

A Textual Taylor Rule: Estimating Central Bank Preferences Combining Topic and Scaling Methods *

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Abstract

Scholars often use voting data to estimate central bankers' policy preferences but consensus voting is common. To get around this, we combine topic-based text analysis and scaling methods to generate theoretically motivated comparative and dynamic measures of central bank preferences on the U.S. Federal Open Market Committee leading up to the financial crisis (2005 - 2008) in a way that does not depend on voting. We apply these measures to a number of applications in the literature. We confirm that committee members on schedule to vote are more likely to express consensus opinion than their off schedule voting counterparts and show that it is Dovish rather than Hawkish members who are more likely to want to amend the official policy statement.

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Political economists have long studied the role of central banks and central bankers in the governance structure of modern countries. Because central bank committees often take “roll call” votes during committee meetings, researchers apply spatial voting models to help understand central bank decision making. With informative voting, researchers can locate central bankers on a single common dimension, based on the correlations in their voting behavior (see for e.g. Chappell et al., 2000; Chang, 2003; Gerlach-Kristen and Meade, 2010; Hix et al., 2010; Adolph, 2013; Eijffinger et al., 2015). Previous work has presented some possible problems with applying spatial voting models to central bank decision making, however. First, committee members often vote according to consensus. Moreover, consensus voting seems to describe most central bank policy outputs irrespective of committee type; this makes computation of spatial preferences difficult because of invariant or sparse data (Riboni and Ruge-Murcia, 2010). Second, the status of committee members such as length of tenure and role, or whether the member is appointed by the president or elected by his district, often predicts whether or not a member will dissent (Meade and Sheets, 2005; Meade, 2005); this makes it hard to distinguish a member’s preferences from their characteristics, especially in the presence of possible omitted variables. Worse, any unwillingness to cast a dissenting vote is exacerbated by a dominant committee Chair (Crawford and Haller, 1990; Shapiro and Varian, 2013). In short, sparse data and variable willingness to dissent when others do not makes methods designed for roll-call voting particularly challenging in this context.

Instead of using voting data to estimate committee members’ preferences, we use a method that combines topic modeling and positional analysis based on a textual interpretation of a theoretical model called the Taylor rule. We use Federal Open Market Committee (FOMC) meeting transcripts between 2005 and 2008 to estimate central bank preferences using the relative emphasis on policy topics that central bankers are mandated to discuss: *inflation* and *unemployment/output*.

Our main contribution is to provide a strategy for estimating central bankers’ preferences using the things that policymakers say in meetings rather than how they vote in roll calls. Rather than using real time economic data such as committee member’s economic forecasts to infer members’

relative emphasis (El-Shagi and Jung, 2015) we compute direct measures by using how much a member emphasizes inflation relative to output and unemployment in a policy meeting. Methodologically, our approach highlights the value in explicitly including speech data and human judgment to assist in the interpretation of unsupervised learning approaches increasingly common in political science (see also Roberts et al., 2014; Lucas et al., 2015). The unusual aspect of our application is to leverage common understanding of the micro-foundations of FOMC deliberation to focus an unsupervised and often hard to interpret machine learning model (Chang et al., 2009).

Our results have several important implications for the politics of committee decision-making and political economy. First, we show that despite their public facing consensus, central bankers express much larger variation in policy positions in speech than they do in votes. This adds to mounting evidence from other domains that finds that policy makers express greater diversity in speech opinions than they do in formal voting behavior (see also Proksch and Slapin, 2012; Schwarz et al., 2015). Second, we also demonstrate the usefulness of using textual analysis tools for discovering policymaking preferences; this is especially useful in estimating preferences of actors working in political institutions where voting data is uninformative but transcripts are available.

1 Central Bank Preferences

The individuals who sit on the FOMC are mandated by U.S. Congress to fulfill three goals: maximum employment, stable prices, and moderate long-term interest rates. Although all members on the FOMC share the same mandate, committee members have different preferences. A useful ranking of central bank preferences is based on their inflation preferences – or how sensitive policymakers are to increases in inflation risks. Borrowing terms used to describe individuals' appetites for war, those that worry more about inflation risks are called *Inflation Hawks* whereas those that worry less about inflation risks are called *Inflation Doves*. Ranking individual central bank committee members according to their preferences along a single common dimension, “how

much do I care about inflation risks relative to output and unemployment risks,” is important as it allows researchers to compare preferences across actors and over time. Importantly members themselves talk about inflation this way: in January 2007, Bank President Geithner (New York) reported his inflation concern strictly using such terms: “We see somewhat less downside risk to growth and somewhat less upside risk to than we did, but the overall balance of risks in our view is still weighted toward inflation.” The fact that committee members have such a mandate and talk in these terms provides an unusual theoretical consensus on a low dimensional structure to understand members’ preferences over a wide variety of apparently disparate policy topics.¹

If members of the FOMC are all tasked with the same objective, why would central bankers have different preferences? First, a member’s characteristics may affect their appetite for inflation, such as who appoints them, their educational training, or their geographical district (Chang, 2003; Hallerberg and Wehner, 2013; Meade and Sheets, 2005; Meade, 2005). Second, central bankers have their own career histories, goals, and objectives (Havrilesky and Gildea, 1991; Adolph, 2013) and we would expect these objectives to influence their policymaking. Finally inter-committee politics may also affect their behavior in committee. Schonhardt-Bailey (2013) shows that hallway conversations as well as explicit deliberation allows central bankers to influence and persuade their colleagues.

Previous measures of central bank preferences have depended on analyzing voting behavior (see for e.g. Chappell, Havrilesky, and Roy McGregor, 2000; Chang, 2003; Gerlach-Kristen and Meade, 2010; Hix, Høyland, and Vivyan, 2010; Adolph, 2013; Eijffinger, Mahieu, and Raes, 2015). Following the roll call voting literature (Poole and Rosenthal, 1997; Carroll et al., 2009; Clinton et al., 2004), scholars have used committee votes to help infer committee members’ policy preferences. For example, Chappell et al. estimate monetary policy reaction functions for individual

¹Unlike most legislative scaling application there are both substantive rather than statistical reasons for selecting a single dimension, and agreement about what the dimension represents. For discussion on the statistical benefits of low-dimensionality see Poole and Rosenthal (1997); Martin and Quinn (2002); and Clinton et al. (2004). For a paper that treats estimation when dimensionality is higher see Lauderdale and Clark (2014).

