Outdated predictions and US monetary policy

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Abstract

Do central bankers take into account past forecasts when making policy decisions? When should they? This article examines the issue using real-time data on US monetary policy. I find evidence that the Fed takes into account past forecasts of output growth and output gap, and that this happens in a manner consistent with the policymaker taking optimally into account how these variables' forecasts are smoothed.

Before each meeting of the Federal Open Market Committee (FOMC), the decision making body of the Federal Reserve, the staff of the Board of Governors of the Federal Reserve System produces projections[1] of the past, present and future development of the economy. This information is then used by the FOMC to make informed decisions on the overnight interest rate and other policy instruments to steer the economy in the desired direction.

The FOMC currently meets eight times each year, on average, and each time the projections are updated. These updates have in recent years actually been the very first thing presented in the projection documents (**Table 1**).

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1. This paper uses the terms "projection" and "forecast" interchangeably.

Summary of the Near-Term Outlook
(Percent change at annual rate except as noted)

Measure	2007:Q3		2007:Q4	
	Oct. GB	Dec. GB	Oct. GB	Dec. GB
Real GDP	**3.3**	**5.0**	**1.4**	**.1**
Private domestic final purchases	2.0	2.1	.3	-.2
Personal consumption expenditures	3.2	2.7	2.3	1.3
Residential investment	-22.4	-20.3	-32.8	-30.0
Business fixed investment	6.2	10.1	3.2	4.4
Government outlays for consumption and investment	3.2	3.9	3.1	2.4
	Contribution to growth (percentage points)			
Inventory investment	-.3	1.0	.6	-.4
Net exports	1.3	1.4	.0	.1

Table 1: Projection summary from December 5 2007 Greenbook.

Do the past projections presented to the policymakers guide policy-making, and if so, why? This paper tries to answer this question. I include past projections in a monetary policy reaction function estimated on real time data and test for their significance. There is some indication that past projections indeed are determinants of US monetary policy, although results depend on the functional form assumed for the reaction function. I am not aware of any previous research testing this issue.[2] Thus this is a novel angle of approach to the much-studied question of Fed's policy-making in real time.

Why would the policymaker ever use outdated information? I will show that if the forecaster takes into account her own previous forecast, then the policymaker should also take into account the previous forecast. This behaviour in part of the forecaster has been called forecast smoothing, or more generally under- or overreaction to new information. A possible justification for underreacting to new information is that the forecaster wants to protect her reputation by not appearing volatile and erratic.

2. Kapinos & Hanson (2013) include past projections in one of their specifications, but only as a technical recourse for differencing out an unobservable variable and not as an object of interest in itself.

I will first augment a baseline monetary policy reaction function with previous forecasts to see if they indeed are policy determinants. In all estimation I use real-time data. I then test the issue using different specifications of the sample, policy target variables and policy horizons. After this I will use a simple model to show how optimal policy takes past projections into account under forecaster's under- or overraction. Finally, I will test whether policymaker's behaviour is consistent with optimality.

The paper proceeds as follows. The next section reviews related literature. Section 2 presents data and variable definitions. Section 3 presents baseline results and robustness tests. Section 4 defines forecaster's behaviour under under- or overreaction and analyses policymaker's optimal response to this, both theoretically and empirically.

1 Related literature

Recent years have seen a proliferation of research using real-time data (Croushore 2011). It is now increasingly recognized that the researcher should use the same information set as the agents whose behaviour she is trying to analyse, be they policymakers or forecasters.

Estimating monetary policy reaction functions, or Taylor rules, is plagued with structural uncertainty. This uncertainty concerns both the functional form of the policy rule and changes in the policy rule within the sample period used. Orphanides (2001) made the disconcerting observation that response parameters for inflation and output gap varied over different policy horizons, even though the overall model fit did not. This makes it difficult for the empirical researcher to rely on any single specification. Due to these concerns over structural uncertainty, Lee et al. (2015) estimate a "Meta Taylor rule", a model averaging exercise over Taylor rules estimated for different policy horizons.

There is also a considerable amount of research on coefficient stability, or regime changes for the US monetary policy post-WWII (see e.g. Sims & Zha 2006, Boivin & Giannoni 2006, Bianchi 2013). The literature is somewhat inconclusive on the issue. Strongest evidence for a regime change is the period following the appointment of Paul Volcker in August 1979, and indeed it is common in the literature to conduct subsample analyses using this as a cutoff point.

