The Making of Hawks and Doves: Inflation Experiences and Voting on the FOMC*

Ulrike Malmendier†
UC Berkeley, NBER and CEPR

Stefan Nagel‡
University of Michigan, NBER and CEPR

Zhen Yan§
University of Michigan

June 13, 2016

Abstract

Macroeconomic models of monetary policy assume that central bankers form rational beliefs based on all available data. We show that personal lifetime experiences significantly affect the forecasts and voting behavior of FOMC members. We link experience-based inflation expectations to the desired level of nominal interest rates using a forward-looking formulation of the Taylor rule. We test the predicted relationship on data of the FOMC voting history from March 1951 to January 2014. We find that a one standard-deviation increase in experience-based forecasts increases the unconditional probability of a hawkish dissent also by about one third, and decreases the unconditional probability of a dovish dissent by about one third. Our results are robust to accounting for the different voting patterns of regional presidents and governors by allowing the thresholds for dissent to vary between groups as well as by other characteristics. We also find a strong direct impact of experiences on forecasts. The difference between FOMC and staff members' inflation forecasts is strongly related to their difference in lifetime experiences of inflation. Our findings imply that personal experiences affect even experts' expectation formation.

*We thank Ricordo Reis, David Robinson, Christima Romer, David Romer, and workshop participants at the Bank of Finland, London School of Economics, Max Planck Institute for Research on Collective Goods, Stockholm School of Economics, University of Bonn, University of Michigan Economics Department and Law School for helpful comments. Jonas Sobott, Jeff Zeidel, and Albert Lee provided excellent research assistance.

†Department of Economics and Haas School of Business, University of California, 501 Evans Hall, Berkeley, CA 94720-3880, ulrike@econ.berkeley.edu

‡Stephen M. Ross School of Business and Department of Economics, University of Michigan, 701 Tappan St., Ann Arbor, MI 48109, e-mail: stenagel@umich.edu

§Stephen M. Ross School of Business, University of Michigan, 701 Tappan St., Ann Arbor, MI 48109, e-mail: zachyan@umich.edu

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

1 Introduction

Macroeconomic models of optimal monetary policy typically abstract from subjective beliefs and preferences of policy makers. In the model, monetary policy makers maximize social welfare, and the relative weights they give to inflation and output stabilization depend on private-sector agent preferences and on objective data. Frequently, policy-makers are assumed to pursue a specific target, e.g., an inflation target (Svensson (1997)), and their actions are determined by beliefs that use all available information. There is no role for subjective beliefs or preferences that would be distinct from those of private-sector agents (see, e.g., Rotemberg and Woodford 1999). Even in models that allow for policy makers having imperfect knowledge, as in Orphanides and Williams (2005), they learn from objective, historical data.[1]

Contrast this approach with the frequent discussions, especially at times when members join or leave central-bank committees such as the Federal Open Market Committee (FOMC) or ECB Governing Council, whether a central banker is a 'hawk' or as a 'dove' and what this means for future policy decisions. Like the quote above, these discussions frequently refer to members' background and personal experiences. As another example consider the commentary at the announcement of Charles Plosser and Richard Fisher stepping down as the Philadelphia and Dallas Federal Reserve Bank Presidents. Newspapers commented on the generational shift "from policy makers trained in the 1970s, who tend to fear inflation

[1] Some literature has explored variations in preferences, such as career-concerns, and in beliefs, such as learning frictions. For an overview see **?**.

above all else" to the 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 policymaking committee and who has become the most outspoken proponent of expanding the Fed's stimulus campaign."[2]

In this paper, we analyze the role of life-time experiences of inflation in affecting monetary policy and the subjective beliefs of policy makers. In particular, we ask whether heterogeneity in inflation experiences can explain the dovish or hawkish voting patterns of Federal Open Market Committee (FOMC) members. The FOMC meets at least four times (and typically eight times) per year in Washington. Member share their assessment of the economic situation and make proposals of appropriate targets and policy measures for the upcoming intermeeting time window as well as for the long-run. We focus on voting decisions on the FOMC as it allows us to study clearly defined policy decisions over a long sample spanning several decades all the way back to the 1950s with detailed information on the personal characteristics of the individuals involved in decision-making. We also relate their inflation experiences to their stated inflation beliefs as stated in their semiannual Monetary Policy Reports (MPR) to the U.S. Congress.

Our central hypothesis is that FOMC member voting decisions are influenced by the inflation experiences they accumulated during their lifetimes. We model the belief formation as an AR(1) adaptive learning rule as in Malmendier and Nagel (2015). Individuals use inflation data realized during their life times up to the FOMC meeting to estimate the long-run mean and the persistence of inflation.

We link experience-based inflation expectations to the desired level of nominal interest

[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.

rates using a forward-looking formulation of the Taylor rule. While the standard specification of the Taylor rule does not allow for heterogeneity between policy makers, we allow FOMC members to differ in their preferences for inflation vs. output stabilization through different weights on inflation and the output gap and to differ in their views about the inflation and output targets as well as the natural interest rate. Second, we introduce a subjective forward-looking element into the Taylor rule by assuming that FOMC members evaluate the deviation from the inflation target partly in terms of their own subjective inflation expectation.

We test the predicted relationship between experienced-based inflation and monetary policy on data of the FOMC voting history from March 1951 to January 2014. We estimate that a one standard-deviation increase in experience-based forecasts increases the unconditional probability of a hawkish dissent also by about one third, and decreases the unconditional probability of a dovish dissent by about one third. Our results are robust to accounting for the different voting patterns of regional presidents and governors by allowing the thresholds for dissent to vary between groups as well as by other characteristics. We also find a strong direct impact of experiences on forecasts, comparing the FOMC members' forecasts in the MPR to the staff forecasts reported in "Greenbooks" a week before each FOMC meeting. The difference between FOMC and staff members' inflation forecasts is strongly related to their difference in lifetime experiences of inflation. Our findings imply that personal experiences affect even experts' expectation formation.

Our paper builds on prior empirical evidence on policy-makers' characteristics that matter for voting. For example, Chappell Jr, Havrilesky, and McGregor (1993) show that the U.S. president exercises influence on FOMC decisions through appointment of Federal Reserve Board governors with particular policy preferences. Chappell, Havrilesky, and McGregor (1995) document differences between Regional Federal Reserve Presidents and Federal Reserve Board members. Chappell Jr and McGregor (2000) document the influence of a number of other personal characteristics including gender. Also related, Chappell Jr, McGregor, and Vermilyea (2004) show that the chairman's opinion receives a disproportionately high weight

in FOMC decisions. While this earlier research focuses on the influence of personal characteristics of policy makers on monetary policy decisions via preferences and incentives, we address the role of subjective beliefs and heterogeneous personal experiences.

Most closely related to our paper, Romer and Romer (2008) show that macroeconomic forecasts produced by FOMC systematically deviate from Federal Reserve staff forecasts and that they are inferior to Federal Reserve staff forecasts in terms of accuracy. Our question then is whether the inferior quality might be a consequence of FOMC members; (over-)reliance on personal experience.

On the theoretical side, our approach is builds on adaptive learning models such as Evans and Honkapohja (2001), Sargent (1999), and Orphanides and Williams (2005). We enrich these models by allowing personal experiences to matter, i.e., for cohort-specific adaptive learning.

2 Empirical Approach

We start by outlining the approach that we use to relate FOMC member inflation experiences to their voting decisions. We will then model the effect of inflation experiences on inflation forecasts, which in turn feed into the voting decision.

2.1 Policy Rule

To isolate the effects of experiences on voting decisions, we need a framework that allows us to also incorporate FOMC member heterogeneity in their policy preferences and incentives. We view policy makers as following (explicitly or implicitly) an interest rate rule that pins down their desired interest rate. Heterogeneity in preferences and experiences results in differences in the desired interest rate, which, if these differences are big enough can result in dissenting voting decisions.

