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ABSTRACT

We show that personal experiences of inflation strongly influence the hawkish or dovish leanings of central bankers. For all members of the Federal Open Market Committee (FOMC) since 1951, we estimate an adaptive learning rule based on their lifetime inflation data. The resulting experience-based forecasts have significant predictive power for members' FOMC voting decisions, the hawkishness of the tone of their speeches, as well as the heterogeneity in their semi-annual inflation projections. Averaging over all FOMC members present at a meeting, inflation experiences also help to explain the federal funds target rate, over and above conventional Taylor rule components.

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I think these three players are all products of their experience. Yellen received her Ph.D in 1971. Fischer in 1969. Both experienced the Great Inflation first hand. Brainard earned her Ph.D in 1989. Her professional experience is dominated by the Great Moderation.

– Tim Duy's Fed Watch, Oct. 12, 2015

Macroeconomic models of optimal monetary policy tend to abstract from individual preferences and subjective beliefs of policy makers. If monetary policy makers appear at all explicitly in such models, they are modeled as maximizing social welfare, and the relative weights they assign to inflation and output stabilization depend on private-sector agent preferences and on objective data. When forming beliefs that affect their actions, these agents use all available information. There is no role for subjective beliefs or preferences that are distinct from those of private-sector agents (see, e.g., Rotemberg and Woodford 1999). Models in which policy makers learn from observing historical data, e.g. Sargent (1999), assume that beliefs are formed based on an objective historical data set that is disconnected from the personal history experienced by a specific individual policy maker.[1]

Contrast this modelling approach with the frequent discussions whether a central banker is a 'hawk' or a 'dove,' and what a new appointment to a central-bank committee such as the Federal Open Market Committee (FOMC) or European Central Bank (ECB) Governing Council means for future policy decisions. Like in the quote above, these discussions frequently refer to an appointee's background and personal experiences. When Charles Plosser and Richard Fisher stepped down as the Philadelphia and Dallas Federal Reserve Bank Presidents in September 2014, many newspapers interpreted this as a generational shift from, as the *New York Times* put it, "policy makers trained in the 1970s, who tend to fear inflation above all else" to a new generation of "younger officials more comfortable with pursuing broader policy goals" and related those differences to personal experiences: "Annual inflation in the United States has averaged 3.8 percent during Mr. Plosser's adult life. By contrast, inflation has averaged just 2.5 percent during the adult life of Narayana Kocherlakota, president of the Federal Reserve Bank of Minneapolis, who at 50 is the youngest member of the policy-making committee and who has become the most outspoken proponent of expanding

[1] Other existing work has explored variations in preferences, such as career-concerns, and variation in belief formation, such as learning frictions. For an overview, see Sibert (2006).

the Fed's stimulus campaign."[2]

In this paper, we analyze how lifetime experiences influence monetary policy views and the stated beliefs of policy makers about future inflation. We show that the lifetime experiences of FOMC members significantly affect their tendency to cast dissenting votes and, as a more subtle expression of their policy leanings, the hawkish or dovish tone in their speeches. Aggregating over all FOMC members present at a meeting, we also show that the average experience-based forecast has incremental explanatory power for the federal funds target rate, over and above conventional forward-looking Taylor rule components. Finally, inflation experiences have a strong direct impact on FOMC members' inflation forecasts as reported in their semi-annual Monetary Policy Reports (MPR) to the U.S. Congress.

Our analysis starts from the voting decisions of FOMC members. We ask whether heterogeneity in inflation experiences can explain their dovish or hawkish voting patterns. The FOMC meets at least four times (and typically eight times) per year in Washington. Members share their assessment of the economic situation and propose targets and policy measures for the upcoming inter-meeting time window, as well as for the long-run. We focus on the ultimate votes of the individual FOMC members as they allow us to study clearly defined policy decisions over a sample spanning several decades, from March 1951 to January 2014, combined with detailed information on their personal characteristics.

Our central hypothesis is that FOMC member voting decisions are influenced by the inflation experiences they have accumulated during their lifetimes. We model members' subjective inflation expectations using an AR(1) adaptive learning rule as in Malmendier and Nagel (2016): Individuals use inflation data realized during their lifetimes up to the FOMC meeting to estimate the long-run mean and the persistence of inflation. In each period, the fitted value based on this learning rule provides an experience-based inflation forecast for each FOMC member.

We then link these experience-based inflation expectations to the desired level of nominal interest rates using a subjective version of the Taylor rule (Taylor 1993). In our formulation, FOMC members can differ in their weights on the inflation and output stabilization objectives, in their views about the appropriate inflation and output tar-

[2] See "Charles Plosser and Richard Fisher, Both Dissenters, to Retire From Fed," by Binyamin Appelbaum, New York Times Sept. 22, 2014, www.nytimes.com/2014/09/23/business/fed-official-crtical-of-policies-set-to-retire-in-march.html.

gets themselves, as well as the level of the natural interest rate. Most importantly, we introduce a subjective forward-looking element by allowing FOMC members to evaluate the deviation from the inflation target partly in terms of their own experience-based inflation forecast.

Our estimation focuses on members' within-meeting heterogeneity in inflation experiences and voting behavior. We find a strong relationship between inflation experiences and voting decisions. A one within-meeting standard-deviation increase in the experience-based inflation forecast raises the probability of a hawkish dissent by about one third, and it lowers the probability of a dovish dissent also by about one third, relative to the unconditional dissent probabilities.

In a second step, we relate inflation experiences to a more subtle expression of monetary policy leanings, namely the hawkish or dovish "tone" of FOMC members expressed in their speeches. FOMC members, and Federal Reserve governors in particular, often seem reluctant to dissent, especially since November 1993 when the Federal Reserve agreed to publish, with a delay, the transcripts of FOMC meetings. Members might voice their concerns about a tight or loose monetary policy in discussions or speeches, but ultimately shy away from casting a dissenting vote. As a consequence, voting data may be too coarse to fully expose the dispersion in FOMC members' views, but the tone of speeches may be more informative about their disagreement.

We categorize language as hawkish or dovish employing the automated search-and-counts-approach of Apel and Grimaldi (2014). We apply their *Net Index* of hawkishness to the sample of "Speeches and Statements" available from the Federal Reserve Archival System for Economic Research (FRASER), as well as additional hand-collected speeches from the websites of the regional Federal Reserve Banks (FRBs). Consistent with our voting results, we find that FOMC members use a more hawkish tone in their speeches when their life-time experiences imply a higher experience-based inflation forecast.

In a third step, we turn from the cross-sectional analysis of individual behavior to the time series of the federal funds rate target. We work with a forward-looking version of the Taylor rule that contains the Federal Reserve Board staff's Greenbook forecast of inflation and the output gap as standard ingredients. We show that the federal funds rate target is tilted away from the Greenbook forecast of inflation towards the average of the experience-based inflation forecasts of the voting members in the corresponding FOMC meeting. This result is robust to controlling for interest smoothing as part of the

Federal Reserve's policy, i.e., including the lagged federal funds rate in the interest-rate rule. Our estimates imply—in a rough calculation that abstracts from the equilibrium consequences of a different interest-rate path—that the federal funds target that the FOMC would have chosen if members had relied only on the staff forecast, not on their own inflation experiences, is quite similar to the actually chosen one in the late 1980s and 1990s, but often by about 50 to 100 basis points lower in the 2000s.

Finally, we ask whether lifetime experiences affect FOMC members' stated beliefs about future inflation. We analyze the individual inflation forecasts FOMC members submit for the semi-annual Monetary Policy Reports (MPRs) to Congress. Romer and Romer (2008) examine the central tendency of these forecasts and find that FOMC members' deviations from the staff's Greenbook forecast *reduce* the forecast accuracy. Working with the individual forecast data, we show that the influence of inflation experiences helps explain why FOMC members deviate from the Greenbook forecasts. We find that members put a weight of 37% and possibly more, depending on the specification, on their experience-based forecasts. The strength of this tilt away from the staff forecast towards the experience-based forecast is broadly consistent with the tilt that we estimated in the federal funds target rate regressions.

Our four sets of empirical results can be parsimoniously explained by a unified model in which inflation experiences affect subjective beliefs about future inflation: When forming beliefs about future inflation, individuals overweight realizations of past inflation that they have experienced in their lives so far. Such a model of *experience-based learning* is also consistent with earlier evidence on experience effects in individual inflation expectations in Malmendier and Nagel (2016). At the same time, it is also possible that there is a preference-based link between inflation experiences and aversion to inflation. However, a preference-based explanation does not easily explain our evidence for at least two reasons. First, under a preference-based explanation, it is not clear why experience-based forecasts from an AR(1) adaptive learning rule would be a good way to summarize FOMC members' inflation preferences. Second, the preference channel explanation does not easily explain the link between inflation experiences and FOMC members' stated beliefs about future inflation in their MPR forecasts. The preference-based explanation would require the MPR forecasts to reflect members' inflation preferences rather than their beliefs about future inflation. This is a possibility, but not the standard interpretation of these data (e.g., Romer and Romer 2008). Irrespective of which of the two channels is the preferred explanation, our findings show

that heterogeneity in lifetime experiences is economically and statistically important in explaining heterogeneity in the monetary policy views and the decisions of the experts on the FOMC. Prior lifetime experiences help predict both the direction and the magnitude of their hawkish or dovish leanings.

This article connects to several strands of literature. First, our analysis of voting behavior builds on prior empirical evidence that links monetary policy decisions to the characteristics of the FOMC members. Chappell, Havrilesky, and McGregor (1993, 1995) and Chappell and McGregor (2000) document that a number of personal characteristics of central bankers, including their role as regional Federal Reserve president versus Federal Reserve governor, are associated with differences in their voting behavior. We contribute to this literature the new insight that differences in personal macroeconomic experiences also generate heterogeneity in voting behavior, and that the direction and strength of members' dissenting views can be linked directly to the magnitude of their lifetime experiences in inflatioin. Moreover, while the earlier literature viewed policy maker characteristics as influences on their preferences or on the incentives they have, our approach is motivated by a subjective beliefs channel, and we show a direct impact of lifetime experiences on stated beliefs about future inflation.

In the same vein, the evidence in this paper also sheds light on the likely consequences of choosing specific individuals as central bankers – a topic much discussed in practice. Romer and Romer (2004) provide narrative evidence that the Federal Reserve chairs are heterogeneous in their views about the workings of the macroeconomy and the potency of monetary policy. They argue that this heterogeneity affects policy choices. Accordingly, Reis (2013) suggests that the choice of a central banker shapes the effective objective function for the central bank. Our evidence suggests that heterogeneity in macroeconomic experiences of central bankers can influence the beliefs that enter as inputs into this objective function.

Our analysis of the tone in FOMC members' speeches relates to the literature on textual analysis in monetary policy. We employ the approach established by Apel and Grimaldi (2014) who measure the tone of the Swedish central bank minutes using an automated search-and-count approach. Apel and Grimaldi find that their measure helps to predict policy rate decisions. Numerous other text-mining approaches have recently been employed, for example by Hansen and McMahon (2016a, 2016b). Lucca and Trebbi (2011) analyze FOMC communication. Using an automated linguistics-based method, they find that the FOMC statement contains useful information predicting

long-term Treasury yields. Most studies in this area focus on transcripts, minutes, and statements of official meetings. We instead focus on how personal experiences can help explain the tone differences across FOMC members' speeches outside their meetings.

Our findings also add to a growing literature that studies experience-related heterogeneity in economic decisions and macroeconomic expectations. Existing research has focused on households (Malmendier and Nagel 2011, 2016), mutual fund managers (Greenwood and Nagel 2009), flood insurance customers (Gallagher 2014), CEOs (Malmendier and Tate 2005; Malmendier, Tate, and Yan 2011), lenders in 18th century Amsterdam (Koudijs and Voth 2016), and investors participating in initial public offerings (Kaustia and Knüpfer 2008; Chiang, Hirshleifer, Qian, and Sherman 2011). This paper is the first to provide such evidence for policy makers. That heterogeneous experiences matter for FOMC decision-making is particularly surprising. FOMC members are presumably well informed about macroeconomic history, and monetary policy may be the most technocratic and model-driven of all economic policy areas. Nevertheless, we find that differences in FOMC members' lifetime experiences induce heterogeneity in their monetary policy views and their inflation expectations.

Finally, in terms of methodology, our study connects to the literature on adaptive learning (Evans and Honkapohja 2001), and more specifically, the application of adaptive learning to model the evolution of monetary policy makers' beliefs (e.g., Sargent 1999; Cogley and Sargent 2005; Primiceri 2006). Following the approach of Malmendier and Nagel (2016), we introduce experience-based heterogeneity into this framework by allowing policy makers to place greater weight on their life-time experiences than on other historical data. This helps shed light on policy maker heterogeneity (that these earlier approaches are silent about) and it allows us to use such heterogeneity for the econometric identification of experience effects.

The rest of the paper is organized as follows. In the next section, we lay out the methodology underlying our empirical approach, including the derivation of FOMC members' desired interest rate and of their learning rule. We then apply this methodology to four different outcome variables. In Section II, we ask whether the dissenting votes of FOMC members can be explained by differences in their lifetime inflation experiences. In Section III, we introduce the Apel and Grimaldi (2014) measure of hawkish tone and apply it to FOMC members' speeches. In Section IV, we connect the average inflation experiences of all FOMC members at each meeting to the federal funds rate decision. In Section V, we show that lifetime experiences also help predict

the MPR inflation forecasts of FOMC members. Section VI concludes.

I Methodology

The key question in this paper is whether the hawkish or dovish leanings and policy outcomes of central bankers are related to their personal lifetime experiences of inflation. We apply the learning-from-experience model of Malmendier and Nagel (2016) to construct experience-based inflation forecasts of central bankers, which in turn feed into their policy decisions.

A Policy Rule

To isolate the effects of prior inflation experiences on policy decisions from other sources of heterogeneity, we need a framework that allows us to also incorporate FOMC members' heterogeneity in their policy preferences and incentives. We model monetary policy makers as following (explicitly or implicitly) an interest-rate rule that pins down their desired interest rate. We use the Taylor rule (Taylor 1993) as a starting point and we augment it to allow for heterogeneity.

The standard Taylor rule implies a nominal interest rate

$$i_t^* = r + \pi^* + \lambda(\pi_t - \pi^*) + \gamma(y_t - y^*) \qquad \text{with } \lambda > 0, \gamma > 0, \tag{1}$$

where π_t is the inflation rate, π^* is the inflation target (assumed to be 2 percent by Taylor), y_t denotes output, y^* is potential output, and r is the "natural" real interest rate consistent with a zero output gap $y_t - y^*$. Orphanides (2003) shows that this rule does a good job in explaining the evolution of the Federal Reserve's policy rate—i.e., the federal funds rate—all the way back to the 1950s (with the exception of a few years in the early 1980s during the "Volcker disinflation.") This does not mean that the FOMC explicitly followed such a rule; instead, it means that the FOMC's interest-rate decisions can be well described by such a rule.

We introduce heterogeneity in two ways. First, we allow FOMC members to differ in their preferences for inflation versus output stabilization through different weights λ and γ on inflation and on the output gap, and we allow them to entertain different views about the targets π^*, y^* and the natural rate r. Second, we introduce a subjec-

tive forward-looking element into the Taylor rule by assuming that FOMC members evaluate the deviations from the inflation target partly in terms of their own subjective inflation expectation. With these sources of heterogeneity incorporated into the policy rule, FOMC member j's desired nominal interest rate at time t becomes

$$i^*_{j,t} = r_{j,t} + \pi^*_{j,t} + \lambda_{j,t}(\omega\pi^e_{j,t+1|t} + (1-\omega)\pi_t - \pi^*_{j,t}) + \gamma_{j,t}(y_t - y^*_{j,t}), \quad \text{with } 0 \leq \omega \leq 1. \tag{2}$$

The parameter ω represents the weight that FOMC members put on their own subjective expectation $\pi^e_{j,t+1|t}$ rather than the objective information π_t.