FOMC members using expressed preferences in the transcripts as their data source. These authors code member preferences into three categories: favoring interest rate tightening, favoring interest rate easing, or consenting to the proposed policy rate (Chappell et al., 2000, p.72).

However, while it seems natural to characterize central bankers as inflation “Hawks” who vote in favor of interest rate tightening and “Doves.” who vote for loosening, this behavior may be a better measure of whether and to what extent policymakers coordinate, rather than their preference similarity or dissimilarity (Shelling, 1978). This is especially likely because in central bank decision-making, public consensus outcomes are partly determined by actors’ desire to minimize apparent divergences of opinion to avoid economic uncertainty and stabilize expectations (Woodford, 2005; Rosa and Verga, 2007). Similarly, members willingness to cooperate often depends on others in the group and especially on the willingness of the committee Chair to allow for public dissent in the first place (Crawford and Haller, 1990; Riboni and Ruge-Murcia, 2010; Shapiro and Varian, 2013).

In addition to these theoretical concerns, we also often observe very little variation in central bank voting behavior, which makes identifying individual committee member preferences statistically challenging. This is especially so in the United States. For example, between 1948 and 2014, FOMC members cast on average only one dissenting vote per meeting, which is less than 10 percent of all votes cast (Thornton and Wheelock, 2014). Between 2005 to 2008, the period that we consider in this paper, there were just seven official dissenting votes out of 255 official roll call votes, about two percent of all votes cast. Finally, dissenting votes are also only cast by a select subset of the committee members. Indeed one member, Bank President Lacker (Richmond), cast four out of the seven dissenting votes between 2005 and 2008. Figure 1 shows the small number of dissents over the period we examine in this paper, demonstrating little variation to actually estimate preferences. For those cases where there is enough variation to estimate members’ preferences, or for those cases where the expressed preferences are used to supplement the data, the recovered estimates remain over-sensitive to information provided by those events where the committee member

dissents.² Thus, while each committee member has the right to vote according to his or her own preferences (or the preferences of his/her underlying constituency), official central bank decision making, at least as it is reported by official voting, most often confirms the status quo policy rate and likely reflects policy cooperation as well as committee members' preferences.³

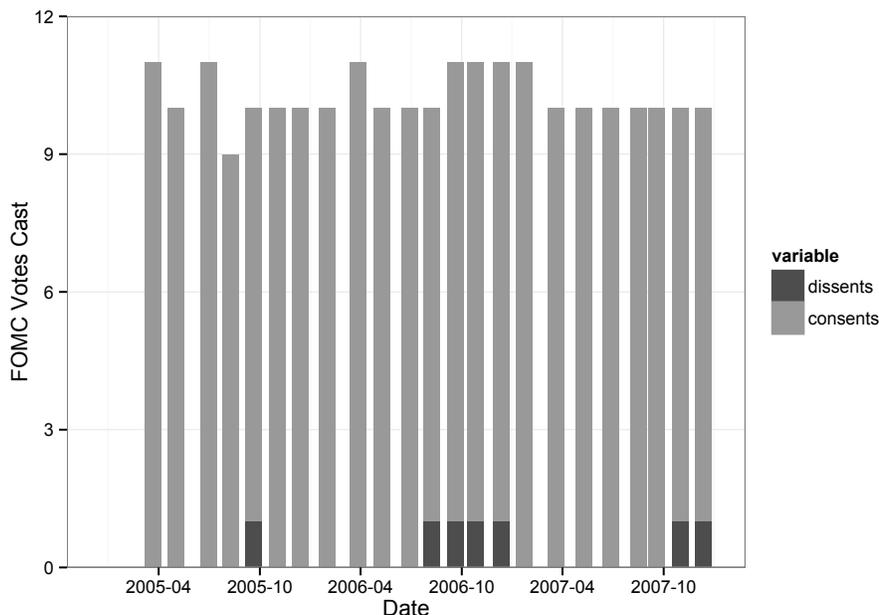


Figure 1: Voting on the FOMC between 2005 and 2008

One solution to this problem is to compute a measure of implied dissents in speech and add this data to observed dissents in votes. Using supplemental information from meeting transcripts, it is possible to identify those cases where members express dissent in the meeting deliberations but refrain from doing so officially when the actual roll call vote is cast (Chappell et al., 2000; Eijffinger et al., 2015; El-Shagi and Jung, 2015). With the inclusion of more cases, this measurement strategy leads to a greater numbers of dissents to the voting data and relaxes some of the problems associated with sparse data. Unfortunately, however, this approach brings up new theoretical and

²Eijffinger, Mahieu, and Raes 2015 develop an empirical model where transcript data supplements official voting records. We return to this in the empirical section.

³Committee members most often vote to maintain rather than increase or decrease interest rates, and conventional policy moves are often restricted to 25 basis points

measurement questions. First, why do some members dissent in speech but not in votes? Second, are dissents in speech and dissents in votes comparable? For example, if a member is willing to dissent both in speech and in votes and another is only willing to express dissent in speech, is the first member relatively more extreme in position location or in position intensity or in both?

To avoid these problems, we construct estimates for FOMC members by using a textual interpretation of interest rate policy-setting based on a monetary policy setting rule called the “Taylor rule.” If central bankers’ policy decisions are based on an expressed trade-off between higher values of inflation and lower values of unemployment/output, then we can use the relative amount of time central bankers spend talking about each to develop a measures of FOMC members’ preferences.