We use the Taylor rule (Taylor 1993) as a starting point to think about the channels through which heterogeneity in preferences and experiences can lead to differences in desired

interest rates. The standard Taylor rule implies a nominal interest rate

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

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. Orphanides (2003) shows that this rule does a good job in explaining the evolution of the Federal Reserves 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, but that the FOMC's interest-rate decisions can be well described by such a rule.

In its standard specification, the Taylor rule does not allow for heterogeneity between policy makers—which is our focus in this paper. We introduce heterogeneity in two ways. First, we allow FOMC members to differ in their preferences for inflation vs. output stabilization through different weights on inflation and the output gap (λ and γ) and we allow them to entertain different views about the targets π^*, y^* and the natural rate r. Second, we introduce a subjective forward-looking element into the Taylor rule by assuming that FOMC members evaluate the deviation 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 is

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

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 could also go further and replace π_t and y_t with expectations of future inflation and output to make it a fully forward-looking Taylor rule as in Clarida, Galí, and Gertler (2000). However, as will be come clear below, this would not change the specification of our

estimating equation in a substantial way because we focus in on cross-sectional heterogeneity between FOMC members rather than the time-series properties of the desired interest rate.

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

$$\lambda_{j,t} = \lambda_0 + (x_{j,t} - \mu_x)'\lambda_1, \tag{3}$$

$$\gamma_{j,t} = \gamma_0 + (x_{j,t} - \mu_x)'\gamma_1, \tag{4}$$

$$\pi^*_{j,t} = \pi^* + (x_{j,t} - \mu_x)'\alpha_1, \tag{5}$$

$$y^*_{j,t} = y^* + (x_{j,t} - \mu_x)'\alpha_2, \tag{6}$$

$$r_{j,t} = r + (x_{j,t} - \mu_x)'\alpha_3, \tag{7}$$

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

$$i_{j,t} \approx a_t + \lambda_0\omega\pi^e_{j,t+1|t} + \kappa' x_j + (\pi_t - \pi^*)x'_j\lambda_1 + (y_t - y^*)x'_j\gamma_1 \tag{8}$$

where a_t is a time fixed effect and κ is a vector of constants.

We now discuss our specification of the subjective inflation expectation $\pi^e_{j,t+1|t}$ before we turn to the econometric application of this model to FOMC voting decisions.

2.2 Learning from experience

The objective of our empirical analysis is to relate FOMC members voting decisions to the inflation experiences they accumulated during their life-time. We use the learning-from-experience framework of Malmendier and Nagel (2015) to model the relationship between experienced inflation and subjective inflation expectations. This model 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, the AR(1) parameters are updated, and the forecast revised. Intuitively, the AR(1) assumption implies that the experienced inflation is summarized in terms of mean inflation rate and inflation persistence.

We make one modification to this framework that allows us to address seasonality in the inflation data. Especially towards the end of our sample period, seasonality in inflation rates has become quite substantial. FOMC members are likely aware of this seasonality pattern in the inflation data, and hence we assume that the perceived law of motion is a seasonal AR(1)

$$\pi_{t+1} = \alpha + \phi_1 \pi_t + \phi_4 \pi_{t-3} - \phi_5 \pi_{t-4} + \eta_{t+1}, \tag{9}$$

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

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

$$b_{t,s} = b_{t-1,s} + \gamma_{t,s} R_{t,s}^{-1} x_{t-1}(\pi_t - b'_{t-1,s} x_{t-1}), \tag{10}$$

$$R_{t,s} = R_{t-1,s} + \gamma_{t,s}(x_{t-1} x'_{t-1} - R_{t-1,s}), \tag{11}$$

where $x_t \equiv (1, \pi_t, \pi_{t-3}, \pi_{t-4})'$. 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 (2015), we specify the gain as

$$\gamma_{t,s} = \begin{cases} \frac{\theta}{t-s} & \text{if } t - s \geq \theta \\ 1 & \text{if } t - s < \theta, \end{cases} \tag{12}$$

This gain specification is 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 (12) is decreasing with the size, $t - s$, of the life-time 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. $\theta > 0$ is a constant parameter that determines how much weight the forecaster puts on recent data vs. data in the distant past. For example, $\theta = 1$ implies equal weighting of recent and data earlier in life, while $\theta > 1$ implies that recent data receives more weight than early life-time experiences.

Malmendier and Nagel (2015) estimate $\theta = 3.044$ from survey data on household 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] We conduct our baseline estimation by setting θ to this value. 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.

2.3 Econometric specification

We then use the FOMC members' heterogeneous desired interest rates to explain their voting decisions. For each meeting, votes are coded $V \in \{-1, 0, 1\}$, for dovish dissent, no dissent, and hawkish dissent. We express the probability of a vote in one of these three categories as a function of the desired interest rate (8) via an ordered probit model

$$P(V_{j,t} \leq k | \pi^e_{j,t+1|t}, x_j) = \Phi\left[\delta_{k,j} - a_t - \lambda_0 \omega \pi^e_{j,t+1|t} - \kappa' x_j - (\pi_t - \pi^*) x_j' \lambda_1 - (y_t - y^*) x_j' \gamma_1\right] \tag{13}$$

[3] Values in a fairly wide range around $\theta = 3.044$ also imply (sensibly) that the initial years in the life-time 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 (2015) discuss this point in more detail.

where $\Phi(.)$ denotes the standard normal cumulative distribution function and we normalize $a_0 = 0$ and all variables should be suitably scaled so that the latent residual has unit standard deviation.[4] Empirically, as element of x_j we use age, gender, and indicators for being a Regional Federal Reserve Bank President (rather than Federal Reserve Board member), member of the Democratic, and an indicator for being in a different party as the current U.S. president.

The model in (13) is a generalized version of the ordered probit model because we allow the thresholds for dissent $\delta_{k,j}$ to vary with the characteristics of the FOMC member. The most important concern is that regional Fed presidents may have different dissent thresholds compared with Federal Reserve Board governors, particularly since November 1993 when the FOMC agreed to publish its lightly-edited meeting transcripts with a 5-year lag. Meade and Stasavage (2008) show, using data from 1989 to 1997, that regional Fed presidents are more likely to disagree with the chairman's rate proposal, especially after 1993. A similar pattern is also apparent in our voting data. Federal Reserve board members have only casted 6 dissents since November 1993 while regional Fed presidents have dissented 71 times. To accommodate the possibility of threshold-heterogeneity among FOMC members, we let the thresholds in (13) depend on the FOMC member characteristics x_j,

$$\delta_{k,j} = \delta_{0,k} + \delta'_{1,k} x_j \text{ for } k = -1, 0$$

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

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

3 Data

We download quarterly CPI series from 1871 Q1 to 2013 Q4 used in Shiller (2005).[5] We measure inflation rates as annualized quarterly changes in the log CPI.

3.1 FOMC voting history

The data on the FOMC voting history comes from several sources. With the issuance of Treasury–Federal Reserve Accord of 1951, the Fed regained its independency from the Treasury's financing needs after World War II. Therefore, we study the FOMC member voting history after the 1951 Accord, covering all the meetings from March 1951 to January 2014.[6] For meetings before January 1966 and after January 1997, we collect the voting history directly from FOMC meeting statements[7] that report the voting results, normally followed by explanation of dissenting opinions, if any. For meetings between January 1966 and December 1996, we use the data from Chappell Jr, McGregor, and Vermilyea (2005).[8] We further collect biographical information for each FOMC member from the Federal Reserve History Gateway[9] and Who's Who database: year of birth, place of birth, gender, graduated program and highest degree earned, served role (board member or regional bank president), the political party of U.S president who appointed the member. We note that 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.[10]

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

[6] The Treasury–Federal Reserve Accord of 1951 was issued on March 4 1951. During our sample period, eight Fed Chairmen lead the FOMC: Bernanke (2/2006 to 1/2014), Greenspan (8/1987 to 1/2006), Volcker (8/1979 to 8/1987), Miller (3/1978 to 8/1979), Burns (2/1970 to 3/1978), Martin (4/1951 to 1/1970), and McCabe (4/1948 to 4/1951).