One can go further and replace π_t and y_t with expectations of future inflation and output to make the Taylor rule fully forward-looking as in Clarida, Galí, and Gertler (2000). However, this does not change the specification of our estimating equation in a substantial way when we focus on cross-sectional heterogeneity between FOMC members, i.e., in our analysis of individual voting decisions and the tone of speeches. It does matter when we examine the time-series of the federal funds rate. In that latter analysis, we will turn to a fully forward-looking specification, albeit with a much shorter sample (due to limited availability of forecast data).

We specify the heterogeneity of FOMC members in the following way:

$$\begin{aligned}
\lambda_{j,t} &= \lambda_0 + (x_{j,t} - \mu_x)'\lambda_1, \\
\gamma_{j,t} &= \gamma_0 + (x_{j,t} - \mu_x)'\gamma_1, \\
\pi^*_{j,t} &= \pi^* + (x_{j,t} - \mu_x)'\alpha_1, \\
y^*_{j,t} &= y^* + (x_{j,t} - \mu_x)'\alpha_2, \\
r_{j,t} &= r + (x_{j,t} - \mu_x)'\alpha_3,
\end{aligned} \tag{3}$$

where $x_{j,t}$ is a vector of characteristics of FOMC member j at time t with population mean μ_x. After substituting these expressions into equation (2) and performing a first-order Taylor approximation of $i_{j,t}$ as a function of $(\pi^e_{j,t+1|t}, x'_{j,t})$ around (π_t, μ'_x), shown in Appendix A, we obtain

$$i^*_{j,t} \approx a_t + \lambda_0\omega\pi^e_{j,t+1|t} + \kappa' x_{j,t} + \pi_t x'_{j,t}\lambda_1 + (y_t - y^*)x'_{j,t}\gamma_1, \tag{4}$$

where a_t is a time fixed effect and κ is a vector of constants. We will utilize this version of the Taylor rule to derive individual desired interest rates and corresponding policy

views, whether expressed in voting decisions or tone.

B Learning from experience

To specify the subjective inflation expectation $\pi^e_{j,t+1|t}$, we employ the learning-from-experience framework of Malmendier and Nagel (2016). Their model aims to capture the relationship between experienced inflation and subjective inflation expectations. It is based on the assumption that an individual making an inflation forecast perceives the inflation process as AR(1). The individual uses data on experienced inflation to estimate the parameters of the AR(1) and to construct a forecast. As the individual experiences a new inflation realization, she updates the AR(1) parameters and revises the forecast. Intuitively, the AR(1) assumption implies that the experienced inflation is summarized in terms of mean inflation rate and inflation persistence.

We modify this framework to address the seasonality of inflation. Especially towards the end of our sample period, the empirical seasonality in inflation rates is substantial, and FOMC members are likely aware of the pattern. Hence, we assume that the perceived law of motion is a seasonal AR(1)

$$\pi_{t+1} = \alpha + \phi_1 \pi_t + \phi_4 \pi_{t-3} - \phi_5 \pi_{t-4} + \eta_{t+1}, \tag{5}$$

where the $t-3$ and $t-4$ lags capture a four-quarter seasonal pattern.

FOMC members use least-squares to estimate the vector b of seasonal AR(1) parameters, $b \equiv (\alpha, \phi_1, \phi_4, \phi_5)'$. Expressed recursively, the least-squares estimates of an FOMC member born in year s are updated every period as follows:

$$b_{t,s} = b_{t-1,s} + \gamma_{t,s} R^{-1}_{t,s} h_{t-1} (\pi_t - b'_{t-1,s} h_{t-1}), \tag{6}$$

$$R_{t,s} = R_{t-1,s} + \gamma_{t,s} (h_{t-1} h'_{t-1} - R_{t-1,s}), \tag{7}$$

where $h_t \equiv (1, \pi_t, \pi_{t-3}, \pi_{t-4})'$. The sequence of gains $\gamma_{t,s}$ determines how strongly cohort s revises the parameter estimates when faced with an inflation surprise at time t. Following Malmendier and Nagel (2016), we specify the gain as

$$\gamma_{t,s} = \begin{cases} \frac{\theta}{t-s} & \text{if } t-s \geq \theta \\ 1 & \text{if } t-s < \theta. \end{cases} \tag{8}$$

This gain specification represents a key difference to standard implementations of adaptive learning (see Evans and Honkapohja 2001), and it is the source of between-cohort heterogeneity in inflation forecasts in our framework. In standard adaptive learning models with decreasing gain, the gain would be decreasing with the size of the total sample of historical data available until t, which is the same for everybody. In contrast, the gain in (8) is decreasing with the size, $t - s$, of the *lifetime* data set of cohort s at time t. As a consequence, younger individuals have a higher gain and therefore react more strongly in response to an inflation surprise than older individuals.

The parameter $\theta > 0$ is constant and determines how much weight the forecaster puts on recent data versus data in the distant past. For example, $\theta = 1$ implies equal weighting of recent data and data earlier in life, while $\theta > 1$ implies that recent data receives more weight than early lifetime experiences. We conduct our baseline estimation by setting $\theta = 3.044$, which is the value Malmendier and Nagel (2016) estimate from the data on inflation expectations in the Michigan Survey of Consumers. This value of θ implies that weights on past observations decline a little faster than linearly, going back from the current period to a weight of zero at birth.[3] By imposing consistency with earlier evidence in this way, we tie our hands with regards to this parameter, rather than picking θ to best fit the FOMC voting data. We also explore robustness to variation of this parameter value around this point estimate. In particular, we re-estimate θ on the Michigan Survey of Consumers for college graduates, a sample that is plausibly more similar to FOMC members, and show that the results are unaffected when we use the corresponding estimate of $\theta = 3.334$.

For a given value of θ, we calculate the experience-based inflation forecast $\pi^e_{j,t+1|t}$ of member j at time t for the forecast horizon until $t+1$ using inflation data since member j's birth year. Our data source is the quarterly CPI series from 1871 Q1 to 2013 Q4 from Shiller (2005).[4] We measure inflation rates as annualized quarterly changes in the log CPI.

We plug the resulting experience-based inflation forecasts $\pi^e_{j,t+1|t}$ into the Taylor-rule formulation of equation (4) to obtain all FOMC members' heterogeneous desired

[3] Values in a fairly wide range around $\theta = 3.044$ also imply (sensibly) that the initial years in the lifetime data set carry very little weight. As a consequence, the inflation forecast of an adult is not sensitive to the precise starting point of the experience accumulation. Malmendier and Nagel (2016) discuss this point in more detail.

[4] See the updated long term stock, bond, interest rate and consumption data at `http://www.econ.yale.edu/~shiller/data.htm`.

interest rates at each point in time during our sample period.

II Inflation Experiences and Voting

As a first step in our analysis, we estimate the effect of inflation experiences on the voting choices of each member at each FOMC meeting.

A Data on the FOMC voting history

We study the FOMC member voting history from March 1951 to January 2014. The starting point of our sample period is dictated by the Treasury–Federal Reserve Accord of 1951, with which the Federal Reserve System re-gained its independence from the Department of Treasury after World War II.

The voting data comes from several sources. For meetings between January 1966 and December 1996, we use the data from Chappell, McGregor, and Vermilyea (2005). For meetings before January 1966 and after January 1997, we collect the voting history directly from FOMC meeting statements. Each statement reports the voting results, typically followed by explanations of the dissenting opinions, if any. We exclude eight dissents who cannot easily be classified as hawkish or dovish. (Details on the construction of the voting data set are provided in Appendix B.) We note that four members of the FOMC were both regional Fed presidents and governors at different points during their career, and we account for their varying roles in our empirical analysis.

We also collect biographical information for each FOMC member from the Federal Reserve History Gateway[5] and the Who's Who database. The data includes the year of birth, place of birth, gender, highest degree earned, the program they graduated from, the role served (board member or regional bank president), and the political party of U.S president who was in office at the time of the member's first appointment. We use these data to construct the vector $x_{j,t}$ of FOMC member j's characteristics that we allow to influence the desired interest rate in equation (4). We include age to make sure the experienced-based inflation forecast is not picking up an age effect, as well as other characteristics that the prior literature has found to be important determinants of FOMC voting decisions (Chappell, Havrilesky, and McGregor 1993; Chappell, Havrilesky, and McGregor 1995; Chappell and McGregor 2000): gender,

[5] `http://www.federalreservehistory.org/People`

Table 1: Summary Statistics

The table shows statistics for all FOMC meetings from 3/8/1951 to 1/29/2014. Details of the data construction are in Appendix B. The first column in Panel A reports the statistics for all FOMC members; columns 2 to 4 focus on members who dissent towards monetary easing (*Dovish Dissent*), members who consent (*Consent*), and members who dissent towards monetary tightening (*Hawkish Dissent*). Panel B reports the pairwise correlation between voting record, experience-based inflation forecast, and a vector of member characteristics. We code $Vote$ as 1 for a hawkish dissent, 0 for consent, and -1 for dovish dissent; *Fed Role* as 1 for regional Fed presidents and 0 for board members; *Party* as 1 if the member was first appointed while a Republican was U.S. president and 0 otherwise; and *Same Party* as 1 if the party of the U.S. president at the time of the appointment is the same as the party of the current president and 0 otherwise.

Panel A

	All	Dovish Dissent	Consent	Hawkish Dissent
#Meetings	659	109	659	178
#Votes	7,350	160	6,925	265
Avg. age	56.4	55.6	56.4	57.1
Avg. tenure (in days)	2,286	1,924	2,285	2,545
% w/ PhD	46.3	50.6	45.8	56.2
% studied Economics	67.5	70.6	67.0	78.9
% Male	93.9	83.1	93.9	100
% Regional Fed president	44.6	23.7	44.0	72.1
% Republicans	53.7	45.0	53.3	70.9
% Same party as current pres.	56.7	67.5	56.6	52.1
Expr.-based infl. fcst.: mean	3.4%	3.8%	3.4%	4.1%
std.dev.	1.8%	2.2%	1.8%	2.1%

Panel B: Pairwise Correlation

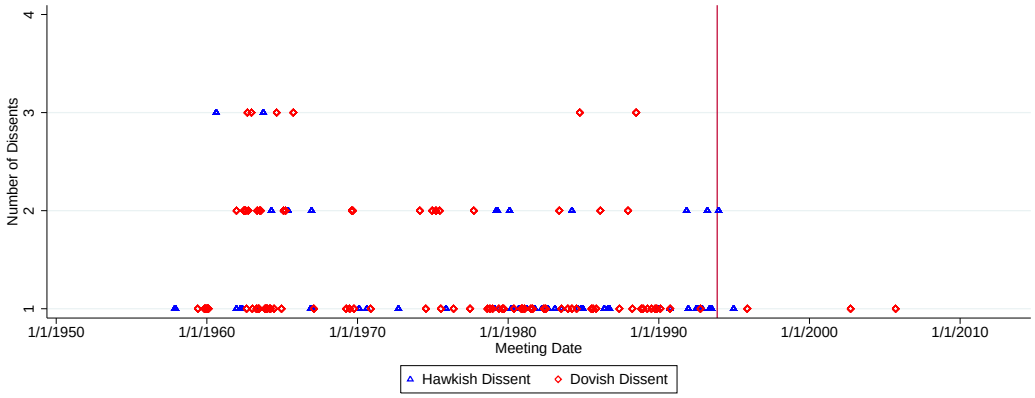
	Vote	Infl. fcst.	Male	Age	Fed role	Party	Same pty.
Vote	1.00	-	-	-	-	-	-
Exp.-based infl. fcst.	0.04	1.00	-	-	-	-	-
Male	0.08	-0.03	1.00	-	-	-	-
Age	0.02	-0.07	0.06	1.00	-	-	-
Fed role: Fed pres.	0.12	-0.01	0.10	-0.09	1.00	-	-
Party: Republican	0.07	0.15	-0.01	-0.02	0.10	1.00	-
Same Party	-0.03	0.05	-0.05	-0.18	0.03	0.12	1.00

indicators for being a Regional Federal Reserve Bank President, being appointed during the time a Republican U.S. president was in office, and for the U.S. president at the time of the first appointment being the same as the party of the current president. For reasons we discuss below, we also include an interaction between the indicator for Regional Federal Reserve Bank President and an indicator for meeting time after November 1993.[6]

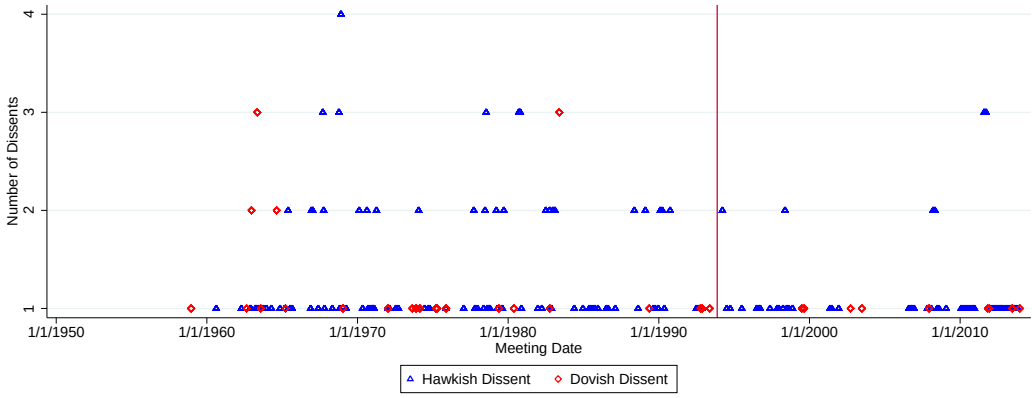
Table 1 presents the summary statistics. In total, we have data from 659 FOMC meetings with 7,350 votes. Over the whole sample, we have 160 dovish and 265 hawkish dissenting votes. For the interpretation of the estimation results below it is useful to keep in mind that the share of dovish and hawkish dissents is quite small, typically somewhere between 2.2% and 3.6%. These averages hide, however, a large degree of heterogeneity by role served and over time.

Figure 1 shows the number of dissents in each FOMC meeting separately for Federal Reserve Board members (Panel a) and Regional Federal Reserve Presidents (Panel b). It is easy to see that governors are much more likely to cast a dovish dissenting vote than a hawkish dissenting vote. The opposite holds for regional presidents. Here we observe a much higher fraction of hawkish dissents, as also indicated earlier in Panel A of Table 1. Figure 1 also reveals that a significant shift in voting behavior occurred in November 1993, indicated by the red line. At that time, the Federal Reserve responded to pressure from Congress for more transparency and accountability and agreed to publish lightly edited transcripts of the FOMC meetings with a five-year lag (Lindsey 2003). Before 1993, the Federal Reserve published individual votes and summary minutes, but not the full transcripts. Meade and Stasavage (2008) find that this change reduced the willingness of FOMC members to verbally express dissent in the meetings. They also find a decrease in the propensity of Federal Reserve board members to dissent in formal voting, but the effect is not statistically significant in their sample until 1997. Figure 1, however, shows a fairly clear pattern. Dissents among Federal Reserve Board members became almost non-existent after the increase in transparency in 1993 (only 6 subsequent dissents). In contrast, dissents among regional Federal Reserve presidents remained quite common (71 subsequent dissents). Thus, the thresholds for FOMC members' to voice dissent seems to have changed in 1993. This is an important feature

[6] We have also checked the robustness to including further available control variables (and their interactions) such as tenure (as a possible control for expertise, cf. Hansen and McMahon 2016a) and educational background. None of our results are affected if we include tenure, tenure squared, and controls for the school attended, the highest degree, and the field studied.