With respect to the forecasts, there is now an extensive literature on Federal Reserve's internal forecasts, presented in the Greenbook, and their accuracy (see Chang & Hanson 2016 for a recent contribution). All these research questions are complicated by issues such as structural breaks within the sample, different policy horizons and data vintage (Croushore 2012a). Possible issues include comparing Fed's forecasts to those of private sector (Romer & Romer 2000, Gamber & Smith 2009) and whether Fed's forecasts display biases (Capistrán 2008).

Most importantly for the topic at hand, there is research on whether forecasters at the Fed under- or overreact to new information. Scotese (1994) argued that forecasters care about their reputation, and this reputation may not depend solely on the mean squared forecast error (MSFE). Forecaster's employers may see MSFE-minimizing forecast revision as too volatile to be credible, and this leads the forecaster to do smooth her projections. Alternatively it is possible that the forecaster overreacts to new information, perhaps in order to not appear sluggish. It should be noted that reputational concerns are only one explanation for this kind of behaviour. One alternative mechanism is that the forecaster cares about policy, and uses the forecasts as tools to influence policy decisions. If, for example, the forecaster would like to see the policymaker reacting faster to new information, she may want to overreact in her own projections.

Scotese (1994) herself found some evidence for smoothing GNP projections by comparing actual forecast revisions to those obtained from a BVAR. Clements et al. (2007) pool forecasts across horizons and find evidence of forecast smoothing for inflation. Messina et al. (2015) test for under- or overreaction using different policy horizons and target variables, and find neither under- nor overreaction in most cases.

2 Data

This section presents the variable definitions and the data used in the analyses.

2.1 Notation and temporal aggregation

I define the dependent variable, the policy rate, as the average policy rate between two successive FOMC meetings. This temporal aggregation scheme is somewhat different than that used in some previous studies, although similar to that used by

Kapinos & Hanson (2013). Researchers have varyingly used quarterly (e.g. Orphanides 2001, Capistrán 2008) and monthly (e.g. Boivin 2006) specifications. Orphanides (2001) aggregates projection data to a quarterly frequency by using information only from the FOMC meeting closest to the middle of the quarter. Boivin (2006) implements his monthly specification by using projections from the last FOMC meeting before the beginning of that month.

In my view the natural unit of analysis for the question in this paper is an FOMC meeting with its associated information set, and because of this these dates define the aggregation of the dependent variable. Prior to 1981 the FOMC met typically twelve times each year, after which it has met eight times per year.

Denote by m a date of an FOMC meeting. Because the forecasts concern specific quarters, define a mapping $\tilde{q}(m)$ which gives the FOMC meeting date as a quarter. Denote the t_1 estimate of a variable v at date t_2 as $F_{t_1}(v_{t_2})$. For any variable v present in a given Greenbook prepared for an FOMC meeting I observe $F_{m-h}(v_{\tilde{q}(m)})$ with $h = \{\underline{h}, ..., 0, ..., \overline{h}\}$, where $\underline{h}$ and $\overline{h}$ define the projectional horizon.[3] The range $\{\underline{h}, \overline{h}\}$ and the set of variables varies between different Greenbooks.

With this notation, a real-time monetary policy reaction function estimated with OLS can be written as

$$i_m = \beta_0 + \gamma_1 i_{m-1} + ... + \gamma_L i_{m-L} + \beta_\pi F_m(\pi_{\tilde{q}(m)+h}) + \beta_x F_m(x_{\tilde{q}(m)+h}), \tag{1}$$

where π is some measure of inflation and x is some measure of real activity or its change, L is the dependent variable lag length and h is the policy horizon. Lagged interest rates are included to account for interest rate smoothing (see e.g. Clarida, Galí & Gertler 2000). (1) describes how the policy rate is set according to previous policy rates and current projections for the policy horizon.

To test for the relevance of past projections, I augment (1) with $F_{m-1}(\pi_{\tilde{q}(m)+h})$ and $F_{m-1}(x_{\tilde{q}(m)+h})$, which are the projections presented in the previous quarter. I then test for the statistical significance of these variables and inspect their coefficient values across different specifications of target variables, policy horizons and samples. At

3. Note that the subindex in F refers to an FOMC meeting, and the subindex in the projection variables refers to quarters. Thus $F_m(v_{\tilde{q}(m)+1})$ for example reads as "forecast of v made in meeting m for the quarter following meeting m.

this stage I am only considering the effects of projections presented in the previous meeting, it is of course possible that the FOMC has an even longer memory.