As a first step, we measure topics using a version of Latent Dirichlet Allocation (LDA) augmented to capture topical phrases as well as single words. We then apply human judgment to identify only those topics that policymakers are mandated to care about (inflation, unemployment/output). Finally, we use the expressed topic mentions of inflation and output and unemployment to scale actors’ relative positions on a single dimension measuring inflation aversion. While other scholars have applied topic models, or similar approaches, using FOMC transcript data, to our knowledge, this paper is the first paper to start from a theoretical model of topic emphasis and then to combine the results from expressed topic emphasis with scaling models common in the literature.⁴

2 Estimating Central Bank Preferences

The Taylor rule is a simple approximation or guideline for what central bankers ought to do given changes in the economy developed by Stanford economist John Taylor. The original rule provides an aggregate policy recommendation for changing the federal funds rate as output and in-

⁴Previous work by Schonhardt-Bailey (2013); Acosta and Meade (2015) models committee member rhetoric using related exploratory scaling models. Our approach is distinguished by a theoretically motivated confirmatory rather than an unsupervised exploratory approach.

flation change over time (Taylor, 1993). Importantly, the Taylor rule represents an explicit reaction function for the monetary policy committee; it shows how the federal funds rate should change in a response to changes in inflation (deviations from target) and changes in output (the output gap).⁵

Taylor's original formula is

$$r = \pi + \frac{1}{2}(y) + \frac{1}{2}(\pi - 2) + 2 \quad (1)$$

where r is the federal funds rate, π is the rate of inflation over the previous 4 quarters, and y is the percent deviation of real GDP to target GDP. Given that the Taylor rule expresses what policy members ought to do given changes in the economy (or the implicit status quo), then we can assume that in order to move the implicit status quo in a direction more favorable to a given member's preferences, the member would have to either emphasize inflation or output more than the status quo to express his or her own preferences.

Importantly, the Taylor rule, or some derivation of the Taylor rule, is used as a guideline in most central banks around the world. The Board of Governors and the research staff at regional Federal Reserve Banks consult with FOMC members about projections from Taylor rule estimates and policymakers are equipped with economic projections from different Taylor rule specifications. For example, Appendix B in the 2008 "Bluebook" presents 6 scenarios of the future economy, 3 of which are based on some derivative of the Taylor rule.⁶ Even when there is uncertainty about the true model of the economy, the Taylor rule is expected to deliver good outcomes in a variety of models. A version of the Taylor rule has been used, for example, to estimate decisions by the ECB's Governing Council (Hayo and Méon, 2013) and for the United States (Plosser, 2014;

⁵For the rest of the paper we refer to output/unemployment so as to capture either the Taylor rule or the Phillips Curve, which models this trade-off according to unemployment. Interestingly, the topics that we uncover with the topic model more often relate to inflation and output rather than inflation and unemployment which suggests that the Taylor rule is a better theoretical foundation than alternative approaches such as the Phillips Curve, or alternatively, that central bank committee members are more likely to frame their speech using the inputs of the Taylor rule rather than the Phillips Curve. The lack of unemployment specific topics in the FOMC is also found in Young and Gandrud (2013).

⁶FOMC Bluebook

Blinder et al., 2005).

In addition to the theoretical and empirical evidence, policymakers themselves talk about unemployment/output and inflation in Taylor rule terms whilst deliberating over monetary policy. For example, in one meeting on November, 2007, Board Governor Kroszner explained that “each incremental step we take with respect to policy easing potentially has higher and higher costs with respect to inflation. There are no free lunches here.” Similarly, even for those cases when the Taylor rule is not used explicitly, members still use these two topics to anchor their thinking. Board Governor Gramlich on June 2005 notes, “We don’t necessarily follow the explicit Taylor rule outcomes of the Bluebook but we look at inflation and unemployment and try to make them hit our target values, at least over some time horizon.”

The Taylor rule expresses a linear trade-off between inflation and output/unemployment, of the form $r = \beta_0 + \beta_1\pi + \beta_2y$ where, according to the weights of the above equation, $\beta_0 = 1$, $\beta_1 = 1.5$ and $\beta_2 = 0.5$. The original Taylor rule is an aggregate policy rule and does not envisage that each individual member will have a different inflation sensitivity. But if we allow for such individual variation we can then estimate rather than stipulate β_1 and β_2 for each member. Expressed as a trade-off between inflation and output concerns, we can represent the balance of an individual member’s considerations built into the rule by $\log \frac{\beta_1}{\beta_2}$. Again, for illustration, consider the original specification, $\log \frac{\beta_1}{\beta_2} = \log \frac{1.5}{0.5} \approx 1$. The interpretation is that an individual has a uniquely preferred proportional emphasis of inflation versus output sensitivity.⁷ In order to be consistent with the ideal point literature, where point predictions are scaled on a single left right dimension, we use inflation sensitivity β_1 as the numerator and β_2 as the denominator. This naturally scales members that are more sensitive to inflation risks to the right of zero positions as “Inflation Hawks” and those to the left of the zero position as “Inflation Doves.” This allows us to systematically locate “Inflation Doves” on the left of the scale, “Inflation Hawks” on the right, and to locate other actors

⁷The original Taylor rule implies that deviation from the inflation target is $\beta_1/\beta_2 = 3$ times more important than the output gap.

between.

The different sensitivity of FOMC committee members to inflation output risks are, of course, unobserved. With informative voting, we might be able to infer positions (Clinton et al., 2004; Lauderdale and Clark, 2014), but because votes are relatively uninformative in the context of FOMC committee meetings we need to look elsewhere for information. We show how to get relative emphasis from the relative amounts of words members deploy on inflation topics versus output topics. We model the counts of words and phrases in the inflation and output topics (c_1 and c_2) respectively as:

$$[c_1, c_2] \sim \text{Binomial}(p_i, N) \quad (2)$$

$$p_i = P(c_1 | N) \quad (3)$$

$$N = c_1 + c_2 \quad (4)$$

Topics not related to inflation or output can be ignored because they give no information about β_1/β_2 .