(a) Dissents by Federal Reserve Board Members



(b) Dissents by Regional Federal Reserve Presidents

Figure 1: Number of dissents in each FOMC meeting. The red vertical line is the time-stamp for Nov. 1993, after which FOMC agreed to make public its lightly-edited transcripts with a five-year lag.

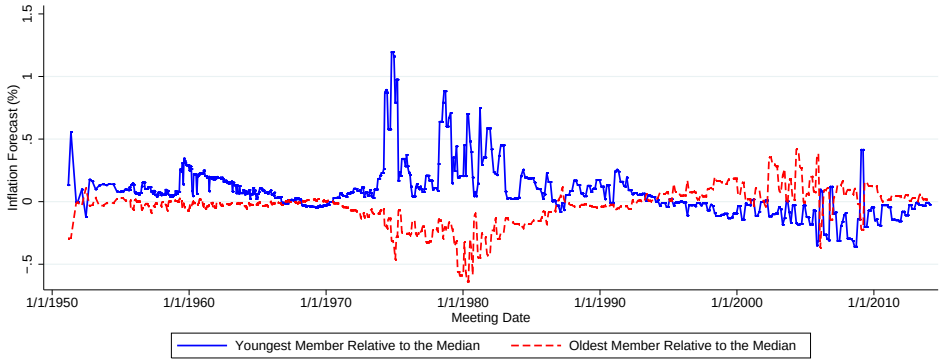
of the data that we will need to accommodate in our econometric specification.

Returning to Panel A of Table 1, we see that hawkish dissenters are also older, have a longer tenure on the FOMC, are more likely to have a PhD, to have studied economics, to be male, and were appointed when the U.S. president in office was from a different party than the current U.S. president. (All differences other than the doctoral degree and field of study are statistically significant.)

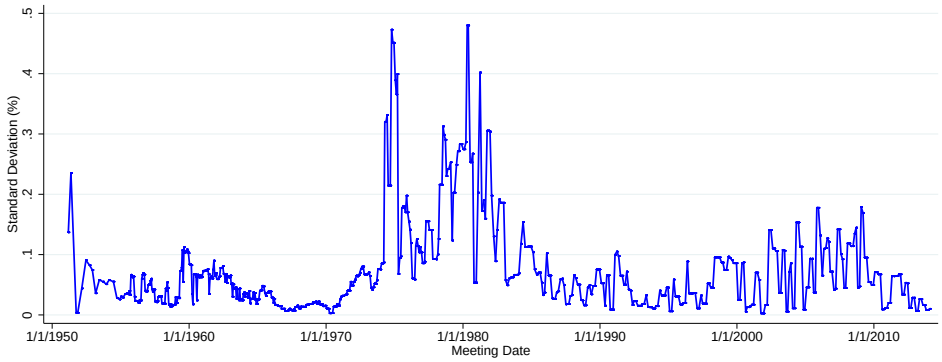
At the bottom of Panel A, we show the mean and standard deviation of FOMC members' experience-based forecasts $\pi^e_{j,t+1|t}$, calculated as described in Section I.B. The average experience-based inflation forecasts for dovish dissenters is 3.8% while the average for hawkish dissenters is 4.1%, though the difference is not significant, and the average among consenters is even lower (3.4%). The difference between dissenters' experience-based forecasts is not significant, though the difference between hawkish dissenters and dovish dissenters combined with consenters is.

Panel B shows the pairwise correlation between the key variables. We note again the positive relationship between the role of Fed president and votes leaning in a hawkish direction, and the same for being male, older, and Republican. Experience-based forecasts and hawkish voting are also positively correlated, and the correlation is significant. Our empirical analysis will test whether this relationship persists when analyzing the between-member variation in experiences after controlling for all other characteristics and their interaction effects, as implied by the policy rule in (4).

In order to illustrate the identifying variation in experience feeding into our estimation, we plot two measures of the cross-sectional differences in experience-based inflation forecasts. Panel (a) of Figure 2 shows the learning-from-experience forecast $\pi^e_{i,t+1|t}$ of the youngest and oldest FOMC members at each meeting, after subtracting the $\pi^e_{i,t+1|t}$ of the median-age member in each meeting. As the plot reveals, these differences take values of at most around 1.5 percentage points. The biggest differences occur during the high-inflation years in the late 1970s and early 1980s, when the youngest members have the highest experience-based forecasts. At that time, younger members' inflation experiences are dominated, to a larger extent than older members' experiences, by the high mean rates of inflation during the 1970s and the high persistence that inflation exhibited during those years. The high perceived mean and high perceived persistence produce, in combination, a high experience-based inflation forecast among younger cohorts in this period. Subsequently, from the mid-1980s onwards, younger members adapted more quickly to the now low rates of inflation and the rela-



(a) Experience-based inflation forecast for the youngest and oldest FOMC member relative to the median age member's forecast



(b) Standard deviation of members' experience-based inflation forecasts

Figure 2: Dispersion of members' experience-based inflation forecasts during each FOMC meeting

tively low persistence, and the lines cross. The perception of a relatively low inflation persistence among younger members also contributes to the spike around 2010, when young members' learning-from-experience forecast is temporarily much higher than the median: When faced with the recession-driven low inflation rates at the time, young members expected a faster reversion of inflation rates up (towards the mean of slightly above 2%) than older members.

As another measure of the differences in experience-based inflation forecasts, Panel (b) plots the time-series of the within-meeting standard deviation of $\pi^e_{i,t+1|t}$. There is a lot of variation in this dispersion measure over time. A somewhat typical value would be around 0.1 percentage points (the full-sample within-meeting s.d. is 0.102 pp). As the age differences between FOMC members are typically not big, their experienced inflation histories are quite similar, and thus the learning model from Section I.B produces forecasts that are quite close for most of the members on the FOMC. Exceptions occur in the late 1970s and early 1980s when high inflation rate realizations lead to substantial dispersion despite the relatively small age differences. It is useful to keep these magnitudes in mind for the interpretation of our empirical tests below. As we will show, even a relatively small dispersion in experience-based forecasts can be sufficient to induce substantial differences in voting behavior.

B Econometric specification

At each FOMC meeting, all current voting members cast a vote to either support or dissent from the proposal of the Fed chairperson. We classify the vote $V_{j,t}$ of member j in the meeting at time t as falling into one of three categories, $V_{j,t} \in \{-1, 0, 1\}$, for dovish dissent, no dissent, and hawkish dissent, respectively. We express the probability of being in one of these three categories as a function of the desired interest rate from equation (4) via the following ordered probit model: For $k \in \{-1, 0\}$

$$\begin{aligned} &P(V_{j,t} \leq k | \pi^e_{j,t+1|t}, x_{j,t}, \pi_t, y_t) \\ &= \Phi[\delta_{k,j,t} - a_t - \lambda_0 \omega \pi^e_{j,t+1|t} - \kappa' x_{j,t} - \pi_t x'_{j,t} \lambda_1 - (y_t - y^*) x'_{j,t} \gamma_1], \end{aligned} \tag{9}$$

where $\Phi(.)$ denotes the standard normal cumulative distribution function, and where we normalize $a_0 = 0$ and suitably scale all variables so that the latent residual has unit

standard deviation.[7]

The model in (9) is a generalized version of the ordered probit model because we allow the thresholds for dissent $\delta_{k,j,t}$ to vary with the characteristics of the FOMC member and across the transparency regime change in 1993. The most important concern motivating this generalization is that regional Fed presidents may have different dissent thresholds compared with Federal Reserve Board governors. As we illustrated in Figure 1, this concern is particularly relevant since the November 1993 change in transparency. To accommodate the possibility of threshold-heterogeneity among FOMC members, we let the thresholds in (9) depend on the FOMC member characteristics $x_{j,t}$, including an interaction between indicators for the role Regional Federal Reserve Bank President and for a meeting time after November 1993:

$$\delta_{k,j,t} = \delta_{0,k} + \delta_{1,k}' x_{j,t} \qquad \text{for } \; k \in \{-1, 0\}.$$

Note that coefficients of $\delta_{0,k}$ and $\delta_{1,k}$ are threshold-specific. With this threshold specification, we obtain a version of the generalized ordered probit model in Williams (2006). We estimate the model with maximum likelihood.

C Baseline Results

Do these differences in the learning-from-experience forecasts of FOMC members help explain differences in their voting behavior? Table 2 presents estimates of our baseline ordered probit specification (9) using data from 1951 to 2014. Our focus is on the coefficient estimate, and the corresponding marginal effect, of each member's experience-based inflation forecast $\pi^e_{j,t+1|t}$. The chairman's vote is excluded from the sample because the chairman never dissented in the FOMC meeting during our sample period.

In addition to the experience-based forecast variable, our sample composition requires us to include a dummy capturing hyperinflation experience. One FOMC member in our data set, Henry Wallich, personally experienced hyperinflation. Mr. Wallich was born in Germany in 1914 into a family of bankers, and he lived through Germany's hyperinflation from 1921 to 1924 before emigrating to the United States in the 1930s and serving as Federal Reserve governor from 1974 to 1986. Mr. Wallich dissented 27 times during his tenure on the Federal Reserve Board, the highest number of dis-

[7] These normalizations are of no consequence for the estimated partial effects and so we do not explicitly write them out.

sents among all FOMC members in Federal Reserve history, according to Thornton and Wheelock (2014).[8] We cannot integrate the hyperinflation observations into the experience-based forecast as the inflation rate reached tens of thousands percent per month in 1923; estimation of an AR(1) with these observations included would produce nonsensical results even with a sample spanning decades. We dub the corresponding indicator "Wallich Dummy." With the caveat that this variable captures the voting behavior of just one individual member, the corresponding coefficient estimate provides at least tentative evidence on the effects of a "hyperinflation" treatment, i.e., how the extreme experience of hyperinflation may have influenced Wallich's monetary policy views.

Column (i) of Table 2 reports estimates for a specification of the ordered probit model (9) where the dissent thresholds can vary with indicators for the type of FOMC member (board governor versus regional president) and with an indicator for the post-November 1993 period, as well as their interaction. This allows the model to accommodate the dramatic shift towards fewer dissents among Federal Reserve Board members after November 1993 that we saw in Figure 1. The coefficient on the experience-based inflation forecast of 216.6 (s.e. 66.1) is significantly different from zero at conventional significance levels. The magnitude of the effect on the probability of dissent can be inferred from the average partial effects (APE) reported in the middle block of the table. An increase of 0.1 percentage points (pp) in the experience-based forecasts of an FOMC member—which, according to Figure 2b, is a typical within-meeting standard deviation of FOMC members experience-based inflation during much of the sample—translates into an increase in the probability of a hawkish dissent vote of roughly 1.21 pp, which is a little less than a third of the unconditional probability of hawkish dissent ($265/6707 \approx 4.0\%$). The probability of a dovish dissent drops by about 0.76 pp, which is approximately a third of the unconditional probability of dovish dissent ($160/6707 \approx 2.4\%$). Thus, the estimates imply an economically large impact of inflation experiences on voting behavior.

The APE of the Wallich dummy indicates that the hyperinflation "treatment" is associated with a very large reduction in the probability of dovish dissent of 5.0 pp, and an increase in the probability of hawkish dissent of 8.0 pp. In other words, the effects

[8] In our sample, we identify only 26 dissents by Wallich, 24 of which were hawkish. The difference to Thornton and Wheelock's classification could be Wallich's vote on the 2/6/1979. In this meeting he dissented regarding the adopted growth rates of the monetary aggregates (M1-M3), but not regarding the open market transactions that were authorized. In our sample, this vote is not counted as dissent.

on probabilities associated with the Wallich dummy are roughly of the same magnitude as those associated with an increase of 1.0 pp in an FOMC member's experience-based inflation forecast.

All results are virtually identical when we allow the dissent thresholds to also depend on the FOMC members' individual characteristics (age, gender, party of president at appointment indicator, and same party as current president indicator), as shown in column (ii).

D Robustness Checks

One potential concern with the estimates in columns (i) and (ii) in Table 2 is that the inclusion of meeting fixed effects in the ordered probit model might introduce an incidental parameters problem.[9] To address this concern, we estimate an alternative specification in which we omit the meeting fixed effects. Instead, we specify that the probabilities of dissent are driven directly by cross-sectional differences (against the incumbent Chairperson) in inflation experiences and other personal characteristics. That is, we forgo the non-parametric controls for the time-specific determinants of voting behavior, but we still remove at least some of them to the extent they are captured by the explanatory variables values associated with the chairperson.

The results are shown in columns (iii) and (iv) of Table 2. The coefficient estimates of the experience-effect forecast variable and the Wallich dummy decrease, but these changes largely reflect the altered econometric specification. As the APE calculations reveal, the implied economic magnitudes remain similar to those in columns (i) and (ii). Both sets of estimates also remain statistically significant. We conclude that our findings are not generated by estimator inconsistencies due to the incidental parameter problem.

As a second robustness check, we test whether we still find experience effects if we employ a simple ordered probit model with fixed dissent thresholds and restrict the analysis to subsamples in which the fixed-threshold assumption is more likely to hold, i.e., prior to the dramatic decrease in dissents since November 1993 and for the votes of regional presidents.

[9] As T increases, the number of meeting fixed effects grows at the same rate as T and therefore, the probit estimator is inconsistent and standard formulas for the asymptotic distribution of the estimator may not provide a good approximation of its finite-sample properties.

Table 2: Experience-based Inflation Forecasts and FOMC Voting Behavior

The sample period is from March 8, 1951 to January 29, 2014. The experience-based inflation forecast for each member at each meeting is calculated by recursively estimating a seasonal AR(1) model using the member's lifetime history of inflation, as described in Section I.B (with $\theta = 3.044$). The *Wallich* dummy equals one if the member is Henry Wallich; 0 otherwise. The average partial effects (APE) reported at the bottom of the table are calculated by taking the partial derivative of the probability of a given voting category with respect to the experience-based inflation forecast at each sample observation and then averaging these partial derivatives across the whole sample. Column (i) and (iii) report the results assuming that the thresholds depend on a) whether the member is a board member or regional president, and b) whether the meeting occurs after Nov. 1993 and the interaction of a) and b). Column (ii) and (iv) report the results assuming that the thresholds depends, in addition, on age, gender, party of president at appointment indicator, and same party as current president indicator. In parentheses we report the standard error based on two-way clustering by both member and meeting.