2.2 Data

Data on effective daily federal funds are from FRED, the St. Louis Fed Federal Reserve Economic Data database. Greenbook projections are obtained from the Philadelphia Fed's Real-Time Data Research Center.[4] The projection horizon and the set of variables varies between different Greenbooks.

To avoid the issue of unconventional monetary policy measures and the zero lower bound, the years after 2007 are restricted outside the sample. Effectively this means discarding the years 2008, 2009 and 2010 as Greenbooks have a 5-year publication lag.

To my knowledge, the first Greenbook was presented for the June 17 1964 meeting of the FOMC and since the beginning of 1966 it has included quarterly projections for inflation and output. The Real-Time Data Research Center provides projections from 1967 onwards in digital format. Of the potential target variables, GDP growth and the change in the GDP deflator are available since the beginning. CPI inflation is available since late-1979.

Estimates of the output gap are not included in the Greenbook, although they have for some time been estimated by the FOMC staff. Orphanides (2004) uses potential output estimates of the Council of Economic Advisers and the Commerce Department for 1966-1980, and "internal Federal Reserve staff estimates" since then. The Real-Time Data Research Center, however, only has output gap data since mid-1987.

Appendix A1 presents the range $\{\underline{h}, \overline{h}\}$ for different target variables over time and the evolution of the federal funds rate over time.

3 Are previous projections policy determinants?

As discussed in section 1, there is great structural uncertainty related to estimating monetary policy reaction functions. I will choose a baseline specification and test for robustness of the results related to sample, policy target variables and the policy

4. Greenbook was the statistical publication presented to the FOMC, containing the projections. Although projections continue, the Greenbook itself was discontinued in 2010.

horizon. Although results are not consistent across specifications, it seems that past projections appear to be determinants of US monetary policy.

In choosing the baseline specification I am maximizing sample size. This means using growth in real GDP as the real variable and growth in the GDP deflator as the nominal variable, and using a contemporaneous Taylor rule specification. These allow me to use data for 1967-2007, altogether 381 observations. I will also run tests for different target variables and different policy horizons. Additionally I will run subsample analyses using rolling regressions. I have also conducted tests using interactions on relative forecast errors of current and past projections, and the business cycle, which can be found in the appendix A2.

I will include three lags of the policy variable in all regressions. This is the number of lags which minimizes the BIC for all specifications with different policy horizons and different target variables, with the curious exception of the baseline specification, for which BIC is minimized with 13 lags. Because the results of the baseline specification with respect to target variables are very similar for 3 and 13 lags of the dependent variable, I will use 3 lags in the baseline variable as well. Using the AIC produces longer and more varying lag lengths.

Table 2 presents the baseline results. Both past projections are significant, although curiously the current projection on inflation is not. The negative coefficient on the past projection of the output variable is consistent with an idea of responding to smoothed projections. The positive coefficient on the past projection of inflation rate, combined with a non-significant coefficient on its current projection, could perhaps be interpreted as a delayed response by the policymaker.

Variable	Estimate	Std.Error	t-value	$Pr(>\|t\|)$
Intercept	0.02	0.1	0.17	0.87
i_{m-1}	1.32	0.05	26.79	0
i_{m-2}	-0.61	0.08	-7.86	0
i_{m-3}	0.23	0.05	4.75	0
$F_m(\pi_{\tilde{q}(m)})$	-0.08	0.05	-1.52	0.13
$F_m(y_{\tilde{q}(m)})$	0.17	0.03	6.11	0
$F_{m-1}(\pi_{\tilde{q}(m)})$	0.13	0.05	2.54	0.01
$F_{m-1}(y_{\tilde{q}(m)})$	-0.14	0.03	-4.84	0

Table 2: Baseline results. i_{m-1} is the policy rate set at previous meeting, and the other lags of the dependent variable are defined accordingly. $F_m(y_{\tilde{q}(m)})$ is the current projection for current real GDP growth and $F_m(\pi_{\tilde{q}(m)})$ is the current projection for growth in GDP deflator. F_{m-1} are projections from the previous FOMC meeting.