Clearly there are other systematic determinants of the proportion (p_i) of inflation related speech, so while more elaborate multidimensional models are certainly possible, we limit our attention to the mandated topics as those are the specified parameters in our Taylor rule.⁸ In order to account for other (time varying) concerns, we also capture shared external shocks to committee rhetoric by adding meeting random effects. We assume that speakers' positions are also exchangeable and model them as draws from a population of committee members. These effects provide our position

⁸One possible concern is that as the housing crisis approaches, members might be more troubled by housing rather than concerned with output or inflation. As shown in table A.1, however, members talk about inflation 8 times more than they do housing which means that adding housing as a topic will do little to change the results.

estimates.

$$\log \frac{p_{i,t}}{1 - p_{i,t}} = a + s_i + m_t \quad (5)$$

Interpreting unobserved terms in the logistic regression model can be motivated either directly, as a form of ‘logit scaling’ from policy position scaling (Lowe et al., 2011), or indirectly, by noting that these quantities are rescaled versions of the positions that would be estimated from automated text scaling (Slapin and Proksch, 2008) using an association model 1985.

In the analyses below, we first fit this model assuming that speaker positions do not change over time. After this, we consider changes in individual preferences. We pay particular attention to important members on the FOMC such as Greenspan (Chairman), Bernanke (Chairman), Geithner (Bank President, NY Fed), and Yellen (San Francisco). We run further robustness checks to examine whether the expressed topics in the economic go-round are same as in the entire transcript and examine whether or not expressed opinions about inflation and unemployment/output correspond with worries about inflation and output dangers rather than rewards. We also use our estimates supplemented with voting data to test the hypothesis that those committee members on schedule to vote are more likely to publicly consent. As a preview, we find that committee members on rotation to vote, and therefore have their vote reported, are more likely than their non-voting counterparts to vote according to consensus opinion. Perhaps more surprising, we also find that more Dovish committee members are associated with greater requests to change the official policy statement.

2.1 Measurement

In theory, we could estimate ideal points using historical data starting in 1993 when the speakers became aware that their meetings were being recorded. However, text-based ideal point estimation implicitly depends on a stable mapping between words and phrases, and the topics they indicate. Because economic and political changes over such a long period make this unlikely. For example, Acosta and Meade (2015) argue that the FOMC’s December 2008 meeting represents

a semantic break from previous statements because of changes in the federal funds rate and the unique discussion of the asset purchases program. We adopt a very conservative approach and restrict the sample time period to the three most recent years for which transcripts are available, leading up to but not including the U.S. financial crisis.

Our unit of analysis is the speaker-meeting. We will analyze speaker-meeting ‘document’ by concatenating each individual’s contributions within each FOMC meeting for the meetings held between February 2005 and December 2007. Meetings are held approximately every 6 weeks or 8 times a year, leading to a total of 24 meetings, which span two days. Each speaker speaks an average of 1020 words per meeting across all meetings. In this paper we focus on the important policy actors by removing speeches made by staff members and other meeting participants that are not either members of the Board of Governors or Bank Presidents as these members do not have official policymaking powers.

To estimate topic prevalence We use the topical n-grams model (Wang et al., 2007) to identify the that central bankers talk about in FOMC meetings and to count how often they are used.⁹ The n-gram topic model is an extension of traditional Latent Dirichlet Allocation (Blei et al., 2003) that allows for both words and phrases to be associated with each other within topics. Specifically, the model posits an unobserved variable ‘between’ tokens indicating whether any two tokens should be treated as a phrase in one of the topics. This allows us to account for economic phrases such as *core inflation* and *price elasticity*, which would otherwise be returned as *price*, and *elasticity*. Because many of the topics that FOMC members discuss reference underlying economic theories and concepts, the use of topic phrases is particularly helpful for organizing and classifying topics. It also allows us to infer phrases of arbitrary length and all some word pairs to be phrases in one topic but not in other topics or verbal contexts.

The Gibbs sampler used to fit the model draws from the posterior distribution of topic assignments within each document. We use the posterior samples from the Gibbs sampler directly to

⁹We use a slightly adjusted version of the implementation in MALLETT

provide our counts. The use of actual topic counts rather than normalized counts is relevant because it allows us to be more certain (or less certain) of the topic balance – and therefore position – of a speaker-meeting document depending on its length; while the relative emphasis on inflation in a speaker-meeting “document” with 75 inflation-related and 25 output/unemployment-related terms is the same as one with 15 inflation-related and 5 output-related terms, we are more sure in the first case than the second.

Once we have an estimate of our topic words and topic phrases, we use the topic words and phrases generated by the n-gram topic model to identify by hand our topics of interest. The remaining topics are discarded. In this data The most prevalent topic is inflation, with the word *inflation* itself used 2964 times whereas the words *unemployment* and *output* are used 261 and 245 times. The word inflation alone as a word (without its related phrases such as *core inflation*, *headline inflation*, and *inflation expectations*) accounts for 22% of the top topic words. Perhaps unsurprisingly, even Dovish central bankers on the FOMC spend most of their time talking about inflation. Table 2 in the appendix shows the top topic words and their counts for all topics.

In order to make sure that the results from the n-gram model that we use to extract topics are robust to different model choices, we run the n-gram model for different numbers of topics. Running the topic model for $\{5, 10, 25, 50\}$ topics, we find that $K = 25$ topics are sufficient to identify the topics at a suitable granularity. From our estimated 25 topics, we finally keep 4 topics – three covering different aspects of output and unemployment and one of inflation.

We expect this topic aggregation strategy to work well when K is relatively large, so that we have a larger number of relatively small but precisely estimated topics to aggregate. Many authors find that statistical measures of overall model fit are negatively correlated with substantive interpretability (Chang et al., 2009), but theoretically driven aggregation allows us to choose less biased models with good representation of our two core theoretical concepts.

To give a sense of what words and phrases are estimated to be generated by the topics we label output and inflation, we show the most likely five words and most likely five phrases associated

with each topic:

- **Output/Unemployment:** productivity, compensation, energy, measured, hour, market psychology, large trucks, filter estimate, price elasticity, weekend strains
- **Inflation:** inflation, percent, year, time, don, basis points, core inflation, monetary policy, inflation expectations, energy prices

Allowing n-grams to be generated by topics provides considerable help for experts attempting to identify which concept is captured by a topic. This is also helped by the fact that FOMC members work with a shared technical vocabulary. This is important because the n-gram allows the model to distinguish between *federal reserve*, *federal funds rate*, and *federal government*, which would alternatively be returned as *federal*, *reserve*, *government*, *funds*, *rate* using a pure bag of words, unigram approach. As can be seen, these are much more ambiguous terms and might therefore compromise topic identification.