	Ordered Probit		Ordered Probit "de-chaired"	
	(i)	(ii)	(iii)	(iv)
Experienced-based forecast	216.6	214.4	97.2	98.5
	(66.1)	(67.8)	(39.5)	(39.0)
Wallich Dummy	1.43	1.39	1.05	1.05
	(0.36)	(0.36)	(0.17)	(0.17)
Meeting FE	Yes	Yes	No	No
Thresholds	Role $\times$ $I_{>93}$	All	Role $\times$ $I_{>93}$	All
Observations	6,707	6,707	6,707	6,707
Pseudo R^2	0.390	0.391	0.097	0.100
APE of experienced-based forecast:				
Dovish Dissent	-7.6	-7.6	-5.1	-5.1
Consent	-4.4	-4.3	-2.5	-2.5
Hawkish Dissent	12.1	11.9	7.6	7.7
APE of Wallich Dummy:				
Dovish Dissent	-0.050	-0.050	-0.055	-0.055
Consent	-0.029	-0.028	-0.027	-0.027
Hawkish Dissent	0.080	0.077	0.082	0.082

Table 3: Experience-based Inflation Forecasts and FOMC voting behavior: Different Sample Periods with Fixed Ordered Probit Thresholds

The experience-based inflation forecast for each member at each meeting is calculated as in Table 2. The *Wallich* dummy equals one if the member is Henry Wallich; 0 otherwise. The average partial effects (APE) reported at the bottom of the table are calculated by taking the partial derivative of the probability of a given voting category with respect to the experience-based inflation forecast at each sample observation and then averaging these partial derivatives across the whole sample. Column (i) reports the results with all FOMC members prior to November 1993. Column (ii) reports the results with regional Fed presidents only prior to November 1993. Column (iii) reports the results with regional Fed presidents only over the entire sample. Column (iv) reports the results with all FOMC members prior to November 1993 and regional Fed presidents only afterwards. In parentheses we report the standard error based on two-way clustering by both member and meeting.

	All Members pre-1993 (i)	Regional Pres. Only Full Sample (ii)	Regional Pres. Only pre-1993 (iii)	Mixed Members Full Sample (iv)
Expr.-based fcst.	230.0	379.2	495.5	230.9
	(80.0)	(103.9)	(155.9)	(68.9)
Wallich Dummy	1.49	-	-	1.51
	(0.37)	-	-	(0.37)
Meeting FE	Yes	Yes	Yes	Yes
Observations	5,123	3,275	2,467	5,931
Pseudo R^2	0.380	0.453	0.492	0.383
APE of expr.-based fcst.:				
Dovish Dissent	-9.5	- 6.4	-8.0	-9.0
Consent	-3.5	-19.5	-21.0	-5.2
Hawkish Dissent	13.0	26.0	29.0	14.2
APE of Wallich Dummy:				
Dovish Dissent	-0.062	-	-	-0.059
Consent	-0.022	-	-	-0.034
Hawkish Dissent	0.084	-	-	0.093

Table 3 presents the results of this exercise. The specification in column (i) employs the voting records of all members from November 1993 onwards. The estimated results turn out to be very close to our benchmark case (with characteristics-dependent dissent thresholds). We estimate slightly larger average partial effects of -9.5 pp for dovish dissents and $+13.0$ pp for hawkish dissents, again measured as the response to an increase of 0.1 pp in FOMC member's experience-based forecasts. The APE of the Wallich dummy also become slightly larger in both directions in this subsample.

In columns (ii) we restrict the sample to regional Fed presidents, but we use all time periods. This subsample exploits the fact, shown in Figure 1, that the November 1993 transparency change did not have much effect on the voting behavior of regional presidents. We find that the estimated effects are even stronger.[10] In this subsample, the proper comparison for the APEs is the unconditional probability of dovish or hawkish dissent by Federal Reserve presidents. The estimated average partial effects (APE) of changes in experience-based inflation forecast on the voting behavior of regional presidents suggests that an increase of 0.1% in the experience-based forecast of regional Fed presidents translates into an increase in the probability of a hawkish dissent by roughly 2.6 pp, which is a bit less than one half of the unconditional probability of a hawkish dissent by regional Fed presidents ($191/3275 \approx 5.8\%$). Meanwhile, the probability of a dovish dissent drops by 0.6 pp, which is roughly half of the unconditional probability of dovish dissent by regional Fed presidents ($38/3275 \approx 1.2\%$). Comparing these numbers to our baseline case with all FOMC members, it appears that past inflation experience has a stronger effect on the votes of regional Fed presidents.

In column (iii), we further restrict the sample of regional presidents to include only the pre-November 1993 periods. The estimated APEs remain very similar. Finally, in column (iv), we analyze the union of the column (i) and column (ii) subsamples, i.e., all members pre-November 1993 and only Fed presidents post-November 1993. The estimated effects are very similar to those in column (i), as well as to the benchmark case.

Appendix C contains an additional set of results with fixed thresholds where we use the full sample of all members and meetings. These results, shown in Table A.1, are again very similar. This simplified specification also allows a straightforward interpretation of the effects of the member characteristics, $x_{j,t}$. We report the coefficients

[10] Since Henry Wallich is not a regional Fed president, we cannot estimated the Wallich dummy coefficient in this case.

associated with these variables in Table A.2.

As a last robustness check, we employ variations in the gain parameter θ of the learning algorithm. So far we fixed θ at the point estimate of 3.044 from Malmendier and Nagel (2016). Relying on a prior estimate has the advantage that we credibly tied our hands, rather than picking θ to fit the voting behavior of FOMC members. We now check how the fit and the estimated APE change if we vary θ. That is, we re-estimate the learning rule for each FOMC member over a range of plausible values of θ. We then re-run the estimation from column (i) of Table 2 with the corresponding alternative experience-based forecasts of inflation.

For our first alternative value, we re-estimate the gain parameter using data from the *Michigan Survey of Consumers* based on the same procedure as in Malmendier and Nagel (2016), but with the sample restricted to college graduates. This sub-sample is more comparable to the FOMC members in terms of educational background. We estimate $\theta = 3.334$ (with s.e. of 0.347). That is, the θ estimate for college grads is less than one s.e. from the full-sample estimate. As column (i) of Table 4 shows, employing $\theta = 3.334$ rather than $\theta = 3.044$ does not alter our findings. The results remain very similar to our baseline estimates in column (i) of Table 2.

Second, we employ a range of θ values between $\theta = 2$ to $\theta = 4$ (in steps of 0.5). As shown in columns (ii) to (v) of Table 4, all results are qualitatively similar to our baseline estimates as in column (i) of Table 2. We conclude that our results are robust to variations over a broad range of plausible θ values.

In summary, we find that lifetime inflation experiences have an economically large and robust effect on FOMC members' voting behavior. When an FOMC members' lifetime experience suggests higher inflation going forward than the experience of their peers, they are more likely to dissent in a hawkish direction. The opposite holds for inflation experiences suggesting lower future inflation; they induce dovish dissents.

III Inflation Experiences and the Tone of FOMC Members' Speeches

The seeming reluctance of governors to dissent, especially since November 1993, indicates that FOMC members may not always fully reveal their disagreement in their voting behavior. They might voice their monetary policy views in discussions or speeches,

Table 4: Experience-based Inflation Forecast and FOMC voting behavior: Varying Weights on Past Experience

The sample period is from March 8, 1951 to January 29, 2014. The ordered probit specification is the same as in column (i) of Table 2, but here with different values of the gain parameter θ in the calculation of the experience-based inflation forecast. The *Wallich* dummy equals one if the member is Henry Wallich; 0 otherwise. The average partial effects (APE) reported at the bottom of the table are calculated by taking the partial derivative of the probability of a given voting category with respect to the experience-based inflation forecast at each sample observation and then averaging these partial derivatives across the whole sample. We assume that the ordered probit thresholds depend on a) whether the member is a board member or regional president, and b) whether the meeting occurs after Nov. 1993 and the interaction of a) and b). In parentheses we report the standard error based on two-way clustering by both member and meeting.

	$\theta = 3.334$ (i)	$\theta = 2$ (ii)	$\theta = 2.5$ (iii)	$\theta = 3.5$ (iv)	$\theta = 4$ (v)
Experience-based forecast	183.8	218.2	256.7	165.4	117.6
	(61.2)	(68.4)	(74.3)	(58.0)	(48.5)
Wallich Dummy	1.42	1.45	1.46	1.41	1.39
	(0.36)	(0.36)	(0.36)	(0.36)	(0.36)
Meeting FE	Yes	Yes	Yes	Yes	Yes
Observations	6,707	6,707	6,707	6,707	6,707
Pseudo R^2	0.389	0.389	0.391	0.388	0.386
APE of experienced-based forecast					
Dovish Dissent	-6.5	-7.7	-9.1	-5.9	-4.2
Consent	-3.8	-4.5	-5.2	-3.4	-2.4
Hawkish Dissent	10.3	12.2	14.3	9.2	6.6
APE of Wallich Dummy					
Dovish Dissent	-0.050	-0.051	-0.052	-0.058	-0.050
Consent	-0.029	-0.030	-0.030	-0.029	-0.029
Hawkish Dissent	0.079	0.081	0.081	0.079	0.078

but ultimately refrain from casting a dissenting vote.

In this section, we test whether FOMC members' attitude towards monetary policy can be detected in the language, or tone, they use in their speeches. To categorize language as hawkish or dovish, we employ an automated search-and-counts-approach that closely builds on the analysis of Apel and Grimaldi (2014). Apel and Grimaldi (2014) examine the Swedish Riksbank minutes and test whether their tone conveys a policy inclination toward loosening or tightening monetary policy. We apply their classification of tone to speeches of FOMC members, with some adjustment to the different context and sample, as described in detail below.

Our starting sample of speeches consists of all $6,353$ "Speeches and Statements" available from the Federal Reserve Archival System for Economic Research (FRASER), and additional 658 hand-collected speeches from the websites of the regional FRBs. To be consistent with the analysis of votes in the previous section, we focus on voting members and remove speeches delivered by the (rotating) non-voting regional Fed presidents. We also drop pdf files that could not be properly converted into text and for which the date of the speech cannot be determined. The final sample consists of $4,298$ speeches for 86 FOMC members in the period from the meeting on March 8th, 1951, to June 2014, with an average of 50 speeches per member. A quarter of the members have 15 or less speeches in the sample, while long-serving FOMC members, especially chairmen, tend to have more than 100 speeches. For example, our sample includes 482 speeches by Alan Greenspan and 264 by Ben Bernanke. Appendix D provides further details on the construction of the data set.

Figure 3 shows the time series of the speeches in our sample. The total number increases over time. From 1965 onwards, the average number of speeches in a quarter is above 17, i.e., more than one speech per FOMC member per quarter. The share of speeches delivered by the chair increases only slightly over time and lies around 30%.

To classify the tone of these speeches, we follow Apel and Grimaldi (2014) and generate two-word combinations from two sets of words: nouns describing the *goals* of a central bank, and adjectives describing the *attitudes* of a central banker towards a goal. The list of *goals* in Apel and Grimaldi (2014) consists of "inflation," "cyclical position," "growth," "price," "wages," "oil price," and "development." We will also show estimation results after adapting the list to the FOMC context by adding "(un-)employment." Apel and Grimaldi had omitted this term because the Swedish Riksbank has price stability as a single goal, while the U.S. Federal Reserve System

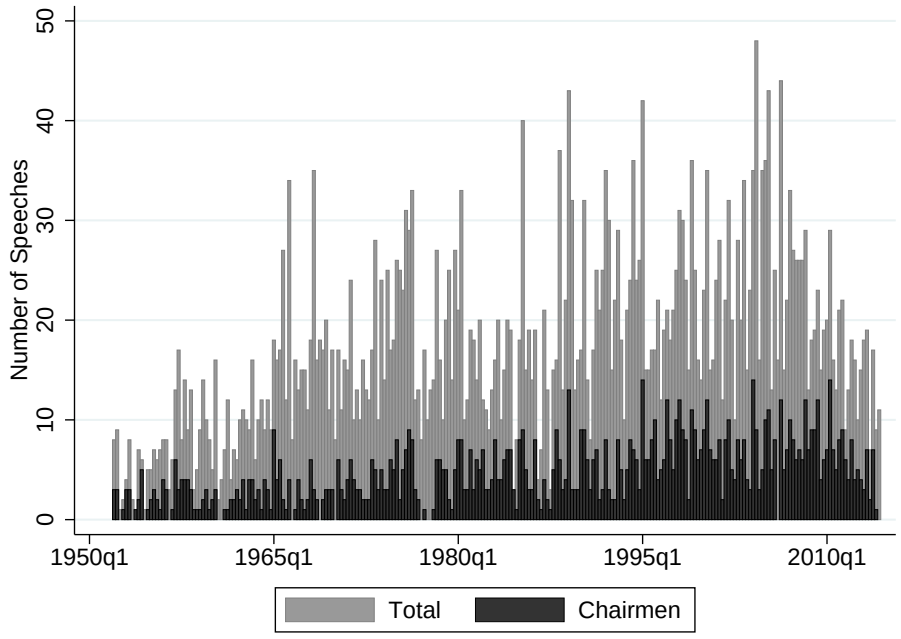


Figure 3: Number of FOMC Member Speeches Over Time

has a dual mandate. The list of *attitudes* consists of "decrease," "slow," "weak," and "low" on the dovish side, and "increase," "fast," "strong," and "high" for the hawkish counterpart. For unemployment, we swap the hawkish and the dovish adjectives.

For each mention of a *goal*, we check whether words from the *attitudes* list occur within a range (n-gram) of two words before and after the *goal*. While Apel and Grimaldi (2014) require the *attitude* word to appear directly before the *goal*, such two-word combinations do not generate sufficient variation between the speeches of FOMC members, possibly because the language is less formal and standardized than the Swedish central bank minutes, and the speeches of the FOMC members address a wider audience. We choose a range of two words before and after the goal (i.e., five-grams) in order to accommodate two-word goals such as "oil price," as well as to accommodate different relative positions of the classification words. For example, an FOMC member might refer to "increasing prices" or mention that "prices are increasing." In addition, by centering the n-grams around the noun of interest, we avoid double-counting: Every word of the speech occurs in at least n n-grams but is only at most once in the center of an n-gram.

We drop n-grams containing more than one "goal" or "attitude" with different con-

Table 5: Tone of Speeches: Summary Statistics

The sample includes voting FOMC members' speeches from March 1951 to June 2014. *Net Index* is an index of hawkishness calculated as described in equation (10). *Hawkish/Dovish Tags* is the average count of hawkish and dovish word combinations in a speech. *Hawkish/Dovish Tags for employment* counts the additional hawkish/dovish word combination per speech for the goal employment/unemployment.

	N	Mean	Std. Dev.	Min	Median	Max
5-grams per speech	4,298	3,411	2,228	11	3,063	28,470
Net Index excl. empl.	4,298	0.11	0.55	-1	0	1
Net Index incl. empl.	4,298	0.11	0.55	-1	0	1
Hawkish Tags excl. empl.	4,298	1.51	3.07	0	0	68
Hawkish Tags for empl.	4,298	0.28	0.83	0	0	14
Dovish Tags excl. empl.	4,298	0.98	2.10	0 0	33	
Dovish Tags for empl.	4,298	0.20	0.70	0	0	12

notations. For example, the sequence "... low growth and unemployment ..." generates a five-gram centered around the *goal* 'growth' combined with the *attitude* 'low;' but the same five-gram also features another *goal*, unemployment. Since these two goals generate a dovish combination ("low growth") as well a hawkish one ("low unemployment"), we drop the five-gram from our analysis.

As in Apel and Grimaldi (2014), we then collapse the number of hawkish and dovish combinations in each speech into a single index:

$$Net\ Index = \frac{Hawkish}{Hawkish + Dovish} - \frac{Dovish}{Hawkish + Dovish}. \tag{10}$$

The index is bounded between -1 and $+1$. A value of -1 indicates that all of the tagged n-grams are dovish, and a value of $+1$ that all tagged n-grams are hawkish. Hence, larger values of *Net Index* indicate greater hawkishness. If no hawkish or dovish n-grams can be found in the text, *Net Index* is set to zero.