Figure 1 presents results from a subsample analysis. As in for example Croushore (2012b), this is implemented using a rolling regression with a 5-year window. The top panel shows p-values for the past projection of inflation (growth of GDP deflator), the bottom panel that for real GDP growth. The p-values for inflation do not have a clear pattern, with the past projection being statistically significant in some periods here and there. The values for the past projections for growth in real GDP, however, display a stronger pattern, with significant effects for the pre 1979-period. Additionally there is a brief period around 2003, when the GDP deflator is also significant.

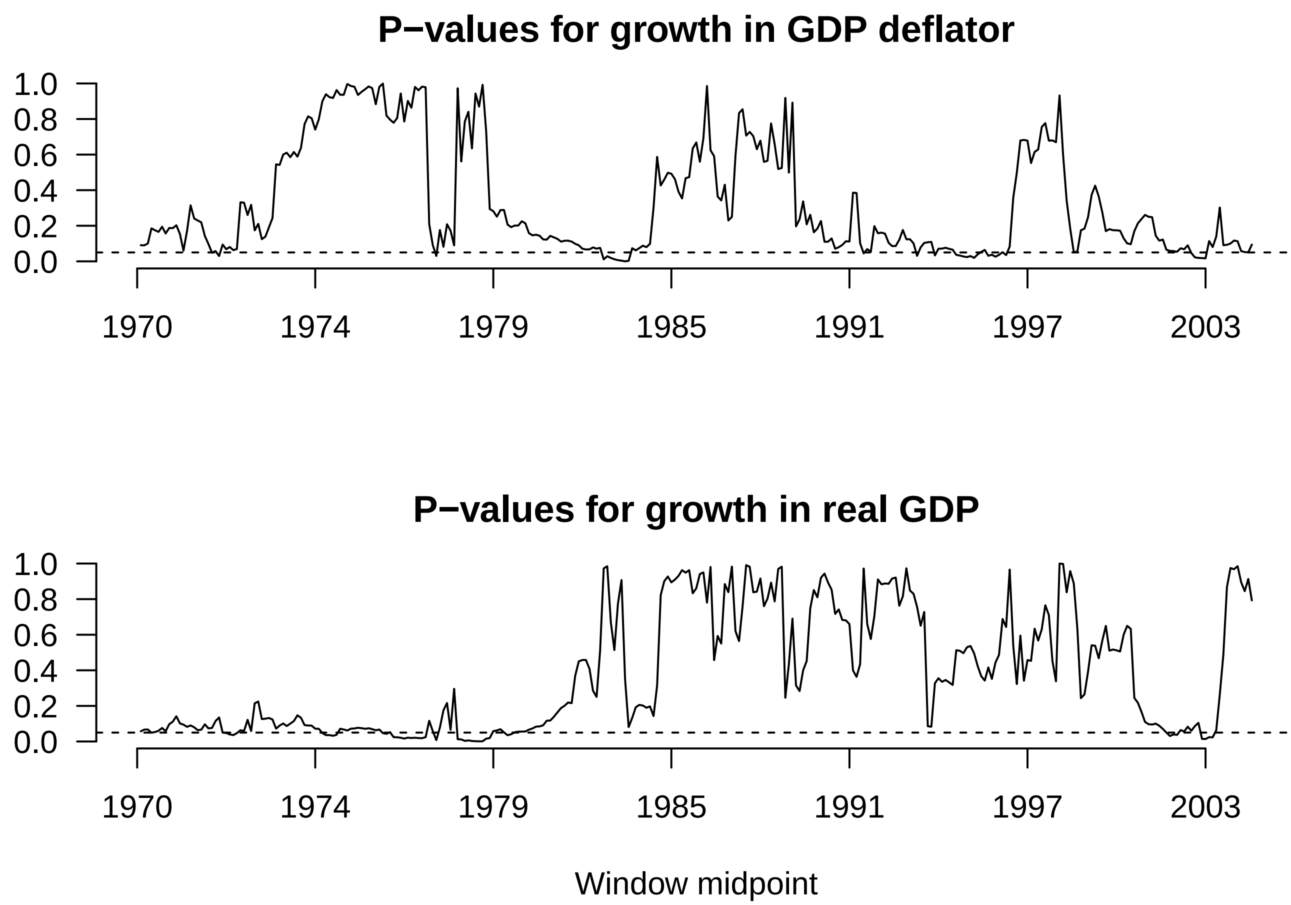

Figure 1: P-values of past projections from rolling regressions. The baseline regression was run as a rolling regression on 5-year intervals. The dashed line depicts the 5 % threshold.