[7] `http://www.federalreserve.gov/monetarypolicy/fomccalendars.htm`

[8] Obtained at `http://professorchappell.com/Data/Book/index.htm`

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

[10] 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 (SF Fed president from 6/04 to 10/10 and governor 8/94 to 2/97 and then again since 10/2010, including her current role as Fed Chairwoman).

3.2 FOMC member inflation forecasts

We further obtain the individual inflation forecasts of FOMC members from the Semiannual Monetary Policy Report (MPR) to the Congress[11]. The individual FOMC members' forecasts become available only with a 10-year lag and the earliest ones available are from 1992, so our sample runs from 1992 to 2004, covering 26 FOMC meetings. The Monetary Policy Report is submitted to the Congress every February and July. The forecasts in February concern the time period from Q4 of the previous year to end to Q4 of the current year. Two sets of forecasts are included in July report; one for Q4 of the previous year to Q4 of the current year and other for Q4 of the current year to Q4 in the next year. We further supplement the individual FOMC members' forecasts with the Fed staff's forecasts through the Green Book available to FOMC members prior to each meeting.[12]

3.3 Summary Statistics

Table 1 presents summary statistics of our data set. In total, we have data from 659 FOMC meetings with 7,350 votes[13] in total. Over the whole sample, we have 160 dovish dissenting votes 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 and somewhere between 2.2% and 3.6%.

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). The figure clearly shows how dissents among Federal Reserve Board members became almost non-existent after the increase in transparency in 1993. In contrast, dissents among regional Federal Reserve presidents are still quite common after 1993. As we explained above, this is why we also explore specifications in which we allow the dissent thresholds to differ board

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

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

[13] We exclude 5 member-votes where the member voted less than 5 times throughout his career and 8 un-codeable votes.

Table 1: Summary Statistics

The table shows statistics for all FOMC meetings from 3/8/1951 to 1/29/2014. We exclude 5 member-votes where the member voted less than 5 times throughout his career, 8 un-codeable votes, and 94 votes casted at un-scheduled meetings. The first column in panel A reports statistics for all FOMC members, while columns 2 to 4 focus on members who dissent towards monetary easing (doves), members who consent, and members who dissent towards monetary tightening (hawks). Panel B reports the pairwise correlation between voting record, experience-based inflation forecast, and a vector of member's characteristics. In particular, we denote $Vote$ being 1 for hawkish dissent, 0 for consent, and -1 for dovish dissent; $Gender$ being 1 for male, 0 for female; $FedRole$ being 1 for regional Fed presidents, 0 for board members; $Party$ being 1 for Republicans, 0 for Democrats; $SameParty$ being 1 if the member's party membership is different from the incumbent president, 0 otherwise.

Panel A

	All	Dovish Dissent	Consent	Hawkish Dissent
#Meetings	659	109	659	178
#Votes	7350	160	6925	265
Avg. age	56.4	55.6	56.4	57.1
Avg. #days at Fed	2286	1924	2285	2545
% w/ PhD	46.3	50.6	45.8	56.2
% male	93.9	83.1	93.9	100
% Fed board	55.4	76.3	56.0	27.9
% same party as incumbent president	56.7	67.5	56.6	52.1
Experience-based inflation forecast	3.4%	3.8%	3.4%	4.1%
Std. of exper.-based infl. forecast	0.018	0.022	0.018	0.021

Panel B: Pairwise Correlation

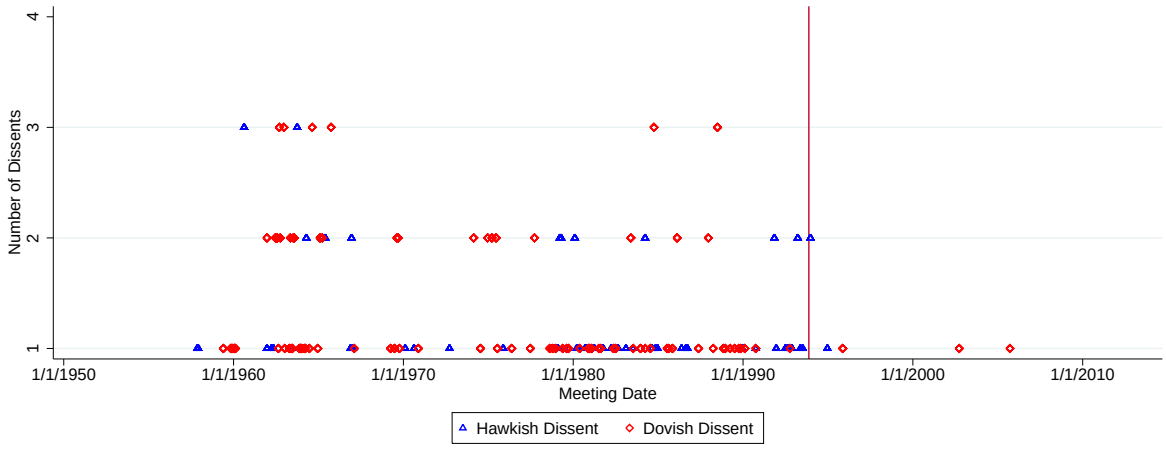
	Vote	Inflation Forecast	Gender	Age	Fed Role	Party	Same Party
Vote	1.00	-	-	-	-	-	-
Inflation Forecast	0.04	1.00	-	-	-	-	-
Gender	0.08	-0.03	1.00	-	-	-	-
Age	0.02	-0.07	0.06	1.00	-	-	-
Fed Role	0.12	-0.01	0.10	-0.09	1.00	-	-
Party	0.07	0.15	-0.01	-0.02	0.10	1.00	-
Same Party	0.03	-0.05	0.05	0.18	-0.03	-0.12	1.00

members and regional presidents.

As Panel A of Table 1 illustrates, hawkish dissenters are more likely to be older, have a longer tenure on the FOMC, have a PhD, male, and a regional Fed president (i.e., not on board), and from a different party than the incumbent US president. Panel A also shows that hawkish and dovish dissenters have, on average, quite different experience-based inflation forecasts. For each FOMC member, we calculate the experience-based inflation forecast $\pi^e_{j,t+1|t}$ as described in Section 2.2. The average experience-based inflation forecasts for dovish dissenters is 3.8% while the average for hawkish dissenters is 4.1%. Consistently, the pairwise correlation between experience-based inflation forecasts and the voting records in Panel B is also positive. This is suggestive that differences in life-time inflation experiences could play a role in "making" a hawk or dove, although a much more careful analysis is of course warranted.