Table 5 provides some summary statistics of *Net Index* and its components. On average, a speech contains 3,411 five-grams, but there is large variation across speeches. A mean of 1.51 five-grams are tagged as hawkish, and 0.98 as dovish, when we use the original set of goals defined in Apel and Grimaldi (2014). By adding "employ-

ment/unemployment" to the goal list, we add an additional 0.28 additional hawkish and 0.20 dovish tags per speech. The average *Net Index* across speeches is about 0.11, irrespective of the specification of the goal list. The positive value indicates that the language used in our sample of speeches is slightly tilted towards a more hawkish wording, albeit with a large standard deviation of 0.55.

To develop our estimating equation, we assume that cross-sectional differences in *Net Index* between FOMC members map approximately linearly into differences in their desired interest rate according to equation (4). We obtain

$$Net\ Index_{j,t} = \alpha_t + \beta_1 \pi^e_{j,t+1|t} + \beta_2' x_{j,t} + \pi_t x_{j,t}' \beta_3 + (y_t - y^*) x_{j,t}' \beta_4, \tag{11}$$

where the coefficients are multiples (by the same factor) of the corresponding coefficients in equation (4). As before in the voting analysis, we relate the outcome during quarter t (speech tone in this case) to $\pi^e_{j,t+1|t}$, which is constructed based on the inflation history leading up to the end of quarter $t-1$. We also continue to focus on cross-sectional heterogeneity by employing time-fixed effects, α_t, to absorb common time-variation in the use of hawkish and dovish expressions.[11] The vector of member characteristics $x_{j,t}$ is the same as in the voting analysis (age, gender, party of president at appointment indicator, and same party as current president indicator) and it can influence the level of hawkishness as well as the extent to which inflation or output gap increase or decrease hawkishness.

In addition, we also account for the fact that measured speech tone is likely subject to additional sources of heterogeneity compared with the voting behavior on the FOMC. 'Speech style' and the choice of words can depend on other personal characteristics of the speaker, including education and prior professional experience. This heterogeneity adds noise and it could introduce correlated omitted variables. We use two approaches to account for these additional personal characteristics. First, we augment (11) with dummy variable controls for education and prior professional experience.[12] We generate indicator variables for having earned a PhD, a JD, an MBA, or a Master's degree as the highest degree earned. We also collect information on FOMC members' prior professional experience from the Fed's History Gateway and from the personal CVs of

[11] For example, in times of high unemployment, all FOMC members might be likely to employ the goal-attitude combination "high unemployment" in their five-grams.

[12] Details on the construction of both variables are at the end of Appendix D, and include summary statistics in Appendix-Table A.3.

Table 6: Experience-based Inflation Forecasts and FOMC Members' Tone of Speeches

Dependent variable is the *NetIndex* measure of speech hawkishness defined as in equation (11). The experience-based inflation forecast for each member at each meeting is calculated as in Table 2. All estimations include the same controls and interactions with recent CPI inflation and unemployment as in Table 2. In addition, we include controls for education and professional background as explained in the text, except for columns (3) and (6) where we instead employ member fixed effects. In columns (2) and (5), we drop speeches from chairmen. The regressions are estimated with OLS. Standard errors, shown in parentheses, are calculated allowing for two-way clustering by FOMC member and year-quarter.

	Net Index excluding (un)empl.			Net Index including (un)empl.		
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Experience-based fcst.	29.05	34.72	35.51	24.65	33.29	39.34
	(14.02)	(18.00)	(16.10)	(13.06)	(17.24)	(14.28)
Wallich dummy	0.10	0.17	-	0.11	0.16	-
	(0.08)	(0.09)	-	(0.07)	(0.07)	-
Member FE	No	No	Yes	No	No	Yes
Year-quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Chair's speeches dropped	No	Yes	No	No	Yes	No
Industry expr. controls	Yes	Yes	No	Yes	Yes	No
Degree controls	Yes	Yes	No	Yes	Yes	No
Adjusted R^2	0.047	0.052	0.058	0.040	0.044	0.048
Observations	4,298	3,300	4,298	4,298	3,300	4,298

FOMC members, and generate indicator variables for prior experience in the financial industry, in non-finance industries, in other government organizations and agencies (besides the Fed), and as an academic (i.e., having worked full-time in an academic department at some point prior to becoming an FOMC member). Second, we absorb any time-invariant personal characteristics with member fixed effects. In this case, the coefficient of interest, β_1, is identified from within-member variation of speech tone as their inflation experience changes. The inclusion of member fixed effects is, on the one hand, most comprehensive in accounting for unobserved person-specific determinants of language use. On the other hand, it removes a substantial amount of variation coming from the differences in average experience-based inflation forecasts between FOMC members.

Table 6 presents the results. In columns (i) to (iii), we use the original *NetIndex*

from Apel and Grimaldi (2014), and in columns (iv) to (vi), we expand the index and add (un-)employment to the list of goals.

Our baseline specification in column (i) shows that differences in inflation experiences have a significant effect on speech tone. The coefficient of 29.05 (s.e. 14.02) is significantly different from zero at the 5% level. An increase of 0.1% in the experience-based forecasts of an FOMC member—which is a typical within-meeting standard deviation—is associated with an increase of about 0.03 in the $NetIndex$. This magnitude seems plausible as the experience effects must be relatively subtle given the relatively small age heterogeneity of FOMC members. In this estimation, it amounts to about 1/16th of a standard deviation of $NetIndex$. Relatedly, we also note that there is a lot of measurement noise in $NetIndex$. This is apparent from the fact that the R^2 is only 4.7% even though we include time fixed effects, and one would expect substantial common time-variation in true hawkishness tone of speeches.

The point estimate for the Wallich dummy suggests that hyperinflation experience predicts a 0.10 higher $NetIndex$ than that of other Fed governors with similar characteristics at the time; but given the standard error (0.08) it is not possible to rule out a zero effect at conventional significance levels in first specification. Nevertheless, it is noteworthy that the ratio of the point estimates for the experience-based forecasts and the Wallich dummy (about 200-300 here depending on the specification) is of the same order of magnitude as in the voting analysis in Table 2 (about 100-150).

In column (ii) we test the extent to which our estimation results are affected by the large number of speeches given by the chairperson. Speeches of the chair might systematically differ from the speeches of other FOMC member for at least two reasons. First, chairs might use a more balanced language for political reasons, especially given that they tend to attract more attention. Second, chairs might use the speeches to provide signals to financial markets, whereas the other FOMC member might primarily use the speeches to communicate their views between each other. When we drop the chair's speeches, we obtain a slightly larger coefficient of 34.72 (s.e. 18.00) which is just about significant at the 5% level. In column (iii), we include member fixed effects and consequently, the coefficient rises a little further and the standard error drops.

In columns (iv) through (vi), we reestimate the specifications from columns (i) through (iii) for the version of *Net Index* that includes (un-)employment as a goal. The results are very similar.

We conclude that the personal lifetime inflation experiences of FOMC members

leave a significant imprint not only on their dissenting votes and the strong policy leanings expressed within those, but also on the more subtle expressions of attitudes towards monetary policy voiced in speeches.

IV Inflation Experiences and the Federal Funds Rate Target

Our analyses of cross-sectional differences in voting decisions and in the tone of speeches reveal that FOMC members rely, to a significant extent, on their own inflation experiences. We now test whether this partial reliance on personal experiences affects even the committee's ultimate decision about the Federal Funds target rate. That is, we check whether there is an incremental effect of FOMC members' experience-based inflation forecast on the consensus decision if we introduce such a channel alongside conventional interest-rate determinants in a Taylor rule.

In the preceding analyses, we were able to identify the effects of inflation experiences from cross-sectional cohort-specific differences in voting and tone in speeches, as well as from changes in those differences over time. Time dummies allowed us to absorb any potentially confounding time-series factors, including conventional determinants of monetary policy. Here, we aim to explain the time series of federal funds rates rather than cross-sectional differences in behavior. As a consequence, we need to take a stand on a specific model of the time-series determinants of monetary policy decisions. We will focus on standard versions of the Taylor rule that have proven successful in the recent empirical literature to address the specification issues as well as possible. Nevertheless, uncertainty about the correct specification of the policy rule as well as the limited data availability in the time-series dimension make identification and estimation much more challenging than in our earlier cross-sectional analyses. However, rather than a stand-alone definitive test of the experience effects hypothesis, these time-series tests should be viewed in conjunction with our earlier evidence from voting decisions and tone in speeches. Our goal in this section is simply to check whether the federal funds rate moves over time in a way that is consistent with this earlier evidence.

We start from the linear approximation of the subjective Taylor rule in (4) that represents the desired federal funds rates of the FOMC members present at the meeting. In our baseline specification, we assume that the federal funds rate target decided at an

FOMC meeting represents the average of the members' desired rate levels. (Alternatively, we use the median or the chairperson's desired rates instead; see the robustness checks in Appendix E.) Averaging equation (4) across all FOMC members present at a meeting at time t, we obtain (see Appendix A)

$$i_t^* = \beta_0 + \bar{z}_t + \beta_e \bar{\pi}^e_{t+1|t} + \beta_\pi \pi_t + \beta_y (y_t - y^*), \tag{12}$$

where $\bar{\pi}^e_{t+1|t}$ is the average of the FOMC members experience-based inflation forecasts as of the meeting at time t, and $\bar{z}_t$ is the time-t average of

$$z_{j,t} = \kappa' x_{j,t} + \pi_t x'_{j,t} \lambda_1 + (y_t - y^*) x'_{j,t} \gamma_1. \tag{13}$$

With $\bar{z}_t = 0$ and $\beta_e = 0$ (if $\omega = 0$) this reduces to the standard Taylor rule. Our earlier analyses of voting and speech tone suggest $\omega > 0$ and hence $\beta_e > 0$, i.e., that FOMC members rely to some extent on their experience-based inflation forecast, over and above the standard inflation- and output-gap components of the Taylor rule.

Turning to the empirical implementation, we aim to minimize the chance that $\bar{\pi}^e_{t+1|t}$ picks up the effects of measurement error in the objective macroeconomic information used by the FOMC. In order to do so, we need to use empirical measurements of π_t and $(y_t - y^*)$ that are as close as possible to the information used by the FOMC. We take three steps. First, as shown by Orphanides (2001, 2003), forecast-based variants of the Taylor rule provide a better empirical fit to the actual decisions about the federal funds rate target than a rule based on realized macroeconomic data. We follow Orphanides (2003) and replace, for every meeting in quarter t, π_t and $(y_t - y^*)$ with the Federal Reserve staff's Greenbook forecasts of inflation from quarter $t-1$ to $t+3$ and forecasts of the output gap in quarter $t+3$.[13] Second, it is important to use the inflation index that the FOMC relies on primarily. We follow Mehra and Sawhney (2010) and Bernanke (2010) and use Greenbook forecasts of the core CPI inflation before the year 2000 and Greenbook forecasts of core PCE inflation thereafter. We refer to the time series that we obtain from joining the core CPI and core PCE series as the staff's core inflation forecast. Third, we follow Coibion and Gorodnichenko (2012) and use one

[13] For the earlier part of the sample, the output gap forecasts were not explicitly included in the Greenbooks, but they were used by the staff of the Board of Governors of the Federal Reserve System in constructing its Greenbook forecast of wages and inflation. See the Philadelphia Federal Reserve (http://www.philadelphiafed.org/research-and-data/real-time-center/greenbook-data/ gap-and-financial-data-set.cfm) for more details.

FOMC meeting per quarter (the one that is closest to the middle of the quarter). This ensures that the CPI information leading up to the end of the previous quarter that is embedded in $\bar{\pi}^e_{t+1|t}$ is available to the FOMC. Moreover, in this way we get data points that are almost equally spaced in time, which is useful when we include lagged interest rates.

We start the sample in 1987Q3 when the Federal Reserve's staff forecast of the output gap become available. As shown in Orphanides (2001), in the periods thereafter, the Taylor rule, and its forecast-based variant in particular, provides a good description of actual Federal Reserve policy. We end the sample in 2007Q2, just before the start of the financial crisis. Mishkin (2010) argues that starting in the summer of 2007, the FOMC reacted to information from financial markets that did not yet show up in inflation and output gap forecasts. As a consequence, the Taylor rule does not provide a good description of the FOMC's policy during this period.[14]

Column (i) of Table 7 provides a benchmark for the analysis of experience effects. We replicate the standard Taylor rule findings (without $\bar{z}_t$ and $\bar{\pi}^e_{t+1|t}$). The estimated coefficients on the output gap (0.67) and on the inflation variable (1.51) are consistent with typical findings in the literature. In column (ii), we include the average experience-based forecast, $\bar{\pi}^e_{t+1|t}$. We estimate a coefficient of 0.38 (s.e. 0.21) that is significantly different from zero at a 10% level. Hence, FOMC members' average experience-based inflation forecast has explanatory power for the federal funds rate target over and above the staff forecast of inflation and the output gap. Considering the coefficients on the two inflation variables together, the weight on the experience-based forecast in our experience-augmented Taylor rule (12) is about $0.38/(1.27 + 0.38) \approx 0.23$.

Column (iii) turns to the full specification (12) by including $\bar{z}_t$, which captures the effect of the changing characteristics of the FOMC members on interest-rate decisions. We construct $\bar{z}_t$ from the estimates in our voting analysis. The fitted values of the latent desired interest rate of our ordered probit model (9) allow us to construct z_t in (13) up to scaling by a constant. More precisely, we use the ordered probit specification with fixed thresholds, shown in the robustness tables in the Appendix in Table A.1. (With characteristics-dependent thresholds, we would not be able to separate the effect of characteristics on the thresholds from the effect on the latent desired interest rate.)

[14] Baxa, Horváth, and Vašíček (2013) provide empirical evidence consistent with this description of FOMC policy. They show that adding financial market variables to the Taylor rule equation matters a lot in 2008-09, over and above inflation and output gap information.

Table 7: Influence of FOMC Members' Inflation Experiences on the Target Federal Funds Rate

The sample period is from the 8/18/1987 to 6/28/2007. The dependent variable is the target federal funds rate set at the FOMC meeting closest to the middle of the quarter t. The experience-based forecast is the average of FOMC members' experienced-based 4-quarter forecast of inflation based on CPI data leading up to the end of quarter $t-1$, calculated as in Table 2. The staff's core inflation forecast is from end of quarter $t-1$ to end of quarter $t+3$ based on the core CPI before 2/1/2000 and the core PCE thereafter. The staff's output gap forecast at quarter t is the forecast for quarter $t+3$. The staff's forecasts of CPI/PCE and of the output gap are from the Philadelphia Fed Greenbook data set. Lagged fed funds rate target is the federal fund funds rate target from the previous quarter's meeting. Columns (i) to (iii) report the OLS estimates based on (12). Columns (iv) and (v) report the estimates of β_e, β_π, β_y, ρ, and c from non-linear least-squares regressions as specified in (15). Columns (iii) and (v) include a proxy for $\bar{z}_t$, the linear combination of five FOMC member characteristics and their interaction with inflation and unemployment estimated from voting data as reported in the Appendix in Table A.1. In parentheses, we report Newey-West standard errors with six lags from column (i) to (iii), and zero lags in column (iv) and (v).