To validate that more counts of inflation words does indicate more concern for rising (rather than falling) inflation and that more output and unemployment words are being used to express concern about falling (rather than rising) employment or output, we examine the inflation statements expressed by committee members by looking at key word in context (KWIC). We search for all instances of *inflation*, *output*, and *employment* and expand the context to include 20 terms and strip whitespace for easier reading. Two graduate student with domain expertise and the first author manually coded 500 randomly selected KWICs for their sentiment. We labeled a statement as 1 if the inflation statement was “Hawkish” (talking about inflation risks), -1 if the statement was “Dovish”, and 0 if the statement is “Neutral” in the sense that it talked about inflation as “On Balance” or “Moderate.” For the output and unemployment topics, coding is the reverse. We then take the majority class of the labeled sentiments across the coders as the final code.

Of the 384 statements that had a sentiment, 66 percent of our hand-coded statements are coded as “Hawkish” whereas 18 percent are coded as “Dovish.” Finally, 16 percent are coded as “Mod-

erate,” suggesting that these are balanced risks statements. The results of our coding is shown graphically in Figure 2. Interestingly, the large expression of inflation risks in the random sample is particularly meaningful given the economic conditions of our sample. In our 3 year sample, average monthly changes in inflation, according to the consumer price index (CPI), is only 0.20% throughout this time period, just slightly above the FOMC’s target rate of 2% annual inflation.¹⁰

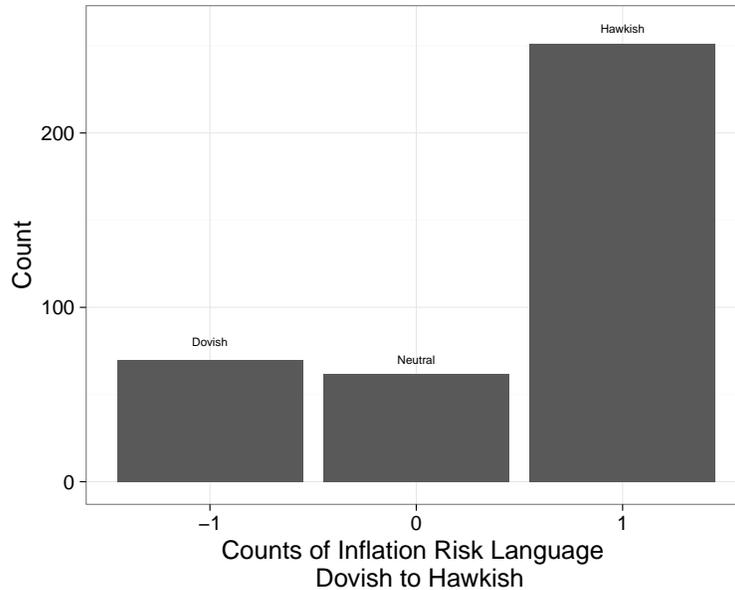


Figure 2: Assessing Inflation Language Sentiment from FOMC Transcripts

3 Results and Discussion

In this section, we present results from combining the topic model and the scaling model and discuss our findings. We also examine the over time preferences of a sub-section of FOMC members. We find a number of important similarities and differences when compared to members’ expressed preferences in voting.

Figure 3 shows the computed average estimates for each FOMC members’ ideal point across the sample period. Each individual’s estimate is a point prediction of their relative inflation prefer-

¹⁰The inter-coder reliability score across the three coders is 0.44 using the Fleiss’ Kappa score for 3 raters.

ences from a mixed model treating speakers as a draw from a wider population of central bankers, each with their own intercept, and controlling for the date of the meeting. Thus we estimate member specific reaction functions based on inflation and output versus employment topic emphasis. This is different from previous studies that estimate each member's implied desired federal funds rate using a fixed-effect model from implied voting decisions (Chappell et al., 2000). The position of each speaker's intercept on the x-axis measures the degree of inflation aversion: that is, how willing a central banker is to forgo an increase in economic activity for a reduction in inflation, with those scaled on the left hand side being relatively more Inflation Dovish than those Inflation Hawkish types on the right hand side.

The results are interesting in that they confirm previous measures while offering some important new insights. The first, and perhaps most obvious difference, is that using speech data, dissenting Bank President Lacker (Richmond) is estimated as having more moderate inflation preferences than if we consider only his voting behavior. Lacker expressed official dissent of changes to the interest rate a number of times during his tenure at the Fed. In 2006, for example, Lacker dissented in the August, September, October, and December meetings. In these meetings, the FOMC decided to keep interest rates the same whereas Lacker voted for additional interest rate tightening, making him extremely Hawkish according to previous methods. Estimates for Lacker based on implied voting, for example, have him the farthest right on the scale for 2007 (Eijffinger et al., 2015). Using our method, we also find Lacker to be very Hawkish in the 2007 period, however, interestingly his average estimate across all meetings in our sample is more moderate and actually estimate Lacker closer to the median position. The fact that our measure can track changes in topic emphasis with greater frequency is exactly why we think our method outperforms previous measures.¹¹

¹¹One possible reason for the difference between speech and votes might be that Lacker uses his reputation as an inflation Hawk to then discuss output and unemployment more freely in speech. For example, in the December 2006 meeting, he says "In past meetings I have expressed misgivings about whether our strategy is going to bring inflation down fast enough. So I won't belabor those again today." Such nuances are lost using measures that only depend on voting behaviors. We thank an anonymous reviewer for pointing this out.