Panel (a) of Figure 2 plots the learning-from-experience forecast $\pi^e_{i,t+1|t}$ of the youngest and oldest FOMC members after subtracting the $\pi^e_{i,t+1|t}$ of the median age member in each meeting. For the interpretation of the our empirical tests below, it is useful to keep in mind that these differences take values of at most around 1.5 percentage points. The biggest differences between younger and older members occur during the high-inflation years in the late 70s/early 80s. Not surprisingly, it is the youngest members for whom we obtain the highest experience-based forecasts around that time. Two effects play a role for this. 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. Both high perceived mean and high perceived persistence combine to produce a high inflation forecast in this high-inflation period. Subsequently, from the mid-1980s onwards, younger members adapted more quickly to the now low rates of inflation and the relatively low persistence. This relatively lower perceived persistence among younger members contributes to the spike around 2010 when young members' learning-from-experience forecast is temporarily much higher than the median. Due to the lower perceived

Panel (a): Dissents by Federal Reserve Board Members



Panel (b): Dissents by Regional Federal Reserve Presidents

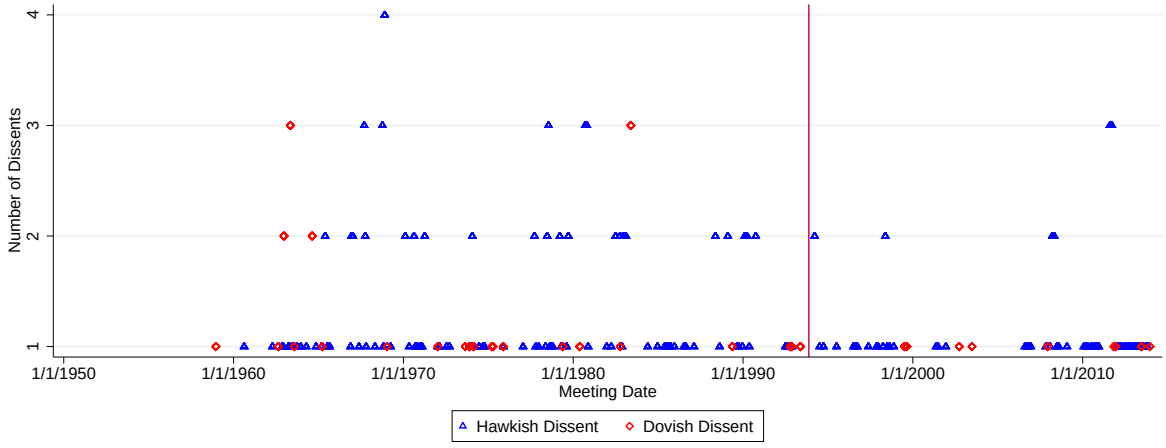
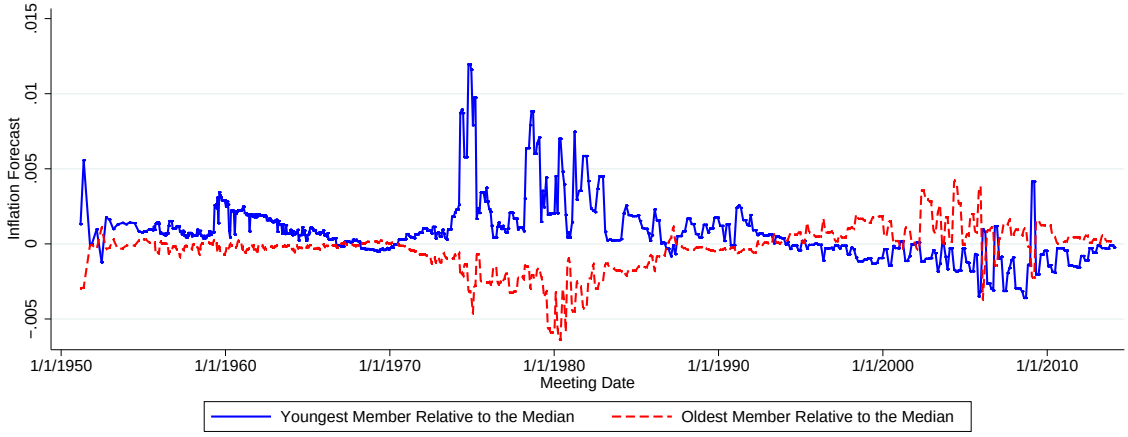


Figure 1: Number of dissents in each FOMC meeting. The red vertical line is the time-stamp for Nov. 1993, after which FOMC agreed to public its lightly-edited transcripts on a 5 year lag

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



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

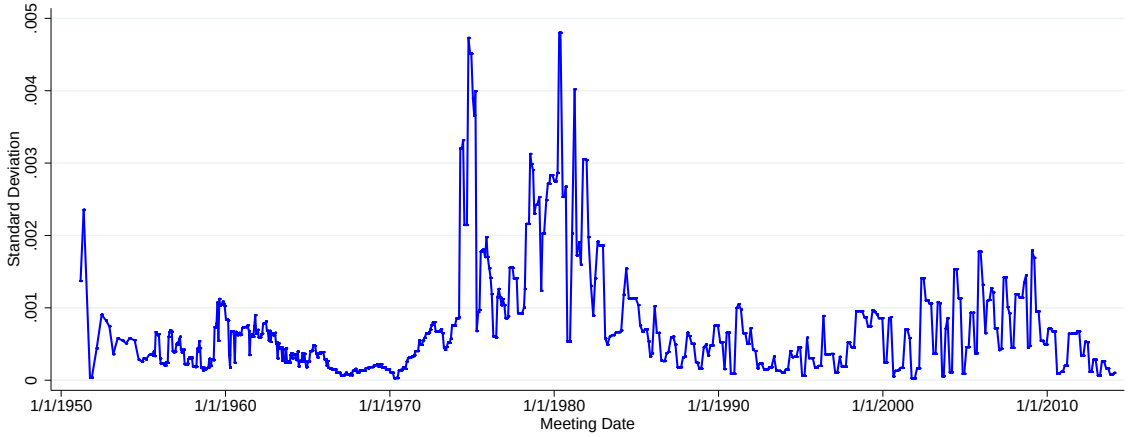


Figure 2: Dispersion of members' experience-based inflation forecasts during each FOMC meeting

persistence, our learning-from-experience model suggests that 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.

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. As the age differences between FOMC members are typically not big, the differences in experience-based inflation forecasts are not huge either. With relatively similar ages, the experienced inflation histories are quite similar and therefore the learning model from Section 2.2 produces forecasts that are quite close for most of the members on the FOMC. Nevertheless, small differences could be sufficient to drive differences in voting behavior and some notable differences do exist, especially during the high inflation years in the late 70s/early 80s.

4 Explaining Dissent with Experience

4.1 Baseline Estimates

We now analyze whether these differences in the learning-from-experience forecast between FOMC members can help explain differences in their voting behavior. Table 2 presents estimates of our baseline ordered probit specification (13) using data from 1951 to 2014. Our focus is on the coefficient, and the marginal effects associated with it, of the 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 any of the meetings throughout the sample period.

In addition to the experience-based forecast, we also include a dummy for FOMC member Henry Wallich, a Federal Reserve governor from 1974 to 1986. Mr. Wallich is the only FOMC member during our sample period who experienced hyperinflation. He was born in Germany in 1914 into a family of bankers and he lived through Germany's hyperinflation in 1923 before emigrating to the United States in the 1930s. Mr. Wallich dissented 27 times during

his tenure on the Federal Reserve Board, the highest number of dissents among all FOMC members in Federal Reserve history.

The voting thresholds, $\delta_{k,j}$ are allowed to depend on a vector of characteristics of the FOMC member. In column (i) and (ii) of Table 2, the thresholds can vary with indicators for Federal Reserve Board member and an indicator for the post-November 1993 period and the interaction of the two. This allows the model to accommodate the dramatic shift towards fewer dissents among Federal Reserve Board members after November 1993 that is evident in Figure 1. In column (iii) and (iv), the thresholds can vary, in addition, with FOMC member age, gender, party membership indicator, and same party as current president indicator.

Column (i) in Table 2 reports estimates of the ordered probit model (13). 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% in the experience-based forecasts of an FOMC member—which, according to Panel (b) of Figure 2, is a typical standard deviation of FOMC members experience-based inflation forecasts in an FOMC meeting in many years—translates into an increase in the probability of a hawkish dissent vote of roughly 1.21 percentage points, 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 percentage points, which is approximately a third of the unconditional probability of dovish dissent ($160/6707 \approx 2.4\%$). Thus, the estimates imply economically significant 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 percentage points and an increase in the probability of hawkish dissent of 8.0 percentage points. In other words, the effects on probabilities associated with the Wallich dummy are roughly of the same magnitude as those associated with an increase of 1.0 percentage points in an FOMC member's

experience-based inflation forecast.