	(i)	(ii)	(iii)	(iv)	(v)
Experience-based inflation forecast	-	0.38	0.61	0.46	0.44
	-	(0.21)	(0.24)	(0.21)	(0.21)
Staff's core inflation forecast	1.51	1.27	1.44	1.27	1.25
	(0.13)	(0.23)	(0.23)	(0.17)	(0.20)
Staff's output gap forecast	0.67	0.69	0.46	0.98	1.00
	(0.06)	(0.06)	(0.10)	(0.08)	(0.15)
Lagged federal funds rate target	-	-	-	0.68	0.69
	-	-	-	(0.04)	(0.04)
Intercept	0.80	0.11	2.17	-0.03	-0.08
	(0.44)	(0.36)	(0.86)	(0.16)	(0.42)
Member characteristics	N	N	Y	N	Y
Method	OLS	OLS	OLS	NLS	NLS
Observations	80	80	80	80	80
Adjusted R^2	0.858	0.865	0.877	0.976	0.976

Averaging across FOMC members each period yields $\bar{z}_t$. Adding $\bar{z}_t$ to the Taylor rule as an explanatory variable in column (iii) of Table 7, we find that the coefficient on the experience-based inflation forecast increases to 0.61 (s.e. 0.24) which is now statistically highly significant.

In columns (iv) to (v), we check whether the experience variable might be picking up the effect of a lagged federal funds rate in these regressions. Existing evidence from the literature on monetary policy rules, e.g., Clarida, Galí, and Gertler (2000) and more recently Coibion and Gorodnichenko (2012), indicates that the Federal Reserve's policy is best characterized by partial adjustment, where the actual fed funds rate target i_t is a weighted average of the desired fed funds rate i_t^* from equation (12) and the lagged actual federal funds rate target i_{t-1},

$$i_t = (1-\rho)i_t^* + \rho i_{t-1}. \tag{14}$$

To check whether accounting for partial adjustment of this form could change the conclusions regarding the experience effects, we combine the partial adjustment rule with (12):

$$i_t = c + (1-\rho)\left[\bar{z}_t + \beta_e \bar{\pi}^e_{t+1|t} + \beta_\pi \pi_t + \beta_y (y_t - y^*)\right] + \rho i_{t-1}. \tag{15}$$

Since the parameter of interest, β_e, is now interacted with $1-\rho$, we estimate (15) with non-linear least squares. We report the estimates of β_e, β_π, β_y, ρ, and c in columns (iv) and (v) for the specification without and with the $\bar{z}_t$ variable, respectively.

Column (iv) presents the version without the $\bar{z}_t$ variable. Consistent with the existing literature on federal funds rate inertia, the lagged target rate has strong predictive power and absorbs a large portion of the residual. The coefficients on the inflation variables are not affected much, though. The estimate of β_e of 0.46 (s.e. 0.21) is now a bit higher than in column (ii), and significantly different from zero at the 5% level. The implied weight on experienced inflation relative to the staff forecast is now $0.46/(1.27+0.46) \approx 0.27$. Turning to the estimation with the $\bar{z}_t$ variable included in column (v), we find that adding $\bar{z}_t$ has very little effect on the estimates when the lagged federal funds rate target present in the regression

Overall, the evidence from the time-series of the target federal funds rate is consistent with the inflation experience effects that we identified in FOMC members'

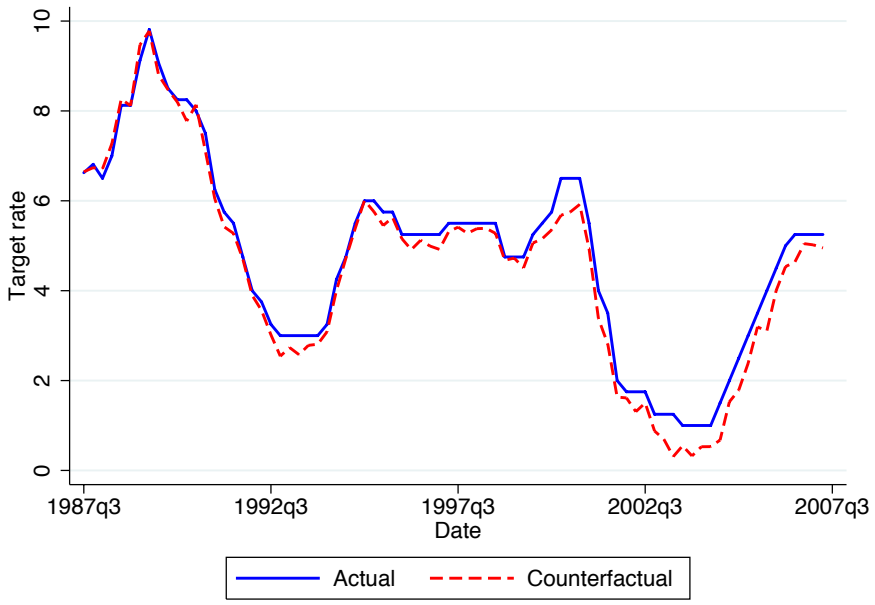


Figure 4: Counterfactual federal funds rate target with experience effects removed

heterogeneous voting decisions and wording of speeches. In Figure 4 we illustrate the magnitude of the effect by constructing a counterfactual federal funds rate target path that removes the estimated experience effects from the actual path. To construct the counterfactual path, we take the actual federal funds rate target and subtract the estimated β_e from column (ii) times the difference between FOMC members' average experience-based forecast and the Greenbook forecast of inflation. This counterfactual path represents the target that the FOMC would have chosen if its members had relied only on the staff forecast, not on their own inflation experiences—at least if we abstract from follow-on equilibrium effects.[15]

As the figure shows, the incremental effects of inflation experiences are substantial at times, but not unreasonably large. In the late 1980s and early 1990s, the effects were small. At the time, the average experience-based forecast remained very close to the staff's core inflation forecast. In contrast, in the 2000s the counterfactual federal funds rate target is often between 50 to 100 basis points lower than the actual federal

[15] If the FOMC had chosen a different target rate path, macroeconomic performance would presumably have been different. As a consequence, the inputs to the Taylor rule would have been different, which would in turn have affected the federal funds rate target. Our simple counterfactual analysis does not consider these equilibrium effects, but it is nevertheless useful to get a sense of the magnitude of the experience effects relative to the other drivers of the federal funds rate target.

funds rate.

V Inflation Experiences and Inflation Forecasts

Our results so far indicate a strong effect of prior inflation experiences on FOMC members' voting behavior and tone, and on the committee's target rate decision. We have built these analyses on the learning-from-experience framework of Malmendier and Nagel (2016). Their framework is one of adaptive belief formation, and Malmendier and Nagel (2016) show that it helps explain household beliefs about future inflation. Thus, a natural interpretation of the findings in this paper is that the experience effects of FOMC members also arise through a beliefs channel. A complementary, or alternative, interpretation is that experience effects arise through a preference channel, i.e., that inflation experiences affect FOMC members' aversion to inflation. While it would be somewhat surprising that the belief-updating scheme in (7), which we use to construct FOMC members' experience-based inflation forecasts, could capture such preference-channel effects, we cannot rule out that learning correlate with changes in inflation aversion.

To shed further light on this issue, we present direct evidence on the relationship between experienced inflation and FOMC members' inflation forecasts. We show that these forecasts, too, are related to differences in FOMC members inflation experiences.

We obtain individual inflation forecasts of FOMC members from the Semiannual Monetary Policy Report (MPR).[16] Twice a year, in February and July, the FOMC prepares a Monetary Policy Report, which is submitted to Congress and which contains the FOMC members' inflation forecasts. The forecasts in February concern the time period from Q4 of the previous year to end to Q4 of the current year. In July, two sets of forecasts are included in the report: one for Q4 of the previous year to Q4 of the current year, and another one for Q4 of the current year to Q4 in the next year. This data set is introduced and described in Romer (2010). We supplement the individual FOMC members' forecasts with forecasts in the "Greenbooks" that are prepared by Federal Reserve staff about a week prior to each FOMC meeting.[17] We use the Greenbooks for the February and July FOMC meeting and match them with

[16] https://www.philadelphiafed.org/research-and-data/real-time-center/monetary-policy-projections/

[17] http://www.federalreserve.gov/monetarypolicy/fomc_historical.htm

the member forecasts from the MPR.

Romer and Romer (2008) show that the central tendency of FOMC members' forecasts deviates from the staff forecast in the Greenbooks, and that this deviation from the staff forecasts reduces the forecast accuracy. Our objective here is to test whether the deviations from staff forecasts reflect the influence of their personal inflation experiences. For this purpose, we extract the individual inflation forecasts contained in the MPRs (rather than the central tendency that Romer and Romer (2008) analyze) to construct a panel data set. The individual FOMC members' forecasts become available only with a 10-year lag, and the earliest ones available are from 1992. Hence, our sample runs from 1992 to 2004, covering 26 FOMC meetings.

We allow FOMC member j's stated forecast at time t, $\tilde{\pi}_{j,t+1|t}$, to be a weighted average of j's experience-based forecast, $\pi^e_{j,t+1|t}$, and the staff forecast reported in the most recent Greenbook, $\tilde{\pi}_{t+1|t}$:

$$\tilde{\pi}_{j,t+1|t} = \phi \pi^e_{j,t+1|t} + (1-\phi)\tilde{\pi}_{t+1|t}. \tag{16}$$

Subtracting $\tilde{\pi}_{t+1|t}$ on both sides, our estimating equation becomes

$$\tilde{\pi}_{j,t+1|t} - \tilde{\pi}_{t+1|t} = a + \phi(\pi^e_{j,t+1|t} - \tilde{\pi}_{t+1|t}) + \varepsilon_t, \tag{17}$$

where we included a constant and a residual to account for other unobserved variables that could influence the FOMC members' forecasts.

One complication when estimating equation (17) is that the forecasted inflation variable switched in February 2000 from the consumer price index (CPI-U) to the price index for personal consumption expenditure (PCE). Our construction of $\pi^e_{j,t+1|t}$ is based on the history of the CPI, and from 2000 to the end of our sample in 2004, the average CPI inflation rate was about 0.40% higher than the PCE inflation rate. We take two approaches to address this discrepancy. First, we simply re-calculate $\tilde{\pi}_{j,t+1|t}$ post-1999 by adding the difference in CPI and PCE inflation rates over the 12 months prior to the meeting to the FOMC member forecast. Second, we estimate a version of equation (17) with time fixed effects. As long as views about the CPI-PCE discrepancy are similar among FOMC members, the effect of the discrepancy will be absorbed by the time fixed effects. In this case, the coefficient ϕ is identified purely from (time-varying) cross-sectional differences between FOMC members in their forecasts and their

Table 8: Influence of FOMC Members' Inflation Experiences on their Inflation Forecasts

The dependent variable is the difference between i) FOMC member's stated inflation projection from the MPR and ii) the most recent Fed Staff's inflation forecast from the Greenbook prior to the February or July FOMC meeting. In February, the horizon of the members' MPR forecasts is over the four quarters until the end of the current year. In July, two horizons are available: four quarters until the end of the current year and the four quarters during next year. The sample period runs from the first half of 1992 to the second half of 2004. The key explanatory variable is the difference between the i) experience-based forecast $\pi^e_{j,t+1|t}$ for each FOMC member at each meeting, calculated as in Table 2, and ii) the Fed staff's inflation forecast. In columns (i) and (iii), from February 2000 and on, we calculate $\pi^e_{j,t+1|t}$ by adding the difference between CPI and PCE inflation rate to each FOMC member forecast. In columns (ii) and (iv) we include the interaction of time fixed effects with forecast horizon fixed effects. In parentheses we report the standard error based on two-way clustering by both member and meeting.

	All FOMC Members		Regional Fed Presidents	
	(i)	(ii)	(iii)	(iv)
Expr.-based fcst. - staff fcst.	0.37	0.81	0.40	1.48
	(0.09)	(0.40)	(0.10)	(0.59)
Meeting × forecast horizon FE	No	Yes	No	Yes
Observations	383	383	190	190
Adjusted R^2	0.347	0.777	0.355	0.764

inflation experiences.

Another complication is that the forecast horizons in the July MPR do not match the usual four-quarter horizon, from end of quarter $t-1$ until end of quarter $t+3$, of the experience-based inflation forecast variable that we used in all of our tests above. We construct experience-based forecasts that match the horizons of the two MPR projections in July as follows: (i) For the current-year July forecast (i.e., the forecast from Q4 of the previous year to Q4 of the current year), we use the average of the two quarter-ahead experience-based forecast (from end of Q2 to end of Q4) and of the realized inflation over the past two quarters (from end of Q4 of last year to end of Q2). And (ii) for the next-year July forecast (i.e., the forecast from Q4 of the current year to Q4 of next year), we subtract the same two-quarter ahead experience-based forecast from the six-quarter ahead experience-based forecast (from end of Q2 this year to end of Q4 next year).

Table 8 reports the estimates of the weight ϕ in equation (17). We find that the experience-based inflation forecast plays a significant role in explaining the variation of members' reported inflation forecasts. The estimate of 0.37 (s.e. 0.09) in column (i) implies that FOMC members put about 37% weight on their experience-based forecast and 63% on the staff forecast. The estimation in column (iii) uses only the forecasts of regional Federal Reserve presidents and the results are very similar. To assess the magnitude of this effect, we can compare these estimate to the those from the federal funds target rate regressions in Table 7. There, we found that members put a weight of around 25% on their experience-based forecast. It is reassuring that the weights obtained from these two different approaches are of the same order of magnitude, and within a one to two standard error range from each other. Moreover, it also seems reasonable that the weight in the interest-rate decision is somewhat lower than in the members' stated inflation forecasts. Deviating from the forecast provided by the Federal Reserve staff in the target-rate decision may require more confidence than deviating in one's forecast that does not directly affect any decisions.

In columns (ii) and (iv), we include time of meeting $\times$ forecast horizon fixed effects in the estimation. The magnitude of the ϕ estimates more than doubles. However, the standard errors become fairly large, and we cannot reject that the estimates are unchanged compared to those in column (i) and (iii).

This last set of findings is consistent with the interpretation that heterogeneity in lifetime experiences of inflation results in heterogeneity in FOMC members' beliefs about future inflation. In this regard, FOMC members' expectation formation appears to be quite similar to that of the individual respondents in the *Michigan Survey of Consumers* studied by Malmendier and Nagel (2016). While the similarity is striking, one potential concern specific to the FOMC setting is that the forecasts stated in the MPR could be affected by strategic concerns, including the desire to appear consistent or to send a message. This concern is somewhat muted because *individual* forecasts are actually not revealed in the MPR and the focus of public attention is usually on the published summary measures, especially the central tendency of the distribution of member forecasts.[18] Moreover, as always with data on reported beliefs, it is important to keep in mind that it may not be possible to cleanly separate beliefs from preferences. However, a direct effect of inflation experienced on beliefs about future inflation provides the most straightforward explanation of the collection of findings—on voting

[18] The individual forecasts are made public only with a 10-year lag.

speech tone, interest-rate target, and stated inflation forecasts—in this paper.

VI Conclusion

We present novel evidence showing that personal lifetime experiences significantly affect the voting behavior, tone of speeches, federal funds rate decisions, and inflation forecasts of FOMC members. Our findings suggests that heterogeneous inflation experiences do generate heterogeneity in the desired policies and the macroeconomic outlook of FOMC members.

Our findings add to a growing literature on the role of experience-based heterogeneity in economic decisions and macroeconomic expectations. While existing studies focus on decisions and expectations of individual consumers and investors, this study is the first one to provide evidence of similar experience effects for policy makers. Given that FOMC members are highly educated decision-makers with extensive expertise and support from professional staff, it is not clear, a priori, and may in fact be particularly surprising, that experience effects of this kind also play a role in their decisions.