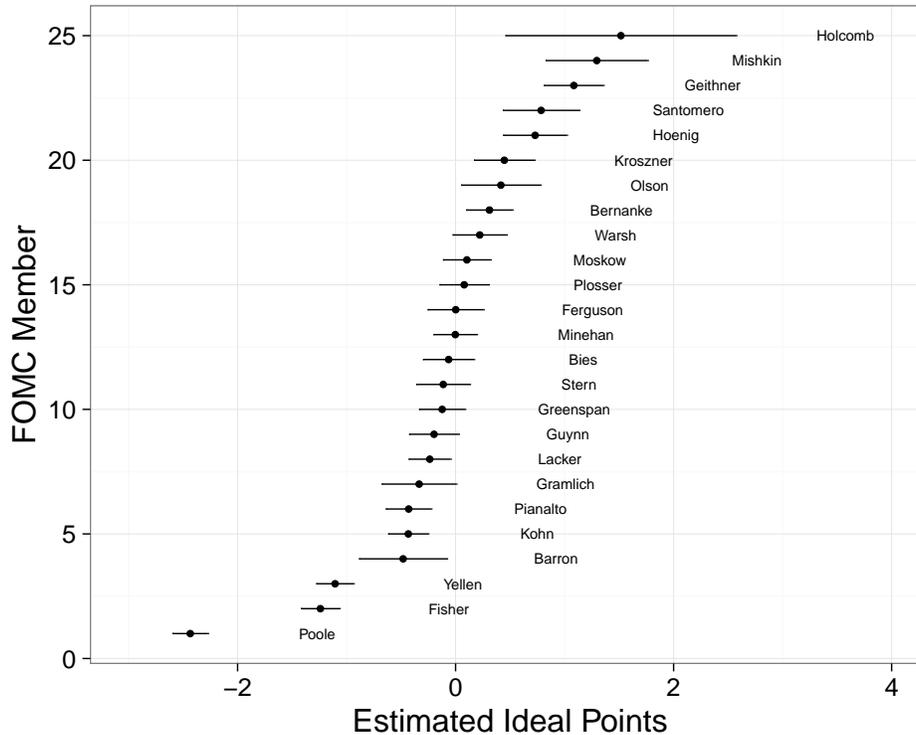


Figure 3: Estimated Fixed Ideal Points from Full Transcripts

Another interesting finding is that Bank President Geithner is estimated as very Hawkish and significantly more Hawkish than both Chairman Bernanke and Chairman Greenspan despite never casting a dissenting vote. This is important for two reasons. First, as President of the New York Fed, Geithner is perhaps most likely to represent the interests of the financial sector than other Bank Presidents; this suggests some evidence that constituency effects may matter (Mukherjee and Singer, 2008, see for e.g.). Second, the New York Federal Reserve Bank President always votes on the FOMC; this means that during his tenure at the FOMC, there was always an “Inflation Hawk” voting at every meeting.

Lastly, Chairman Greenspan straddles the middle position when compared against his two successors, Chairman Bernanke and Chair Yellen. Surprisingly, Bernanke is estimated as relatively more inflation adverse than either Greenspan or Yellen, whereas unsurprisingly, Yellen is estimated as more Dovish. Table 3 in the Appendix reports the full set of static ideal point estimates for

FOMC members.

Do these fixed-point positional estimates really uncover noticeable differences in individuals' inflation preferences as expressed in FOMC meetings? Similar to our model, Eijffinger et al. (2015) also find differences between the average Board Governor and Bank President and also find that the dispersion of members' opinions gets wider as the financial crisis approaches. Furthermore, we find that variation in the dispersion of agreement and disagreement remains even when we account for aggregate changes in the economy (modeled as member invariant time shocks) suggesting that actors' preferences change independently of shocks to the overall economy, which are captured in the model separately using meeting random effects m_t .

3.1 Applications

This section demonstrates the usefulness of our new estimates for testing existing findings in the literature.

3.1.1 Persuasion and strategic speech

One possible concern is that our estimates only capture members' strategic speech positioning in meetings as members try to build coalitions and persuade their colleagues rather than talk about their true policy positions. Former FOMC member Alan Blinder's has argued, however, that it is almost impossible for committee members to maintain strategic speech positions due to repeated interaction among members and long tenure length among those on the committee (Blinder, 1998). If non-strategic speech making is true, we would expect to see essentially identical positions expressed under all circumstances and throughout each subsection of the policy meeting. Conveniently for us, FOMC meetings begin with an 'economic go-around' during which members read prepared speeches, and then move to open discussion. Speeches in the 'economic go around' typically discuss economic developments in a member's home district and have been distributed to the Chairman prior to the meeting. As a result the data generating process for the speeches are made under very different conditions than during deliberations at the time of the meeting. These

speeches report first about local inflation concerns and then about local unemployment and output concerns, mimicking the parameters of our Taylor rule. In our period ‘economic go around’ is introduced by the Committee Chair and concluded by a presentation by a staff member, either Vincent Reinhart or FOMC secretary Brian Madigan.

The uniformity of the meeting procedures means that we can easily select a subset of the members’ speeches where members are most likely to be discussing their own regional economic outlook as opposed to other parts of the meeting where members may be more likely engaged in questioning or persuasion with the others, or in building cooperation and consensus among their colleagues, which may entail greater levels of strategic speech-making. Similarly, they are more likely to focus on regional rather than national level macroeconomic indicators.

To test Blinder’s assertion that committee members are non-strategic in policy meetings, we apply the same position estimation model to just the first half of the meeting containing only the economic go-around and compare to the estimates from the complete meeting transcripts. Figure 5 shows the comparison. Most members have estimated preferences that are similar across the economic go-around subsample and the full sample. We can see how much they depart by how much they deviate from the 45 degree line. Instead of being strategic, we can observe that everyone gravitates towards a stronger emphasis towards inflation talk over unemployment and output talk in the full meeting discussion compared to the economic go-around. What this suggests is that all members exhibit stronger anti- inflation preferences when discussing the national level economy rather than their own regional economy. Further, there is little evidence to suggest that “Hawks” pretend to be “Doves” or vice-versa at different points during the meeting.

Importantly, our estimates for Lacker, the key dissenter throughout this period, continues to be estimates as more moderate than his dissenting voting record would suggest. Further, like his counterparts sitting on the FOMC, this is true regardless of whether we use the complete transcripts or the economic go-round sub-sample to estimate his ideal point.