Column (i) in Table 3 reports the coefficients on the characteristics upon which the voting thresholds are based given the ordered probit model (13). Overall, the positive coefficients on the Role dummy, 1 for regional Fed presidents and 0 otherwise, and the Post-1993 dummy suggest that regional Fed president are more hawkish than board members and meanwhile, we are likely to observe a more hawkish vote after November 1993. In addition, regional Fed presidents are less likely to put themselves in the dovish category than in the non-hawkish one ($0.59 > 0.43$) and a non-dovish vote is more likely to occur than a hawkish dissent after November 1993 ($7.12 > 0.31$). Furthermore, as the coefficients on the interaction between Role and Post-1993 indicate, compared to board members, regional Fed presidents are less likely to push themselves away from dovish dissents after November 1993 ($-1.77<0$). However, these regional Fed presidents are more likely to cast hawkish dissents than board members ($1.13 >0$) after November 1993.

One potential concern with the estimates in column (i) (and (iii)) in Table 2 is that an incidental parameters problem could arise from the inclusion of meeting fixed effects in the ordered probit model.[14] To address this concern, we investigate an alternative specification in which we omit the meeting fixed effects, and we instead specify that the probabilities of dissent are driven directly by cross-sectional differences (against the incumbent Chairperson) in inflation experiences and other personal characteristics. As column (ii) (, and (iv)) in Table 2 shows, the results with this modified specification are similar to those in column (i) (and (iii)).

4.2 Alternative values for the gain parameter

So far we fixed the gain parameter in the learning algorithm at the point estimate of $\theta = 3.044$ from Malmendier and Nagel (2015). By relying on prior information in this way, we tied our

[14] As T increases, the number of meeting fixed effects grows at the same rate as T and therefore, the probit estimator is inconsistent and asymptotic theory may not provide a good approximation of the 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 life-time history of inflation, as described in Section 2.2 (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 (ii) 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 (iii) and (iv) report the results assuming that the thresholds depends, in addition, on age, gender, party membership 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 (i)	Ordered Probit de-"chaired" (ii)	Ordered Probit (iii)	Ordered Probit de-"chaired" (iv)
Experienced-based forecast	216.6	97.2	214.4	98.5
	(66.1)	(39.5)	(67.8)	(39.0)
Wallich Dummy	1.43	1.05	1.39	1.05
	(0.36)	(0.17)	(0.36)	(0.17)
Meeting FE	Yes	No	Yes	No
Thresholds	Role $\times$ $I_{>93}$	Role $\times$ $I_{>93}$	All	All
#Obs.	6707	6707	6707	6707
Pseudo R^2	0.390	0.097	0.391	0.100
APE of experienced-based forecast:				
Dovish Dissent	-7.6	-5.1	- 7.6	-5.1
Consent	-4.4	-2.5	-4.3	-2.5
Hawkish Dissent	12.1	7.6	11.9	7.7
APE of Wallich Dummy:				
Dovish Dissent	-0.050	-0.055	-0.050	-0.055
Consent	-0.029	-0.027	-0.028	-0.027
Hawkish Dissent	0.080	0.082	0.077	0.082

Table 3: Experience-based Inflation Forecasts and FOMC voting behavior: Threshold Effects

The sample period is from March 8, 1951 to January 29, 2014. Column (i) and (ii) 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. Column (iii) and (iv) report the results assuming that the thresholds depend on a) a vector of characteristics of the member, including age, gender, Fed Board member/Regional Bank President indicator, party membership indicator, and same party as current president indicator, and b) whether the meeting occurs after Nov. 1993. In parentheses we report the standard error based on two-way clustering by both member and meeting.

	(1)	(2)	(3)	(4)
Vote $\leq$ -1				
Role	0.59	0.42	0.60	0.43
	(0.19)	(0.15)	(0.19)	(0.15)
Post-1993	7.12	2.31	6.97	2.15
	(1.53)	(0.56)	(1.54)	(0.55)
Role*Post-1993	-1.77	-1.00	-1.73	-0.96
	(0.54)	(0.33)	(0.54)	(0.32)
Age	-	-	0.00	-0.00
	-	-	(0.01)	(0.01)
Same Party	-	-	0.21	-0.03
	-	-	(0.19)	(0.08)
Gender	-	-	1.12	0.48
	-	-	(0.59)	(0.46)
Party	-	-	0.32	0.05
	-	-	(0.22)	(0.13)
Vote $\leq$ 0				
Role	0.43	0.29	0.43	0.28
	(0.16)	(0.14)	(0.15)	(0.13)
Post-1993	0.31	-1.30	0.30	-1.25
	(1.31)	(0.54)	(1.33)	(0.55)
Role*Post-1993	1.13	0.87	1.15	0.88
	(0.43)	(0.32)	(0.44)	(0.32)
Age	-	-	0.01	-0.00
	-	-	(0.01)	(0.01)
Same Party	-	-	0.10	0.11
	-	-	(0.16)	(0.09)
Gender	-	-	4.55	4.23
	-	-	(0.46)	(0.34)
Party	-	-	0.55	0.20
	-	-	(0.17)	(0.11)

hands because we did not pick θ to fit the voting behavior of FOMC members. It would nevertheless be of some interest to see to what extent the fit and the estimated APE changes if we vary the θ parameter. To check this, we take the re-estimate of the learning rule for each FOMC member with a different value of θ and then we re-run the estimation from column (i) of Table 2 with these alternative experience-based forecasts of inflation. As Table 4 shows, the results are qualitatively similar to our baseline estimates as in column (i) of Table 2.

4.3 Fixed Dissent Thresholds

As a further robustness check, in this section, we explore the ordered probit model with fixed-threshold in different subsamples that are less likely to be heterogeneous regarding the dissent threshold as we discussed in section 4.1. Table 5 presents the results of this exercise.

Column (i) looks at the voting records of all FOMC members prior to November 1993. This allows us to avoid the dramatic change in board member's voting behavior before and after November 1993 as shown in Figure 1 and therefore, justifies the use of fixed-threshold model. Not surprisingly, the result turns out to be very close to our benchmark case (with endogenous dissent thresholds). Column (iv) makes one more revision of what column (i) does by including the regional Fed presidents after November 1993 whose voting behavior seem to quite stable over time. As expected, again, the results look very similar to that of column (i) as well as the benchmark case.

Column (ii) and (iii) only focus on the regional Fed presidents. Column (ii) looks at the pre-1993 period while column (iii) covers the entire sample period. As can be seen, the results of column (ii) and (iii) are quite similar. For brevity, let's look at the column (iii) for now. As the average partial effects (APE) on experience-based inflation forecast suggest, throughout the sample period, 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 vote of roughly 2.6 percentage points, which is a bit less than one half of the unconditional probability of hawkish dissent casted by regional Fed presidents ($191/3275 \approx 5.8\%$). Meanwhile, the

Table 4: Experience-based Inflation Forecast and FOMC voting behavior: Exploring Variation in Weights on Past Experience - with characteristics-based and post1993 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 life-time history of inflation, as described in Section 2.2, but here in this table with different values for the gain parameter θ. 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 thresholds depend on a) whether the member is a board member or regional president, and b) whether the meeting occurs after Nov. 1993. In parentheses we report the standard error based on two-way clustering by both member and meeting.

	$\theta = 3$	$\theta = 2$	$\theta = 2.5$	$\theta = 3.5$	$\theta = 4$
Experience-based forecast	216.6	218.2	256.7	165.4	117.6
	(66.1)	(68.4)	(74.3)	(58.0)	(48.5)
Wallich Dummy	1.43	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
#Obs.	6707	6707	6707	6707	6707
Pseudo R^2	0.390	0.389	0.391	0.388	0.386
APE of experienced-based forecast					
Dovish Dissent	-7.6	-7.7	-9.1	-5.9	-4.2
Consent	-4.4	-4.5	-5.2	-3.4	-2.4
Hawkish Dissent	12.1	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	0.080	0.081	0.081	0.079	0.078

probability of a dovish dissent drops by 0.6 percentage points, which is roughly half of the unconditional probability of dovish dissents 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 regional Fed president's voting behavior than on that of all FOMC members.