The evidence in this paper also helps shed light on the behavioral origins of 'experience effects'. The overweighting of personal experiences by individual consumers documented in the earlier literature could perhaps be explained by informational frictions that restrict the availability of data they did not experience themselves. For sophisticated policy makers like the FOMC members in this study, such an explanation seems less plausible. Presumably, FOMC members are extensively exposed to historical macroeconomic data. Thus, there seems to be a deeper behavioral reason for why personal experiences get a relatively high weight in belief formation, even if historical information is easily accessible.

On the policy side, our results add a twist to the practical notion that the choice of a policy maker can have a long-lasting impact on policy outcomes: To predict a policy makers leanings, it is helpful to look at the person's prior lifetime experiences. For a given outcome variable of interest, here inflation, we can calculate their weighted average experience with (roughly) linearly declining weights, and obtain a directional and quantitative prediction about their future decision-making. It will be interesting to explore in future research to what extent such a model of experience-based learning is helpful in predicting policy maker behavior in other policy areas.

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Appendix for Online Publication

A First-order Taylor approximation of the Subjective Taylor Rule

We start from the subjective Taylor rule in equation (2), and substitute the linear specifications in (3) to obtain.

$$\begin{aligned} i_{j,t} = r &+ (x_{j,t} - \mu_x)'\alpha_3 + \pi^* + (x_{j,t} - \mu_x)'\alpha_1 \\ &+ \big(\lambda_0 + (x_{j,t} - \mu_x)'\lambda_1\big)\big[\omega\pi^e_{j,t+t|t} + (1-\omega)\pi_t - \pi^* - (x_{j,t} - \mu_x)'\alpha_1\big] \\ &+ \big(\gamma_0 + (x_{j,t} - \mu_x)'\gamma_1\big)\big[y_t - y^* - (x_{j,t} - \mu_x)'\alpha_2\big]. \end{aligned} \tag{A.1}$$

We then perform a first-order Taylor approximation of $i_{j,t}$ as a function of $(\pi^e_{j,t+1|t}, x'_{j,t})$ around (π_t, μ'_x), which yields

$$\begin{aligned} i_{j,t} \approx r &+ \pi^* + \lambda_0(\pi_t - \pi^*) + \gamma_0(y_t - y^*) + (\pi^e_{j,t+1|t} - \pi_t)\omega\lambda_0 \\ &+ (x_{j,t} - \mu_x)'\left[\alpha_3 + \alpha_1 - \lambda_0\alpha_1 - \gamma_0\alpha_2 + \lambda_1(\pi_t - \pi^*) + \gamma_1(y_t - y^*)\right] \end{aligned} \tag{A.2}$$

We can rewrite this expression as

$$\begin{aligned} i_{j,t} \approx a_0 &+ \left[\lambda_0(1-\omega) - \mu'_x\lambda_1\right]\pi_t + (\gamma_0 - \mu'_x\gamma_1)(y_t - y^*) \\ &+ \lambda_0\omega\pi^e_{j,t+1|t} + \kappa' x_{j,t} + \pi_t x'_{j,t}\lambda_1 + (y_t - y^*)x'_{j,t}\gamma_1, \end{aligned} \tag{A.3}$$

where

$$\begin{aligned} a_0 &= r + \pi^*(1 - \lambda_0) - \mu_x(\alpha_3 + \alpha_1 - \lambda_0\alpha_1 - \gamma_0\alpha_2 - \lambda_1\pi^*), \\ \kappa &= \alpha_3 + \alpha_1 - \lambda_0\alpha_1 - \gamma_0\alpha_2 - \pi^*\lambda_1. \end{aligned}$$

Collecting the first three terms on the right-hand side of (A.3) into a_t yield equation (4) in the main text. Defining

$$\beta_0 = a_0, \qquad \beta_e = \lambda_0\omega, \qquad \beta_\pi = \lambda_0(1-\omega) - \mu'_x\lambda_1, \qquad \beta_y = \gamma_0 - \mu'_x\gamma_1, \tag{A.4}$$

and averaging across FOMC members at meeting time t yields equation (12) in the text.

B Vote Sample Construction

Our sample of FOMC votes starts in 1951, after the official statement about the agreement between Treasury and Federal Reserve was issued on March 4, 1951. During our sample period from March 1951 to January 2014, eight Fed Chairmen lead the FOMC: McCabe (4/1948 to 4/1951), Martin (4/1951 to 1/1970), Burns (2/1970 to 3/1978), Miller (3/1978 to 8/1979), Volcker (8/1979 to 8/1987), Greenspan (8/1987 to 1/2006), and Bernanke (2/2006 to 1/2014).

The data set is constructed from two main sources. First, for meetings before January 1966 and after January 1997, we collect information on the votes from the FOMC meeting statements, available at `http://www.federalreserve.gov/monetarypolicy/fomccalendars.htm`. Second, for meetings between January 1966 and December 1996, we use the data from Chappell, McGregor, and Vermilyea (2005), available at `http://professorchappell.com/Data/Book/index.htm`. In this latter data, we correct one coding error: In the meeting on 11/5/1985, governor Seger cast a dovish dissent (-1); the original data set had her vote coded as consent (0).

We also note several discrepancies between our sample and the data employed by Thornton and Wheelock (2014) in their analysis of votes in the Federal Reserve Bank of St. Louis Review.

- For the meeting on 10/3/1961, the Fed Review data records one dissent. We find no dissent in that meeting according to the meeting minutes.

- For the meeting on 2/9/1983, the Fed Review data records one dissent. We find four dissents reported in the minutes.

- Other discrepancies reflect dissents that occurred in conference calls (no separate Record of Policy Actions was released), which are not included in our sample. Our sample does include nine conference calls (94 total votes and 2 dissents), after which a separate Record of Policy Actions/Statement was available. We exclude those from the baseline sample. Including them does not alter the results.

We further exclude five votes by the two members who voted less than five times during their tenure with the FOMC, Paul Miller and Jamie Stewart. Mr. Miller only had one vote because he died in office (on Oct. 21 1954) less than three month after he was appointed to the Board of Governors (on Aug. 13 1954). Mr. Stewart cast four votes as the acting governor, when he was the first vice president of New York Fed, from June through December 2003, during which the position of New York Fed president was vacant after the resignation of McDonough resigned in 2003 and his successor Geithner took place in Nov. 2003.

After the above corrections (and excluding the 94 votes from the conference calls in our sample), our sample contains 160 dovish dissents, 265 hawkish dissents, and 8 un-codeable dissents between 3/8/1951 to 1/29/2014.[19] The eight un-codeable dissents are as follows:

- In the 12/19/1961 meeting, Robertson dissented with the reason explained as follows: *"While Mr. Robertson's analysis of the economic situation and the proper direction of policy was the same in its essentials as that of the majority, he voted against adoption of this directive on the grounds that it was undesirable to tie monetary policy to the bill rate."* See `www.federalreserve.gov/monetarypolicy/files/fomcropa19611219.pdf`.

- In the 7/30/1963 meeting, Bopp dissented with the reason explained as follows: *"Mr. Bopp stated that he had voted favorably on the policy directive at the July 9 meeting because it seemed to him that the use of the different instruments of monetary policy should be consistent and an increase in the discount rate was then imminent. Under such circumstances, it had seemed undesirable to reverse what had taken place in terms of yields only to reverse again. His vote, therefore, was essentially a vote on tactics. As to the future, it was still an open question whether short-term rates could be maintained at the new levels, and reserve availability at the old. Under these conditions, he agreed with the view that it would be desirable to maintain essentially an even keel for the time being, and to supply reserves through purchases of coupon issues, selling bills if necessary. In his opinion, emphasis should be placed on the availability of reserves."* See `www.federalreserve.gov/monetarypolicy/files/fomchistmin19630730.pdf`.

[19] There are 13 additional dissents that occurred between 1936 and 1950, and two dissenting votes were cast during the nine conference calls in our sample. Neither are not included in our data.

- In the 12/12/1967 meeting, Maisel dissented with the reason explained as follows: *"Mr. Maisel dissented from this action in part because he thought the directive was susceptible to an interpretation under which growth in member bank reserves and bank deposits would be slowed too abruptly, and perhaps succeeded by contraction. He favored seeking growth rates in reserves, deposits, and bank credit considerably below the average rates thus far in 1967, but still high enough to facilitate expansion in GNP at a somewhat faster rate than had prevailed on average in the first three quarters of the year. He noted that whether or not interest rates would rise further under the course he advocated would depend upon the strength of market demands for funds in relation to the supplies that would be available under such a Committee policy. Mr. Maisel also thought that the statement of the Committee's general policy stance contained in today's directive had far too narrow a focus; in particular, he objected to the omission of reference to the basic policy goal of facilitating sustainable economic expansion. This omission resulted from the substitution of language stating that it was the Committee's policy "to foster financial conditions conducive to resistance of inflationary pressures and progress toward reasonable equilibrium in the country's balance of payments" for the language of other recent directives stating that it was the Committee's policy "to foster financial conditions, including bank credit growth, conducive to sustainable economic expansion, recognizing the need for reasonable price stability for both domestic and balance of payments purposes."* See `www.federalreserve.gov/monetarypolicy/files/fomcropa19671212.pdf`.

- In the 1/11/1972 meeting, Brimmer dissented with the reason explained as follows: *"Mr. Brimmer shared the majority's views concerning broad objectives of policy at this time, and he indicated that he would have voted favorably on the directive were it not for the decision to give special emphasis to total reserves as an operating target during coming weeks. In his judgment the Committee should have had more discussion of the implications of that decision, and in any case it should have postponed the decision until after it had held a contemplated meeting to be devoted primarily to discussion of its general procedures with respect to operating targets."* See `www.federalreserve.gov/monetarypolicy/files/fomcropa19720111.pdf`.

- In the 7/17/1973 meeting, Francis dissented with the reason explained as fol-

lows: *"Mr. Francis dissented from this action not because he disagreed with the objectives of the policy adopted by the Committee but because he believed that—as had proved to be the case following other recent meetings—the objectives would not be achieved because of the constraint on money market conditions."* See `www.federalreserve.gov/monetarypolicy/files/fomcropa19730717.pdf`.

- In the 7/20/1976 meeting, Volcker dissented with the reason explained as follows: *"Mr. Volcker dissented from this action because in the present circumstances he would not wish to raise or lower the Federal funds rate by as much as 1/2 of a percentage point—a change that might be interpreted as a strong signal of a change in policy and that could have repercussions in financial markets—in response merely to short-term fluctuations in the monetary aggregates that might well prove transient."* See `www.federalreserve.gov/monetarypolicy/files/fomcropa19760720.pdf`.

- In the 12/22/1981 meeting, Soloman dissented with the reason explained as follows: *"Mr. Solomon dissented from this action because he felt it was particularly important at the beginning of an annual target period that the Committee not formulate its directive in terms that conveyed an unrealistic sense of precision. In his view, the directive language referring to the November-to-March growth rates in M1 and M2 did seem to convey such a sense."* See `www.federalreserve.gov/monetarypolicy/files/fomcropa19811222.pdf`.

- In the 2/9/1983 meeting, Horn dissented with the reason explained as follows: *"Mr. Black and Mrs. Horn dissented from this action because they preferred to give more weight to M1 as a policy objective. While recognizing the difficulties in interpreting M1 currently, they believed that over time M1 was more reliably related to the Committee's ultimate economic objectives than were the broader aggregates and that it constituted a better basis for setting appropriate paths for reserve growth. They also favored reemphasizing M1 because they viewed it as a more controllable aggregate. In addition, Mr. Black indicated that he saw a need for lower target ranges, but he wanted to reduce monetary expansion gradually to avert dislocative effects."* See `www.federalreserve.gov/monetarypolicy/files/fomcropa19830209.pdf`. And, we record Black's vote as hawkish (+1) in this meeting.

As we note in the main text, four members of the FOMC where both regional Fed presidents and governors at some point during their career, and we account for their varying roles in our empirical analysis. These four members are: Phillip Coldwell (Dallas Fed President from 2/68 to 10/74 and governor from 10/74 to 2/80), Oliver Powell (governor from 9/50 to 6/52 and Minneapolis Fed President from 7/52 to 3/57), Paul Volcker (NY Fed president from 5/75 to 8/79 and Fed Chairman from 8/79 to 11/87), and Janet Yellen (governor from 8/94 to 2/97, SF Fed president from 6/04 to 10/10, and and then again governor since 10/2010, including her current role as Fed Chairwoman).

C Simple Ordered Probit Estimates

This section presents estimates from an ordered probit model as in (9), but with fixed dissent thresholds. Note that we will use the fitted values from this estimation to construct the $\bar{z}_t$ variable in (12), which is the basis for the results on the Fed Funds Rate target presented in Table 7.

Table A.1 presents the ordered probit estimates. In column (i) we employ time fixed effects, and in column (ii) we express explanatory variables values as deviations from their values for the chairperson. The results are similar to the corresponding ones in Table 2 in the main text.

This fixed-threshold specification also offers the opportunity to examine the coefficients of the control variables. In the characteristics-dependent specification they are difficult to interpret because their effect on the dissent threshold is intertwined with their effect on the conditional mean of the latent variable and hence the voting decision. Table A.2 presents the coefficient estimates, including those for the interactions. Directionally, the results are broadly sensible. For example, FOMC members put more weight on current inflation and less weight on unemployment if they are older, are regional Fed presidents, male, appointed when a Republication U.S. president was in office, and are not in the same party as the current president. However, many of these estimates are statistically not significantly different from zero. To interpret the direct effect of the characteristics, we need to add the interacted terms evaluated at particular values of CPI inflation (e.g., 2%) and unemployment (e.g., 6%). Doing so reveals that there is a fairly strong association of hawkishness with with regional president role and appointment while a Republican president was in office, while female gender

Table A.1: Experience-based Inflation Forecasts and FOMC voting behavior: Simple Ordered Probit without Characteristics-Dependent Thresholds

The sample period is from March 8, 1951 to January 29, 2014. The experience-based inflation forecast for each member at each meeting is calculated by recursively estimating a seasonal AR(1) model using the member's lifetime history of inflation with $\theta = 3.044$, as described in Section I.B. The *Wallich* dummy equals one if the member is Henry Wallich; 0 otherwise. The average partial effects (APE) reported at the bottom of the table are calculated by taking the partial derivative of the probability of a given voting category with respect to the experience-based inflation forecast at each sample observation and then averaging these partial derivatives across the whole sample. In parentheses, we report the standard error based on two-way clustering by both member and meeting.

	Ordered Probit	Ordered Probit "de-chaired"
	(i)	(ii)
Experienced-based forecast	192.2	89.7
	(60.0)	(36.1)
Wallich Dummy	1.6	1.2
	(0.4)	(0.2)
Meeting FE	Yes	No
Observations	6,707	6,707
Pseudo R^2	0.370	0.082
APE of experienced-based forecast:		
Dovish Dissent	-7.0	-4.7
Consent	-4.1	-2.3
Hawkish Dissent	11.1	7.1
APE of Wallich Dummy:		
Dovish Dissent	-0.06	-0.06
Consent	-0.03	-0.03
Hawkish Dissent	0.09	0.09

is associated with a more dovish voting behavior.

D Speech Sample Construction

The FRASER economic history database at the Federal Reserve Bank of St. Louis maintains a digital library of speeches of past and current FOMC members.