The full meeting sample seems to estimate stronger member dispersion than the sub-sample,

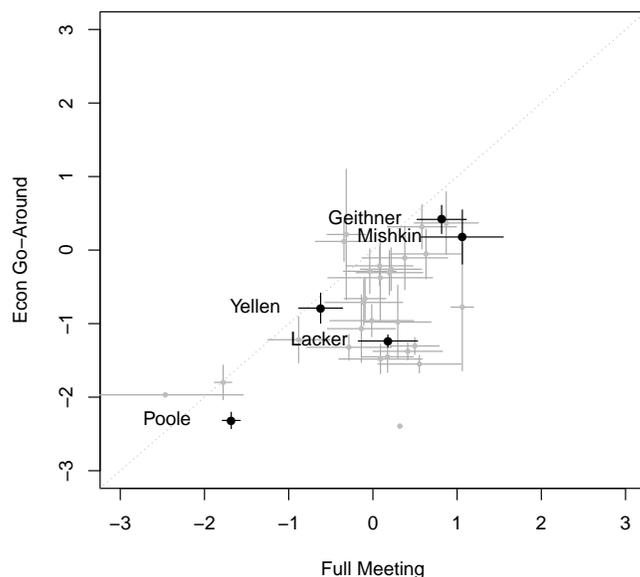


Figure 4: Comparing Topic Emphasis from Full Transcripts and Economic go-round

with Yellen and Poole in particular, estimated as more Dovish in the full meeting than in their prepared speeches. This is also true for those on the right, with Geithner and Mishkin, for example, estimated as more Hawkish in the full sample than in their prepared speeches in the economic go-round. The high degree of overlap in the estimates, especially for those members straddling the middle, gives us confidence that what we are uncovering are consistent positions rather than bursts of strategic emphasis of certain topics. Well this analysis provides some evidence of consistent opinions across different sub-sections of the committee meeting and among each-other, it does not capture strategic speech constraints resulting from the eventual publication of the transcripts.¹² This may mean that our estimates reflect a lower-bound of what committee members may actually want.¹³

¹²See Meade and Stasavage (2008)

¹³Thanks to an anonymous reviewer for pointing this out.

3.1.2 When do Members' Dissent?

At any given time, the total number of FOMC committee members officially included in the roll call vote is twelve. These twelve people include seven members of the Board of Governors of the Federal Reserve System; the president of the Federal Reserve Bank of New York; and four of the remaining eleven Reserve Bank presidents. The four Bank Presidents serve one-year terms and voting rotates according to a agreed calendar (i.e. members do not select themselves into any given meeting). Despite lacking voting privileges at some (but not all) meetings, the remaining Reserve Bank presidents attend meetings, make economic assessment of the economy, and express their individual policy positions for both the policy rate and the official policy statement in the transcripts prior to the roll call.

Using a natural experiment to analyze the effect of transparency on members incentives to dissent, Meade and Stasavage (2008) find evidence that voting members are much less likely to dissent than non-voting members. We retest this finding using our data, taking into account a member's estimated ideal point as well as whether the member is on schedule to vote or not.

Following the procedure by Meade and Stasavage (2008), using the transcripts, we code dissent as a binary measure based on whether a policymaker voiced disagreement with the Chair's policy proposal during the policy debate before the formal roll-call vote. Further, to take a more generous measure of "dissent," we code a member as dissenting even if the member expresses dissent only in speech and not in the roll call; this gives us a larger number of dissents to work with (32 vs 7). Furthermore, instead of just looking at dissenting votes that protest changes in the policy interest rate, we also examine whether members propose changes to the official policy statement which is publicized after the decision; this includes an even larger number of dissents (118 out of 425 total). Following Meade and Stasavage (2008), we expect a negative relationship between those members on rotation to vote and expressing a dissenting opinion, regardless of their policy position. The rationale is that consent is more likely expressed by voting members due to strategic incentives to minimize economic and policy uncertainty that results from dissenting opinions.

We test this hypothesis by regressing dissent on member ideal points and voting status, with meeting random effects to control for over-time changes in the economy. The results are shown in Table 1. Model (1) predicts dissent over the policy interest rate, and model (2) predicts dissent over the text of the official policy statement.

Table 1: Predicting Dissents in Policy Rates and Policy Statements with Ideal Points and Voting Status

	<i>Dependent variable:</i>	
	Dissent Policy Rate (1)	Dissent Statement (2)
Estimated Ideal Points	-0.042 (0.188)	-0.213* (0.125)
On Schedule to Vote	-0.567 (0.429)	-0.758*** (0.275)
Constant	-2.467*** (0.865)	0.385 (0.558)
Observations	334	333
Log Likelihood	-92.01	-191.23
Akaike Inf. Crit.	192.01	390.46
Bayesian Inf. Crit.	207.25	405.69

*p<0.1; **p<0.05; ***p<0.01

We find evidence in support of the hypothesis that publication of votes engenders consensus opinion among *those members on schedule to vote*. Committee members who are on schedule to vote are only half as likely to dissent on the statement and on the policy rate and than their colleagues not on schedule to vote.¹⁴ This confirms theories that argue that official voting behavior mostly likely reflects strategic behavior towards coordination in addition to sincere expression of policy positions. Furthermore, more dovish policy preferences are associated with requesting

¹⁴Fixed effects versions of the model show similar results and are available in the supplementary materials.

amendments to the policy statement.

4 Conclusion

This article shows the usefulness in combining topic and scaling methods to estimate central bank policy positions. We develop a new way to estimate central bank preferences on the FOMC based on topics that committee members are mandated to talk about. We extract topic-counts from committee meeting transcripts and compute relative topic emphasis to help identify differences in actors' policy positions. Our main contribution is that we offer an estimate of FOMC members' preferences based on private policy deliberations that occur before members agree (or disagree) to coordinate their policy actions by roll call voting and we do so for all members, irrespective if they are on cycle to vote or not. By using textual information as data to help uncover each member's relative inflation emphasis, we offer ideal point estimates based on a members' professed inflation aversion.

We show greater variation in FOMC members' preferences than what we see in voting behaviors. This supports recent evidence in other domains where researchers also uncover greater variation in speech than in votes. We also find that by only analyzing voting data, researchers likely overemphasize a dissenter's dissimilarity with his or her colleagues. This latter point is especially important because both researchers and market participants use voting behavior to predict changes in key interest rates. One fruitful item for further research, therefore, is to examine whether there exists an similar relationship between dissents in speech and changes to key interest rates. It is not clear whether the pathway of expressed dissent goes from speech to votes or if these two policy behaviors are separate. Do committee members start off making verbal protests in private only to build up to official dissent or do policymakers use these two behaviors distinctly so as to satisfy different goals?

