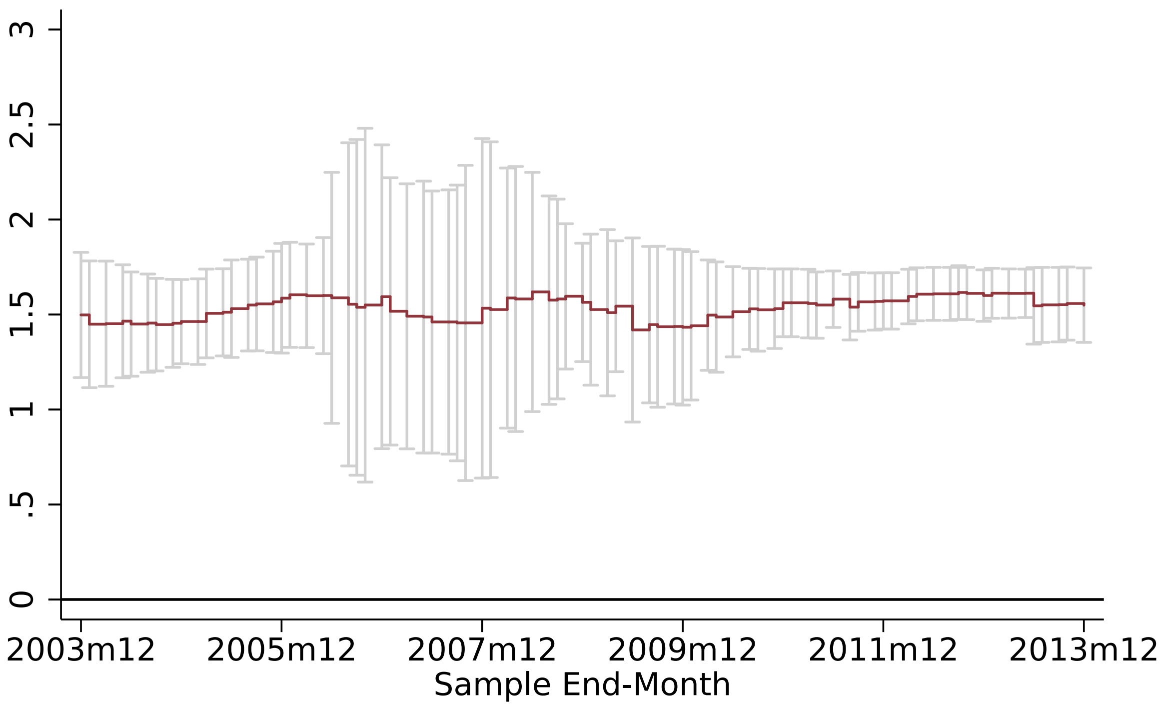


Figure A7: Estimates of π^* Over Expanding-Window Samples
Sample: 2000m1 to 2003m12...2013m12



Solid line shows estimated inflation target for sample period from 2000m1 to indicated end-month. Gray brackets indicate 95% confidence interval.