4.4 Robustness and Validation: FOMC Members' Speeches

To be completed.

5 Explaining inflation forecasts with experience

Our presumption so far has been that the effects of differences in inflation experiences on FOMC member voting operate through differences in beliefs about future inflation rates. We now complement this analysis with evidence on FOMC member inflation forecasts. We show that these forecasts, too, are related to differences in FOMC members inflation experiences.

Twice a year, in February and July, the FOMC prepares inflation forecasts, which are submitted to Congress as part of the Monetary Policy Report. We focus on the inflation forecasts contained in this report. Romer and Romer (2008) compare the central tendency of the FOMC member inflation forecasts to the 'staff forecast' produced by Federal Reserve Board staff. They find that FOMC members deviation from the staff forecast reduces the accuracy of the forecast in forecasting inflation. Our objective here is to find out whether these deviations of FOMC members forecasts from the staff forecast reflect the effects of FOMC members inflation experiences.

For this purpose, we work with panel data on individual FOMC members forecasts (rather than the central tendency that Romer and Romer (2008) analyze).

$$\tilde{\pi}^e_{j,t+1|t} = (1-\phi)\pi^e_{t+1|t} + \phi\pi^e_{j,t+1|t}, \tag{14}$$

Table 5: Experience-based Inflation Forecasts and FOMC voting behavior: Exploring Variation in Sample Period with fixed thresholds

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 life-time history of inflation, as described in Section 2.2 (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) reports the results with all FOMC members prior to Nov. 1993. Column (ii) reports the results with regional Fed presidents only prior to Nov. 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 Nov. 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 Member Pre-Nov. 1993 (i)	Regional President Only Pre-Nov 1993 (ii)	Regional President Only Full Sample (iii)	Mixed Member Full Sample (iv)
Experienced-based forecast	230.0	495.5	379.2	230.9
	(80.0)	(155.9)	(103.9)	(68.9)
Wallich Dummy	1.49	-	-	1.51
	(0.37)	-	-	(0.37)
Meeting FE	Yes	Yes	Yes	Yes
#Obs.	5123	2467	3275	5931
Pseudo R^2	0.380	0.492	0.453	0.383
APE of expr.-based fcst.:				
Dovish Dissent	-9.5	-8.0	- 6.4	-9.0
Consent	-3.5	-21.0	-19.5	-5.2
Hawkish Dissent	13.0	29.0	26.0	14.2
APE of Wallich Dummy:				
Dovish Dissent	-0.062	-	-	-0.059
Consent	-0.022	-	-	-0.034
Hawkish Dissent	0.084	-	-	0.093

where $\tilde{\pi}^e_{j,t+1|t}$ is the reported forecast of FOMC member j, $\pi^e_{t+1|t}$ here stands for the staff forecast, and $\pi^e_{j,t+1|t}$ is, as before, the experience-based forecast. which leads us to estimate

$$\tilde{\pi}^e_{j,t+1|t} - \pi^e_{t+1|t} = a + \phi(\pi^e_{j,t+1|t} - \pi^e_{t+1|t}) + \varepsilon_t \tag{15}$$

where we included a constant and a residual to account for other unobserved variables that could influence the FOMC member forecast.

One complication 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 experience-based forecast variable is based on the history of the CPI and so this generates a substantial discrepancy. 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. In the first approach, we calculate $\tilde{\pi}^e_{j,t+1|t}$ on the left-hand side of (15) in the post-1999 part of the sample by adding the difference CPI - PCE inflation rate to the FOMC member forecast. In the second approach, we estimate (15) with time fixed effects. Time fixed effects can absorb the discrepancy even if it is not well captured by the realized CPI-PCE inflation rate difference, as long as views about the are similar among FOMC members. Inclusion of time fixed effects further allows us to absorb the effects of any other time-varying variables that may affect FOMC member forecasts. In the time fixed effects regressions, the coefficient ϕ is identified purely from cross-sectional differences between FOMC members in their forecasts and their in inflation experiences.

Another complication is the mismatch in forecast horizon between members' experience-based forecasts and the projections they submit to Congress relating to the July MPR. In particular, the experience-based forecast used in the voting analysis above is from quarter $t-1$ to $t+3$ (four quarters ahead) while the reported projections are either from Q4 of previous year to Q4 of current year or from Q4 of current year to Q4 of next year. To address this discrepancy, we reconstruct experience-based forecasts to be based on i) from quarter $t-1$ to $t+1$ (two quarters ahead), and ii) from quarter $t-1$ to $t+5$ (six quarters ahead),

Table 6: Influence of FOMC Members' Inflation Experiences on FOMC Members' Inflation Forecasts

The sample period is from the first half of 1992 to the second half of 2004. For each year, three sets of inflation projections are included; February-forecast for the current year, July-forecast for current year and July-forecast for next year. The dependent variable is the difference between i) FOMC member's inflation projection from the Semiannual Monetary Policy Report (MPR) to the Congress and ii) the Fed Staff's inflation forecast from Green Book available prior to each FOMC meeting. The key explanatory variable is the difference between i) experience-based forecast for each FOMC member at each meeting, which is calculated by recursively estimating an AR(1) model using the member's life-time history of inflation, as described in Section 2.2 (with $\theta = 3.044$) and ii) the Fed Staff's inflation forecast. From February 2000 and on, we calculate $\hat{\pi}^e_{j,t+1|t}$ by adding the difference between CPI and PCE inflation rate to each FOMC member forecast. Meeting×Forecast FE are three indicators for Feb-current-year forecast, July-current-year forecast, and July-next-year forecast, respectively. In parentheses we report the standard error based on two-way clustering by both member and meeting.

	All FOMC Member		Regional Fed President	
	(i)	(ii)	(iii)	(iv)
Exper.-based Forecast - Staff Forecast	0.399	0.805	0.434	1.481
	(0.089)	(0.412)	(0.092)	(0.624)
Meeting×Forecast FE	No	Yes	No	Yes
Observations	383	383	190	190
Adjusted R^2	0.363	0.799	0.372	0.784

and then use them to match the forecast horizons of the two sets of projections in the July MPR, respectively.

Table 6 reports the estimates of Eq. (15) both with and without time fixed-effect. As can be seen, the experience-based inflation forecast does play a important and significant role in explaining the variation of member's reported inflation forecast. As column (i) and (iii) suggest, on average, FOMC members tend to assign roughly 40% of the weight on their experience-based forecasts when formulating their submission of inflation forecast. Meanwhile, regional Fed presidents seem to rely more on their past experience and put about 43% of the weight on their experience-based forecast when they report their inflation forecast.

6 Effects of Experiences on the Federal Funds Rate Target

Our earlier analysis of cross-sectional differences in voting decisions suggests that when voting in FOMC meetings and when forecasting inflation rates, FOMC members rely to some extent on their experience-based inflation forecast. As a final step, we now test whether this partial reliance on personal experiences also affects the federal funds rate decided in the FOMC meetings. To do this, we check whether there is an incremental effect of FOMC members' average experience-based inflation forecast if we introduce it alongside conventional interest-rate determinants in a Taylor rule.