Finally, our results also provide important policy implications. The Bank of England recently changed its procedures and will make permanent recordings and transcripts of Monetary Policy

Committee meetings (Warsh, 2014). While some have warned that by doing so, committee members may stifle their debate, we suggest that this need not stifle diversity in deliberation.

Moving away from the FOMC and central banking, our approach also provides an important tool for researchers that are interested in estimating actors' preferences in political institutions where expressed dissents are rare. As we show in this paper, matching human judgment with unsupervised learning techniques allows us to estimate members' preferences despite the fact that institutional norms encourage consensus opinions. Such an approach can be applied beyond central banks. For example, our method can be applied to other domains such as policymaking in legislative committees, security agreements such as the Iran nuclear deal framework, IMF Ministerial Committees and Executive Board decisions, or any other political institution where policy consensus is crafted prior to the taking of a roll call vote and meeting transcripts are available.

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A Appendix

Table 2: Top topic unigram words for k=25 and number of instances using keywords in context

Unigram	Count
inflation	2964
output	261
unemployment	245
year	1685
percent	1589
markets	1093
nation	657
financial	626
district	603
president	543
capital	399
contacts	396
mortgage	358
president	543
terms	371
people	362
laughter	298
monetary	263
ceo	190
world	148
statement	141
december	130
katrina	125
july	85
florida	81
largest	81

Table 3: Individual Ideal Point estimates for FOMC members derived from topic proportions in FOMC meeting transcripts from February 2005 to January 2008.

	Ideal Point	Lower Bound	Upper Bound
POOLE	-2.49	-2.65	-2.32
FISHER	-1.29	-1.47	-1.11
YELLEN	-1.16	-1.33	-0.98
BARRON	-0.53	-0.94	-0.13
KOHN	-0.49	-0.67	-0.30
PIANALTO	-0.48	-0.69	-0.27
GRAMLICH	-0.38	-0.73	-0.04
LACKER	-0.29	-0.48	-0.10
GUYNN	-0.25	-0.48	-0.02
GREENSPAN	-0.17	-0.39	0.04
STERN	-0.16	-0.41	0.08
BIES	-0.11	-0.35	0.12
MINEHAN	-0.05	-0.25	0.15
FERGUSON	-0.05	-0.31	0.21
PLOSSER	0.03	-0.20	0.25
MOSKOW	0.05	-0.17	0.27
WARSH	0.17	-0.08	0.42
BERNANKE	0.26	0.05	0.47
OLSON	0.37	0.00	0.73
KROSZNER	0.40	0.12	0.67
HOENIG	0.68	0.39	0.97
SANTOMERO	0.74	0.38	1.09
GEITHNER	1.03	0.76	1.31
ROSENGREN	1.15	0.31	1.99
MISHKIN	1.25	0.78	1.72

Table 4: Verbatim Discussion of Inflation Risks in FOMC Committee Meetings in 2007 by Yellen and Bernanke

Date:	Yellen:	Bernanke:
Jun. 27:	Risks to inflation are also significant	Risks to inflation to the upside and remain the predominant concern
Aug. 17:	There is downside pressure on inflation	Risks to inflation remain on the upside
Sept. 18:	I lowered my inflation forecast slightly	I see less upside risk. I think the slowing that we are likely to see will probably remove some of the upside risk that we have been concerned about. But, I don't dismiss inflation risks by any means, and we know that policy changes can work through expectations as well as resource pressures, and so I consider that to be a serious concern
Oct. 30:	Inflation news has continued to be favorable but some upside risk has become prominent	If you wanted to be defensive about inflation, you could point out that the movement in oil prices and the dollar and so on is in part due to our actions. But it is also due to a lot of other things [...] That said, I share with Governor Warsh the concern that the visibility of these indicators day after day in financial markets and on television screens has a risk of affecting inflation psychology. I do worry about that. I think we should pay attention to that. So I do think that is a concern, and we obviously need to take it into consideration in our policies, in our statements, and in our public remarks.
Dec. 11:	[D]ata on the core measure continues to be favorable. Wage growth remains moderate, and the recent downward revisions to hourly compensation have relieved some worries there. Inflation expectations remain contained. As I mentioned, I expect some labor market slack to develop, and this should offset any, in my view, modest inflationary pressures from past increases in energy and import prices and help keep core PCE price inflation below 2 percent. Continued increases in energy and import prices pose some upside risk to the inflation outlook, but there are also downside risks to inflation associated	With respect to inflation—again, people made these points as well— it is unfortunate that we do have some instability, some risks there. We saw some stabilization of the dollar over the past six weeks. That is obviously not exogenous. It depends on our behavior and our communication. I think oil prices depend also to some extent on our policy, directly or indirectly. We will be seeing some ugly near-term inflation numbers with oil price increases, which we hope will move out of the data shortly, but we're not sure. So obviously we have to watch that.

Table 5: Formal Dissents by FOMC Meeting

Sep. 2005	Voting against was Mark W. Olson, who preferred no change in the federal funds rate target at this meeting.
Aug. 2006	Voting against was Jeffrey M. Lacker, who preferred an increase of 25 basis points in the federal funds rate target at this meeting.
Sep. 2006	Voting against was Jeffrey M. Lacker, who preferred an increase of 25 basis points in the federal funds rate target at this meeting.
Oct. 2006	Voting against was Jeffrey M. Lacker, who preferred an increase of 25 basis points in the federal funds rate target at this meeting.
Nov. 2006	Voting against was Jeffrey M. Lacker, who preferred an increase of 25 basis points in the federal funds rate target at this meeting.
Nov. 2007	Voting against was Thomas M. Hoenig, who preferred no change in the federal funds rate at this meeting.
Dec. 2007	Voting against was Eric S. Rosengren, who preferred to lower the target for the federal funds rate by 50 basis points at this meeting.