One issue is that there is uncertainty regarding the specific form of the Taylor rule. To account for this, I test for past projections using different policy horizons and different target variables.

Table 3 gives coefficient values and associated standard errors for past projections estimated in specifications with different horizons, target variables and samples. Specification 1 and 2 have the same set of target variables, and specifications 2 and 3 use the same samples. The target variables are real GDP growth and growth in GDP deflator in specifications 1 and 2, and output gap and CPI inflation in specification 3. Samples begin at the Apr 4 1967 FOMC meeting in specification 1, and at the

Sep 16 1987 meeting in specification 2. Note that the sample size varies between horizons somewhat, as "further away" projections such as those two quarters past or four quarters ahead are not available in all Greenbooks.

The results are mixed. The most consistent result is that past projections of the past are not significant in any of the specifications (with the exception of output gap in specification 3 with p-value of 0.07) which seems reasonable. In addition, the contemporaneous and one-period-forward projections of GDP or output gap are consistently negative and significant with the exception of contemporaneous real GDP growth for the post-1987 sample. The positive effects of past projections of real GDP growth for the longer sample are somewhat curious, and not present in any of the other specifications.

		Specification 1		Specification 2		Specification 3	
Horizon	Observations	$F_{t-h}(y_t)$	$F_{t-h}(\pi_t)$	$F_{t-h}(y_t)$	$F_{t-h}(\pi_t)$	$F_{t-h}(y_t)$	$F_{t-h}(\pi_t)$
−2	372/156	0.01	0.02	0.03	0.01	−0.13	−0.02
		(0.02)	(0.05)	(0.02)	(0.03)	(0.08)	(0.02)
−1	381/160	−0.01	−0.03	0.02	0.01	−0.12*	0.02
		(0.02)	(0.05)	(0.02)	(0.03)	(0.07)	(0.02)
0	381/160	−0.14***	0.13**	−0.03	0.09***	−0.21***	0.01
		(0.03)	(0.05)	(0.02)	(0.03)	(0.05)	(0.02)
1	363/160	−0.11**	−0.09	−0.04**	0	−0.16***	0.04
		(0.04)	(0.07)	(0.02)	(0.04)	(0.04)	(0.03)
2	353/160	−0.01	0.03	−0.06**	−0.19***	−0.12***	−0.02
		(0.05)	(0.09)	(0.03)	(0.05)	(0.04)	(0.05)
3	326/160	0.17**	0.24*	−0.02	−0.04	−0.07*	−0.06
		(0.07)	(0.13)	(0.04)	(0.08)	(0.04)	(0.06)
4	286/159	0.21**	0.08	−0.02	−0.03	−0.08*	−0.12
		(0.1)	(0.17)	(0.06)	(0.09)	(0.04)	(0.08)

Table 3: Tests for different horizons, target variables and samples. y refers to $F_{m-1}(y_{\tilde{q}(m)-h})$ and π refers to $F_{m-1}(\pi_{\tilde{q}(m)-h})$, where y is either real GDP growth or the output gap and π is inflation measured by either GDP deflator or the CPI. The numbers not in parentheses are coefficient values and the numbers in parentheses are associated standard errors. Specification 1 has real GDP growth and growth in GDP deflator as target variables, and sample starting from the April 4 1967 FOMC meeting. Specification 2 has the same target variables, but a sample starting from the Sep 16 1987 FOMC meeting. Specification 3 has the output gap and CPI inflation as target variables, with a sample starting from the Sep 16 1987 meeting. The numbers in the "Obs" column correspond to numbers of observations in the longer and the shorter sample, respectively. Stars (***/**/*) denote t-test p-values of ($< 0.01/< 0.05/< 0.1$).

4 Forecaster's under- or overreaction and the optimal policy response

Previous section presented some evidence that past projections are policy determinants (or at least have been in the historical sample analysed). This section gives a simple model of forecaster's under- or overreaction to new information, and shows how taking into account past projections under this behaviour is optimal policy.