Our baseline specification is based on the assumption that the federal funds rate target decided in an FOMC meeting represents the average of the desired federal funds rate of the FOMC members. Averaging equation (2) across FOMC members at meeting t, and simplifying by setting $\bar{x}_t = \mu_x$, we get

$$i_{j,t} = r + \pi^* + \lambda_0\omega(\bar{\pi}^e_{t+1|t} - \pi^*) + \lambda_0(1-\omega)(\pi_t - \pi^*) + \gamma_0(y_t - y^*) \tag{16}$$

where $\bar{\pi}^e_{j,t+1|t}$ is the average, at the meeting at time t, of the FOMC members experience-based inflation forecasts. We also explore versions without the simplifying assumption $\bar{x}_t = \mu_x$. In this case, time-variation in the average characteristics of the FOMC members (age, board governor, gender, party membership, membership in the same party as the current president), as well as interactions of those average characteristics with $\pi_t - \pi^*$ and $y_t - y^*$, could play a role in affecting the federal funds rate target. Estimating the coefficients on all these characteristics-related variables and interactions with much precision is not possible, which is why we focus on a much more parsimonious approximation with $\bar{x}_t = \mu_x$ in our baseline specification. However, we will show that the coefficient estimate on $\bar{\pi}^e_{j,t+1|t}$ is robust to inclusion of these additional terms.

One potential objection to this specification based on the average desired federal funds rate among FOMC members is that decisions of a committee do not necessarily reflect the

average opinion of the committee's members. In our application this is not a crucial issue, though. Very often, the difference between the average experience-based forecast of the FOMC members in a meeting and the conventional objective inflation rate component of the Taylor rule is substantially bigger than the differences between FOMC members. In other words, it doesn't matter much whether we use the mean, the median, or any specific FOMC member's experience-based forecast. For robustness, we present specifications in which we use the median as well as chairman's experience-based forecast instead of the average across FOMC members.

With $\omega = 0$ equation (16) reduces to the standard Taylor rule. Our earlier analysis of cross-sectional differences in voting decisions suggests $\omega > 0$, i.e., FOMC members rely to some extent on their experience-based inflation forecast. Here we test whether this partial reliance on personal experiences also affects the federal funds rate decided in the FOMC meetings. To do this, we check whether there is an incremental effect of $\bar{\pi}^e_{t+1|t}$ over and above that of the standard inflation and output gap components of the Taylor rule.

In order to minimize the chance that $\bar{\pi}^e_{t+1|t}$ could be picking up the effects of measurement error in the objective macroeconomic information used by the FOMC, it is important that we use empirical measurements of π_t and y_t that are as close as possible to the information used by the FOMC. First, forecast-based variants of the Taylor rule provide a better empirical fit to the actual federal funds rate target than a rule based on realized macroeconomic data (Orphanides 2001; Orphanides 2003). We follow Orphanides (2003) and replace, for every meeting in quarter t, π_t and y_t by the Federal Reserve staff's Greenbook forecasts of inflation from quarter $t-1$ to $t+3$ and forecasts of the output gap in quarter $t+3$.[15] 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

[15] 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.

the time series that we obtain from joining the core CPI and core PCE series as the staff's core inflation forecast.

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 period thereafter, the 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 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. Baxa, Horváth, and Vašíček (2013) provide empirical evidence consistent with this description of FOMC policy. They show that financial market variables added to the Taylor rule equation matter a lot in 2007-08, over and above inflation and output gap information.

Column (i) in Table 7 presents the baseline specification corresponding to equation (16). The estimated coefficients on the output gap (0.68) and the two inflation variables ($1.27 + 0.43 = 1.70$) are consistent with typical findings in the literature. The key finding here, however, is that the FOMC members average experience-based inflation forecast forecast adds explanatory power for the federal funds rate target over and above the staff forecast of inflation and the output gap. The coefficient of 0.43 (s.e. 0.20) is significantly different from zero at conventional levels of statistical significance. The coefficients on the two inflation variables imply that the weight ω on the experience-based forecast in our experience-augmented Taylor rule (16) is about $0.43/1.70 \approx 0.25$. For comparison, our analysis of FOMC members' inflation forecasts in Table 6 suggests that their inflation expectations put a weight of about 0.50 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 is reasonable that the weight in the interest-rate decision is somewhat lower than in the members' stated inflation forecasts. Deviating from

the "objective" forecast provided by the Federal Reserve in the target-rate decision may require more confidence than deviating when stating a forecast that does not directly affect any decisions.

Columns (ii) shows that the coefficient on the experience-based forecast does not change much if we use a different horizon for the output gap forecast (t instead of $t+3$). The specification in column (iii) addresses a potential concern that our experience-based forecast variable (which is calculated from historical headline CPI data) could just be proxying for headline CPI information that the FOMC looks at in addition, or instead of the staff's core forecast that we included in the Taylor rule, rather than an experience effect. To check this, we add the staff's headline CPI inflation forecast to the regression. This small and statistically insignificant coefficient on this variable confirms the arguments in Mehra and Sawhney (2010) and Bernanke (2010) that the FOMC looks primarily at core inflation forecasts, not at headline inflation forecasts, and it shows that the experience-based forecast variable does not just proxy for omitted headline CPI inflation information.

In column (iv) we replace the average experience-based inflation forecast of FOMC members with the median one. In column (v) we use the chairman's experience-based forecast. As the table show, these changes result in only minor changes in the coefficient estimate. 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. As a consequence, it doesn't matter much which measure of central tendency of the experience-based forecasts, or which individual experience-based forecast is used. All of them are highly correlated.

Finally, column (vi) adds cross-sectional averages of all the FOMC member characteristics that we considered in our analysis of voting decisions (age and dummies for board governor, gender, party membership, membership in the same party as the current president), as well as their interactions with the $t-1$ to $t+3$ core inflation forecast and the $t+3$ output gap forecast. This is the specification one obtains by averaging (2) across FOMC members at

Table 7: Influence of FOMC Members' Inflation Experiences on 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 each FOMC meeting in quarter t. Both staff's forecasts of CPI/PCE and output gap are from the Greenbook data set. The experience-based forecast is the average (unless otherwise stated) of member's experienced-based CPI forecast at each meeting. The staff's core inflation forecast represents the core CPI forecast before 2/1/2000 and then becomes core PCE forecast afterwards. In parentheses, we report Newey-West standard errors with twelve lags. Column (vi) repeats the regression of column (i), but with the the average FOMC member characteristics (age and dummies for board governor, gender, party membership, membership in the same party as the current president) included as well as their interactions with the inflation and output gap forecasts (coefficients not shown).

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Avg. exper.-based CPI inflation fcst. ($t-1$ to $t+3$)	0.43	0.38	0.43			0.39
	(0.20)	(0.17)	(0.20)			(0.15)
Median exper.-based CPI inflation fcst. ($t-1$ to $t+3$)				0.44		
				(0.20)		
Chair's exper.-based CPI inflation fcst. ($t-1$ to $t+3$)					0.45	
					(0.20)	
Staff's core inflation fcst. ($t-1$ to $t+3$)	1.27	1.23	1.12	1.27	1.26	
	(0.22)	(0.15)	(0.31)	(0.22)	(0.22)	
Staff's CPI inflation fcst. ($t-1$ to $t+3$)			0.19			
			(0.25)			
Staff's output gap fcst. ($t+3$)	0.68		0.68	0.68	0.68	
	(0.06)		(0.06)	(0.06)	(0.06)	
Staff's current-quarter output gap fcst. (t)		0.63				
		(0.07)				
Intercept	-0.07	0.21	-0.16	-0.07	-0.08	-
	(0.35)	(0.35)	(0.41)	(0.35)	(0.35)	-
Members' Characteristics and Interactions	N	N	N	N	N	Y
Obs.	160	160	160	160	160	160
Adj. R^2	0.862	0.903	0.862	0.862	0.863	0.930