To construct our sample of speeches, we first download the HTML source code of the webpage listing the *Statements and Speeches of Federal Reserve Officials*. The source code contains a list of the FOMC members and their record IDs. (See the screenshot in Figure A.1a.) Each record ID uniquely identifies a webpage with the links to all speeches of the respective FOMC member.

We use the record IDs to download the HTML source code of those webpages (see Figure A.1b), and then extract the so-called issue IDs of the individual speeches. The issue IDs, in turn, link to the webpages containing the metadata of the speeches, including the links to the pdfs (see Figure A.1c). We collect all links to the pdfs of the speeches in a single text document and parse the document to the *wget* function, which downloads the pdf files.[20] Finally, we hand-collected speeches from the websites of the regional FRBs for the regional presidents.

To search the speeches for hawkish and dovish language, the downloaded pdfs are fed to *R* using the *readPDF* function of the text mining package *tm*. (Even though some of the speeches are photographs of the manuscript, the images are already translated into text and we do not have to run OCR for any of the cases.) We restructure the text into sequences of five adjacent words, and then select the relevant subset of goal-centered five-grams. For example, words from the sentence "Inflation continued to be well behaved, and in fact with talk of lower oil prices there was even a whiff of deflation." said by Thomas Meltzer in a 1985 address to the Harry J. Loman Foundation, initially show up in twenty nine different five-grams. Only two of these five grams are kept and searched for words from the *attitudes* list: "[*two words from the previous sentence*]. Inflation continued to" and "of lower oil prices there". After searching for these attitude words, the second five-gram is tagged as dovish, because it contains the word "lower" from the *attitudes* list, and the first is not tagged at all.

There is a cluster of short speeches with around 500 n-grams. Checking these

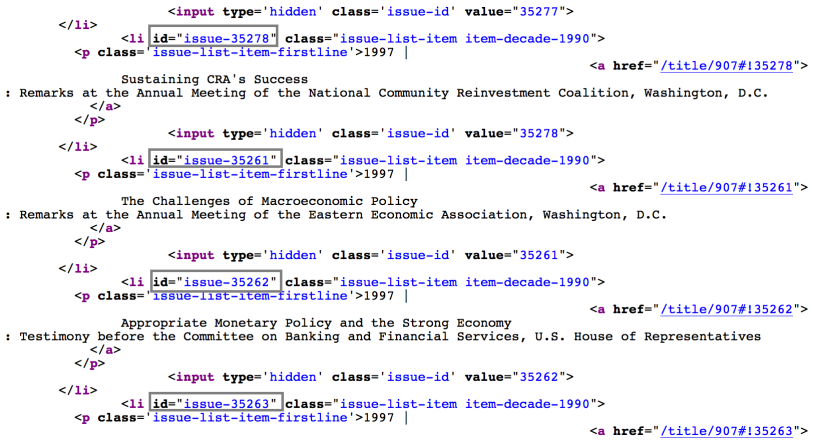
[20] We invoke the *wget* function from www.gnu.org/software/wget/Overview via OS X Terminal.

Table A.2: Expr.-based Infl. Fcst. and FOMC voting behavior: All coefficients

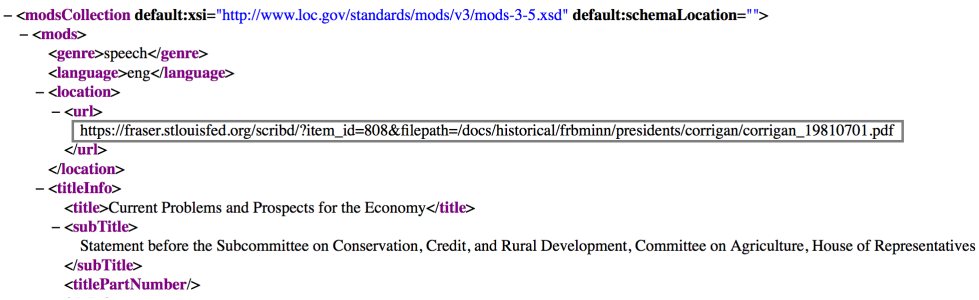
The sample period is from March 8, 1951 to January 29, 2014. The variables are defined as in the text. In parentheses we report the standard error based on two-way clustering by both member and meeting.

	Ordered Probit	Ordered Probit - "de-chaired"
Experienced-based forecast	192.24	89.66
	(60.04)	(36.12)
Wallich Dummy	1.57	1.16
	(0.37)	(0.18)
Age	-0.04	-0.03
	(0.03)	(0.01)
Fed Role	0.41	0.15
	(0.36)	(0.28)
Gender	0.01	0.09
	(0.87)	(0.58)
Party	1.09	0.47
	(0.46)	(0.29)
Same Party	-0.09	-0.42
	(0.43)	(0.25)
Fed Role $\times$ $\mathbb{1}_{\text{Post1993}}$	-0.11	-0.03
	(0.25)	(0.20)
CPI $\times$ Age	0.45	0.44
	(0.30)	(0.14)
CPI $\times$ Fed Role	4.23	5.42
	(3.88)	(1.96)
CPI $\times$ Gender	12.44	6.22
	(6.21)	(3.23)
CPI $\times$ Party	-5.83	-1.72
	(4.08)	(2.57)
CPI $\times$ Same Party	-0.88	-2.85
	(3.68)	(1.88)
Unemp. rate $\times$ Age	-0.67	-0.39
	(0.45)	(0.25)
Unemp. rate $\times$ Fed Role	-1.21	-2.25
	(5.90)	(4.89)
Unemp. rate $\times$ Gender	-9.87	-4.49
	(11.54)	(6.58)
Unemp. rate $\times$ Party	9.78	5.16
	(7.61)	(4.47)
Unemp. rate $\times$ Same Party	0.36	-7.43
	(7.60)	(4.31)
Meeting FE	Yes	No
Observations	6707	6707
Pseudo R^2	0.370	0.082

(a) Step 1: HTML source code of the FRASER webpage for the *Statements and Speeches of Federal Reserve Officials*. The record IDs, highlighted by the box, identify the webpages with all speeches of the respective FOMC member.



(b) Step 2: HTML code identified by the record ID obtained in the previous step. The issue IDs, highlighted by the boxes, identify the webpages with the metadata of the speeches of the respective FOMC member, including the links to the pdf files with the speeches.



(c) Step 3: Metadata of a speech, including a link to the pdf (highlighted by the box).

Figure A.1: FRASER Source Code to Obtain Speech PDFs

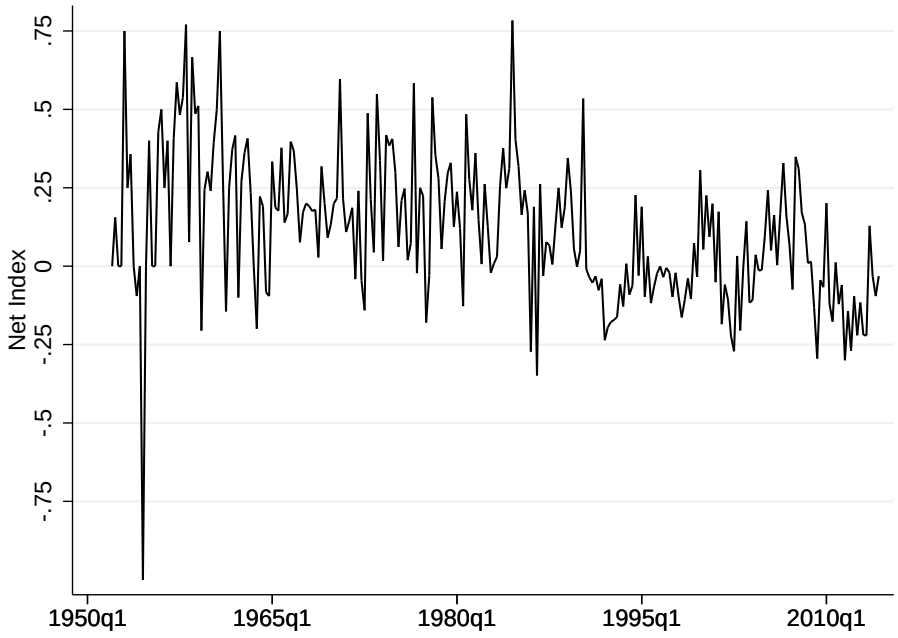


Figure A.2: Net Index Over Time. The graph depicts the average *Net Index* (using the expanded set of goals) of all speeches in year-quarter.

speeches by hand reveals that a large fraction are short opening remarks and introductions for other speeches, or short-hand notes for longer speeches instead of full transcripts. Controlling for these short speeches by including an indicator variable for less than 750 n-grams has virtually no effect on the results.

In the main text, we describe the construction of the *Net Index* of speech hawkishness. Figure A.2 plots the time-series of the index. The index decreases slightly over time, especially after 1980. But overall there is fairly strong time-variation without much persistence. This may reflect a considerable amount of measurement noise in *Net Index*. The more muted amplitude of the *Net Index* in later sample years probably reflects the substantially larger number of speeches available, rather than a general trend towards a more neutral language, implying that the mean of *Net Index* contains less measurement error in later years.

As also discussed in the main text, our analysis of FOMC members' choice of words and tone of speeches might warrant further controls for personal characteristics to reduce noise and concerns about correlated omitted variables. We construct control variables for education and prior professional experience. Information on education,

Table A.3: Summary Statistics on FOMC Members' Educational Background

The table below shows statistics on the educational background for the 144 FOMC members who voted at least 5 times during the meetings from 3/8/1951 to 1/29/2014. Panel A shows every school that awarded the highest degree of at least three members, along with the number of bachelor's and PhD degrees awarded by those schools. Panel B shows the frequency with which each degree type was the highest degree awarded to an FOMC member. All data is from the Federal Reserve History Gateway.

Panel A: Most Common Schools

School	Highest Degree	PhD	Bachelors
Harvard University	24	10	8
University of Pennsylvania	10	6	4
MIT	7	7	1
University of Michigan	6	4	1
University of Missouri	6	1	3
Indiana University	5	4	2
University of Chicago	4	4	1
John Hopkins University	4	2	0
Stanford University	4	1	3
UCLA	3	3	0
University of Wisconsin	3	3	0
University of California, Berkeley	3	2	3
Yale	3	1	5
University of Virginia	3	1	3
Columbia University	3	1	2
Iowa State University	3	1	1
NYU	3	1	1
Georgetown University	3	0	1

Panel B: Highest Degree

School	Number of FOMC Members	Percentage
PhD	65	45.1%
JD	22	15.3%
Master's	20	13.9%
Bachelor's	17	11.8%
MBA	15	10.4%
Other	5	3.5%

including degree type and degree granting institutions, is available from the member biographies provided by the Fed on the Federal Reserve History Gateway website.

Table A.3 shows the summary statistics on the educational background for the 144 FOMC members in our sample.: 45.1% of members have a PhD as their highest degree, while 15.3% have a law degree, and 10.4% have an MBA. 24 of the 144 members hold their highest degrees from Harvard, ten from the University of Pennsylvania, seven from MIT, and six each from the University of Michigan and the University of Missouri. Harvard has also granted the most PhDs to FOMC members (ten). MIT follows with seven, six members have PhDs from the University of Pennsylvania, and four have PhDs from the Universities of Chicago, Michigan, and Indiana each. 67.4% have their highest degree in economics, or majored in it if their highest degree is a bachelors.

Also from the Federal Reserve History Gateway website, we collect mentions of FOMC members' industry experience prior to their first FOMC meeting. Members are classified as having had, or not had work experience in the financial industry, an academic department, the military, a government agency other than the Federal Reserve or the military, and other industries, e.g. manufacturing. 76 of the 144 members with at least three votes are classified as having financial industry experience, 74 as having worked at another government agency, 62 in academia, 53 in another industry, and 37 as having military experience.

E Target Federal Funds Rate Regressions with Median and Chair's Experience Measures

The results on experience effects on the fed funds rate target in Table 7 use a measure of mean experiences across FOMC members. To address the concern that committee decisions do not necessarily reflect the average opinion of the committee's members, we show that our results are robust to using the median or the chairman's experience-based forecast, rather than the average. We also note that the concern is immaterial in our application as the difference between the average experience-based forecast at a meeting and the conventional, objective inflation-rate component of the Taylor rule tends to be substantially bigger than the differences between FOMC members. As a result, it does not matter much whether we use the average, the median, or even any specific FOMC member's experience-based forecast.

Table A.4: Influence of FOMC Members' Inflation Experiences on Target Federal Funds Rate: Median and Chair's Experienced Inflation

The sample period is from the 8/18/1987 to 6/28/2007. The dependent variable is the target federal funds rate set at the FOMC meeting closest to the middle of the quarter t. The experience-based forecast is the median (chair's) experienced-based CPI forecast from quarter $t-1$ to quarter $t+3$ at each meeting. The staff's core inflation forecast is from quarter $t-1$ to quarter $t+3$ and represents the core CPI before 2/1/2000 and the core PCE thereafter. The staff's output gap forecast at quarter t is the forecast for quarter $t+3$. The staff's forecasts of CPI/PCE and of the output gap are from the Philadelphia Fed Greenbook data set. Lagged fed funds rate target is the federal fund funds rate target from the previous quarter. Columns (i) to (iii) report the OLS coefficient estimates for the estimating equation in (12). Columns (iv) and (v) report the estimates of c, β_e, β_π, β_y, and ρ from non-linear least-squares regressions as specified in (15). In parentheses, we report Newey-West standard errors with six lags from column (i) to (iii), and zero lags in column (iv) and (v).

	(i)	(ii)	(iii)	(iv)	(v)	(vi)	(vii)	(viii)
Exper.-based infl. fcst. (median)	0.39	0.62	-	-	0.47	0.46	-	-
	(0.21)	(0.24)	-	-	(0.21)	(0.21)	-	-
Exper.-based infl. fcst. (chair)	-	-	0.40	0.63	-	-	0.47	0.45
	-	-	(0.22)	(0.24)	-	-	(0.21)	(0.21)
Staff's core inflation forecast	1.27	1.44	1.26	1.44	1.26	1.25	1.26	1.25
	(0.23)	(0.23)	(0.23)	(0.23)	(0.17)	(0.20)	(0.17)	(0.20)
Staff's output gap forecast	0.69	0.46	0.70	0.46	0.98	1.00	0.98	1.00
	(0.06)	(0.10)	(0.06)	(0.10)	(0.07)	(0.15)	(0.07)	(0.15)
Lagged federal funds rate target	-	-	-	-	0.68	0.69	0.68	0.69
	-	-	-	-	(0.04)	(0.04)	(0.04)	(0.04)
Intercept	0.10	2.16	0.10	2.19	-0.03	-0.08	-0.03	-0.08
	(0.35)	(0.86)	(0.36)	(0.86)	(0.16)	(0.42)	(0.16)	(0.42)
Member characteristics	N	Y	N	Y	N	Y	N	Y
Method	OLS	OLS	OLS	OLS	NLS	NLS	NLS	NLS
Observations	80	80	80	80	80	80	80	80
Adjusted R^2	0.866	0.877	0.866	0.878	0.976	0.976	0.976	0.976

In columns (i) and (ii) of Table A.4, we use the median, and in columns (iii) and (iv) the chairman's experience-based forecast. As the table show, these changes result in only minor changes in the coefficient estimate compared with Table 7. The same is true when we add the lagged federal funds rate in columns (v) to (viii). The reason is that the time-series variation in the members' experience-based forecasts relative to the staff forecast is much greater than the dispersion between members' experience-based forecasts. These results imply that it does not matter much which measure of central tendency of the experience-based forecasts, or which individual experience-based forecast is used.