Under forecaster's under- or overreaction the revised forecast is some weighted average of the optimal[5] forecast and the previous forecast (or multiple previous forecasts in a more general case). Denote by $F_t^*(x_{t+h})$ the optimal forecast for x_{t+h} made at t, and by by $F_t(x_{t+h})$ the one actually made. This simple case of smoothing behavior can be written as

$$F_t(x_{t+h}) = (1-\alpha)F_t^*(x_{t+h}) + \alpha F_{t-1}(x_{t+h}), \tag{2}$$

where $\alpha \leq 1$ determines the degree of under- or overreaction: for $\alpha > 0$ the forecaster underreacts to new information ("smooths forecasts"), for $\alpha < 0$ the forecaster overreacts, and for $\alpha = 0$ forecasts are memoryless.[6] The policymaker then sets the policy instrument i to minimize some loss in terms of the actual value of x, which means that the policymaker uses the forecast information given to make inferences on the optimal forecast. We can describe policy "reactions" to past projections as

$$\frac{\partial i_t}{\partial F_{t-1}(x_{t+h})} = \frac{\partial i_t}{\partial F_t^*(x_{t+h})} \frac{\partial F_t^*(x_{t+h})}{\partial F_{t-1}(x_{t+h})}. \tag{3}$$

From (1) we can derive $\frac{\partial F_t^*(x_{t+h})}{\partial F_{t-1}(x_{t+h})} = \frac{\alpha}{\alpha-1}$. Suppose that $\frac{\partial i_t}{\partial F_t(x_{t+h})} > 0$, which would be the case for inflation or output gap, for example: an increase in projected inflation induces a rise in policy rates. This then implies that $\frac{\partial i_t}{\partial F_{t-1}(x_{t+h})} < 0$ if forecasts are smoothed, and $\frac{\partial i_t}{\partial F_{t-1}(x_{t+h})} > 0$ if the forecaster overreacts.

5. I am using the word "optimal" here to refer to optimality from the point of view of the user of the forecast, who presumably wants to use mean squared error-minimizing forecasts.

6. For $\alpha > 1$ forecasts eventually explode into negative or positive infinity, and because of this property this behaviour can be excluded at least in the long run. It is of course possible for the policymaker to believe that $\alpha > 1$, at least in principle.

Table 4 uses a numerical example to illustrate the case for smoothing. The forecaster is known to always give its inflation forecast halfway between the optimal and the previous forecast (that is, $\alpha = 0.5$). The forecaster derives the the second column (the updated forecast) as a function of the first and third columns, (previous forecast and optimal forecast, respectively). The policymaker then derives the third column from observing the first and the second. A lower previous forecast means a higher optimal forecast, which warrants a higher policy rate.

	$F_{t-1}(x_{t+h})$	$F_t(x_{t+h})$	$F_t^*(x_{t+h})$
Case 1	2	4	6
Case 2	3	4	5

Table 4: A numerical example illustrating forecaster's behavior and policymaker's inference under smoothing. x is a policy target variable, which the forecaster projects (e.g. inflation). The policymaker observes previous and current forecasts $F_{t-1}(x_{t+h})$ and $F_t(x_{t+h})$, respectively, and deduces $F_t^*(x_{t+h})$ knowing the forecasters smoothing behavior (here, $\alpha = 0.5$ in equation (2) in text).

To get a more accurate prediction from this very simple model, consider running a regression

$$i_t = \beta_0 + \beta_{CF} F_t(x_{t+h}) + \beta_{PF} F_{t-1}(x_{t+h}) + \epsilon_t, \tag{4}$$

where β_{CF} is the coefficient on the current forecast and β_{PF} is the coefficient for the previous forecast. Under optimal policy

$$\begin{aligned} \beta_{CF} &= \frac{\partial i_t}{\partial F_t(x_{t+h})} \\ &= \frac{\partial i_t}{\partial F_t^*(x_{t+h})} \frac{\partial F_t^*(x_{t+h})}{\partial F_t(x_{t+h})} \\ &= \frac{\partial i_t}{\partial F_t^*(x_{t+h})} \times \frac{1}{1-\alpha} \end{aligned} \tag{5}$$

and

$$\begin{aligned} \beta_{PF} &= \frac{\partial i_t}{\partial F_{t-1}(x_{t+h})} \\ &= \frac{\partial i_t}{\partial F_t^*(x_{t+h})} \frac{\partial F_t^*(x_{t+h})}{\partial F_{t-1}(x_{t+h})} \\ &= \frac{\partial i_t}{\partial F_t^*(x_{t+h})} \times \frac{\alpha}{\alpha - 1}. \end{aligned} \tag{6}$$

Combining (5) and (6) we get

$$\frac{\beta_{CF}}{\beta_{PF}} = -\frac{1}{\alpha} \tag{7}$$

Using this framework, we can test whether the policymaker uses past projections optimally. I will estimate (2) and test if the coefficients obtained for α are consistent with (7) taking into account the coefficients for current and previous forecasts in the baseline specification in Table 2. I will proxy the unobserved F^* with the realized value of the variable, which is consistent with F^* indeed being the optimal forecast.