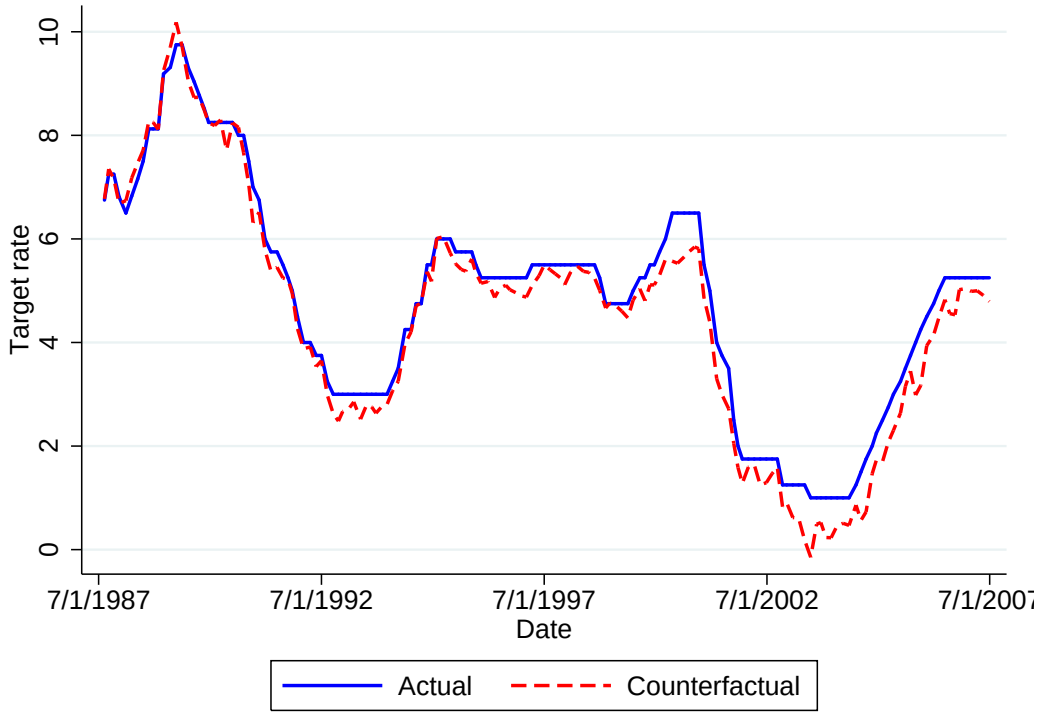


Figure 3: Counterfactual federal funds rate target with experience effects removed

meeting t without the simplifying assumption $\bar{x}_t = \mu_x$. For brevity, we don't tabulate all the coefficients on the average characteristics and their interactions with inflation and output gap forecasts. Most of them are statistically not significantly different from zero. This is not surprising, since we are adding 15 additional variables to a time-series regression with only 160 (autocorrelated) observations. The important point for our purposes is that the addition of all these variables leaves the coefficient on the experience-based forecast almost unaffected.

The results so far suggest that FOMC members partial reliance on their own inflation experiences influenced the federal funds rate target set by the FOMC. How big is this effect? To assess the magnitude, we construct a counterfactual federal funds rate that removes the experience effect: We compare the fitted values from column (i) in Table 7 with the fitted value that we would get if we replaced FOMC members' average experience-based forecast with the staff forecast of core inflation. Put differently, to get this counterfactual fitted value

we set $\omega = 0$ in 16. The difference between the first, actual, fitted value and the second, counterfactual, one is the experience effect. We then subtract this experience effect from the actual federal funds rate target to obtain the counterfactual federal funds rate target shown in Figure 3. The interpretation of this counterfactual target rate is that it is the target that the FOMC would have chosen if members had relied only on the staff forecast, not on their own inflation experiences. It is important to keep in mind, though, that if the FOMC had chosen a different target rate path, then macroeconomic performance would 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 follow-on equilibrium effects, but it is nevertheless useful to get a sense of the magnitude of the experience effects. As Figure 3 shows, the effects 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 funds rate.

7 Conclusion

We present novel evidence showing that personal lifetime experiences significantly affect the forecasts and voting behavior of FOMC members. This evidence adds to a growing literature on the role of 'experience effects', a term first coined by Malmendier and Nagel (2011) in the context of stock-market investment. What is still debated is whether such influences are weaker among more highly educated decision-makers or even experts. Our results here suggest that this is not necessarily the case.

References

Baxa, J., R. Horváth, and B. Vašíček (2013). Time-varying Monetary-Policy Rules and Financial Stress: Does Financial Instability Matter for Monetary Policy? *Journal of Financial Stability 9*(1), 117–138.

Bernanke, B. S. (2010). Monetary Policy and the Housing Bubble. Speech at the Annual Meeting of the American Economic Association.

Chappell, H. W., T. M. Havrilesky, and R. R. McGregor (1995). Policymakers, Institutions, and Central Bank Decisions. *Journal of Economics and Business 47*(2), 113–136.

Chappell Jr, H. W., T. M. Havrilesky, and R. R. McGregor (1993). Partisan Monetary Policies: Presidential Influence Through the Power of Appointment. *Quarterly Journal of Economics*, 185–218.

Chappell Jr, H. W. and R. R. McGregor (2000). A long history of FOMC voting behavior. *Southern Economic Journal*, 906–922.

Chappell Jr, H. W., R. R. McGregor, and T. Vermilyea (2004). Majority Rule, Consensus Building, and the Power of the Chairman: Arthur Burns and the FOMC. *Journal of Money, Credit and Banking*, 407–422.

Chappell Jr, H. W., R. R. McGregor, and T. A. Vermilyea (2005). *Committee Decisions on Monetary Policy: Evidence from Historical Records of the Federal Open Market Committee*. MIT Press.

Clarida, R., J. Galí, and M. Gertler (2000). Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory. *Quarterly Journal of Economics 115*(1), 147–180.

Evans, G. W. and S. Honkapohja (2001). *Learning and Expectations in Macroeconomics*. Princeton, NJ: Princeton University Press.

Malmendier, U. and S. Nagel (2015). Learning from Inflation Experiences. *Quarterly Journal of Economics*, forthcoming.

Meade, E. E. and D. Stasavage (2008). Publicity of Debate and the Incentive to Dissent: Evidence from the US Federal Reserve*. *Economic Journal 118*(528), 695–717.

Mehra, Y. P. and B. Sawhney (2010). Inflation Measure, Taylor Rules, and the Greenspan-Bernanke Years. *FRB Richmond Economic Quarterly 96*(2), 123–151.

Mishkin, F. S. (2010). Monetary Policy Flexibility, Risk Management, and Financial Disruptions. *Journal of Asian Economics 21*(3), 242–246.

Orphanides, A. (2001). Monetary Policy Rules Based on Real-Time Data. *American Economic Review 91*(4), 964–9999.

Orphanides, A. (2003). Historical Monetary Policy Analysis and the Taylor Rule. *Journal of Monetary Economics 50*(5), 983–1022.

Orphanides, A. and J. C. Williams (2005). The Decline of Activist Stabilization Policy: Natural Rate Misperceptions, Learning and Expectations. *Journal of Economic Dynamics and Control 29*, 1927–1950.

Romer, C. D. and D. H. Romer (2008). The FOMC versus the Staff: Where Can Monetary Policymakers Add Value? *The American Economic Review*, 230–235.

Rotemberg, J. J. and M. Woodford (1999). Interest Rate Rules in an Estimated Sticky Price Model. In J. B. Taylor (Ed.), *Monetary Policy Rules*. University of Chicago Press.

Shiller, R. J. (2005). *Irrational Exuberance*. Princeton, NJ: Princeton University Press.

Svensson, L. E. (1997). Inflation Forecast Targeting: Implementing and Monitoring Inflation Targets. *European Economic Review 41*(6), 1111–1146.

Taylor, J. B. (1993). Discretion versus Policy Rules in Practice. *Carnegie-Rochester Conference Series on Public Policy 39*, 195–214.

Williams, R. (2006). Generalized Ordered Logit/Partial Proportional Odds Models for Ordinal Dependent Variables. *Stata Journal 6*(1), 58–82.