As Croushore (2012a) notes, the concept of a "final" value is somewhat difficult, as updates to price indices induce changes in very distant past. For example the benchmark revision of GDP in January 1996 changed real GDP growth rates in the 1950's. For this reason some researchers (e.g. Auerbach & Gorodnichenko 2012) use (also) measure of final data closer to the real-time projection. For robustness I will use both final-vintage data from FRED and an alternative measure which uses the final available data point from Greenbooks. To take an example, the final Greenbook projection for real GDP growth in 1968:Q3 was presented in the June 1969 Greenbook.

Table 5 presents the results. The variables under y refer to regressions and tests on real GDP growth, and those under π refer to those on growth in GDP deflator. Specification 1 uses final values from Greenbooks, and specification 2 uses final values from a current-vintage FRED database.

The first row depicts α-estimates from the forecasting equation (2). The implied assumption that coefficient values sum to unity was not rejected in any specification, and the values presented in the table are obtained from a specification with this restriction in place. The degree of smoothing is quite similar across specifications and across variables. The value implies quite a large degree of smoothing; it is not however easy to compare this estimate to those obtained in the previous literature, which use different methods.

The second row gives $-\frac{1}{\alpha}$, which should correspond to the ratio of the coefficients on previous and current projections, respectively. The third row presents the actual ratio, as estimated in the baseline equation. Note that the forecast equations are run separately for output growth and inflation, but the β-coefficients are estimated from a policy reaction function with both target variables included simultaneously. Finally the fourth row gives p-values of a non-linear Wald-test on the restriction that the estimated ratio is equal to the ratio implied by the forecasting equations.

For real GDP growth we cannot reject the null hypothesis that the coefficient ratio is equal to the implied ratio. This is consistent with the policymaker using past projections in an optimal way to account for the smoothing inherent in the forecasts.

For the growth in GDP deflator, consistency with optimality is rejected, but I do not want to put too much weight on this result. Firstly, as is evident in Table 3, the role of past projections of the inflation rate is much less robust than that of the real GDP growth rate / output gap. Secondly, the estimated coefficient ratio implies a value of α larger than unity, which is not consistent with well-behaved forecasts.

	y		π	
	1	2	1	2
α	0.74	0.8	0.76	0.76
Implied $\frac{\beta_{CF}}{\beta_{PF}}$	-1.35	-1.24	-1.31	-1.31
Estimated $\frac{\beta_{CF}}{\beta_{PF}}$	-1.18		-0.57	
Pr(implied=actual)	0.13	0.58	0	0

Table 5: Testing policy responses' consistency with optimality under forecast smoothing. The columns under y refer to regressions and tests on real GDP growth, and those under π refer to those on growth in GDP deflator. Specification 1 uses final values from Greenbooks, and specification 2 uses final values from a current-vintage FRED database. α is an estimate from equation (2) in text, with F^* proxied with final values and estimated for the baseline $h = 0$ horizon specification. Implied $\frac{\beta_{CF}}{\beta_{PF}}$ is $-\frac{1}{\alpha}$, per equation (7) in text. Implied $\frac{\beta_{CF}}{\beta_{PF}}$ is the ratio of the estimates for current and previous projections in the baseline specification, the results of which are found in Table 2. Pr(implied=actual) is the p-value of a non-linear Wald-test where the actual coefficient ratio is set to the implied coefficient ratio. All estimates are for the full 1967-2007 sample.

5 Conclusions

Policymakers at the Federal Reserve are routinely presented with information concerning not only current, but also previous forecasts of the economy. In this paper I have given some evidence that the FOMC seems to take these previous forecasts into account when making decisions on the Federal funds rate. The evidence for this is strongest and most consistent for the real targets of monetary policy, the growth rate of real GDP or the level of the output gap. It is shown that using past projections is optimal when forecasts are smoothed. The empirical estimates suggest that the joint behaviour of the FOMC and its Staff is indeed consistent with this kind of optimality with respect to real GDP growth and output gap.

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Appendix

A1

Figure A1 presents the available projections in Greenbooks for different target variables. Horizons range from -4 (4 quarters behind) to 9 (9 quarters forward).

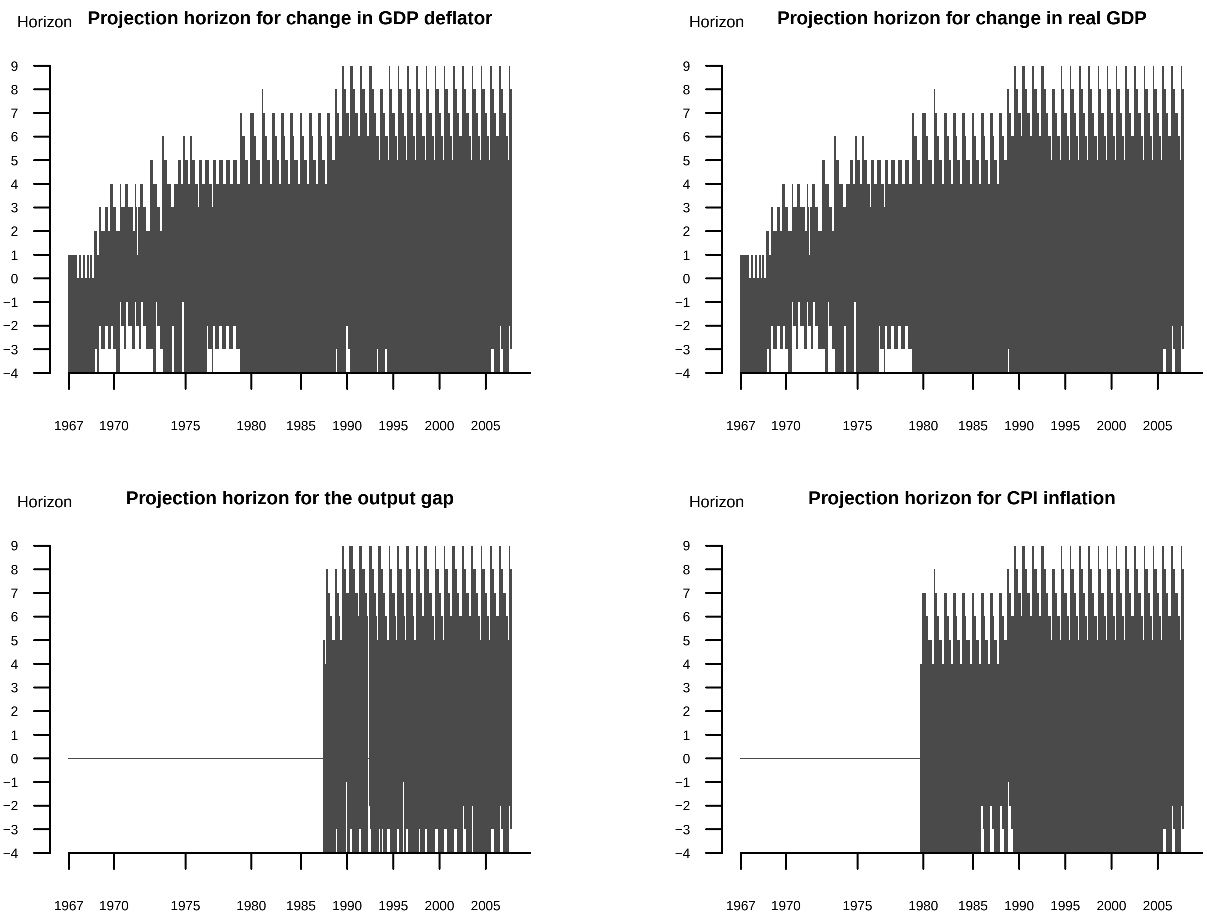

Figure A1: Available projections in Greenbooks for different target variables.

Figure A2 presents the between-meeting averages of the effective federal funds rate. Vertical dashed lines represent the starting points for the availablility of CPI inflation and output gap. Note that specifications 2 and 3 in **Table 4** in text rely on the sample beginning from the latter line.

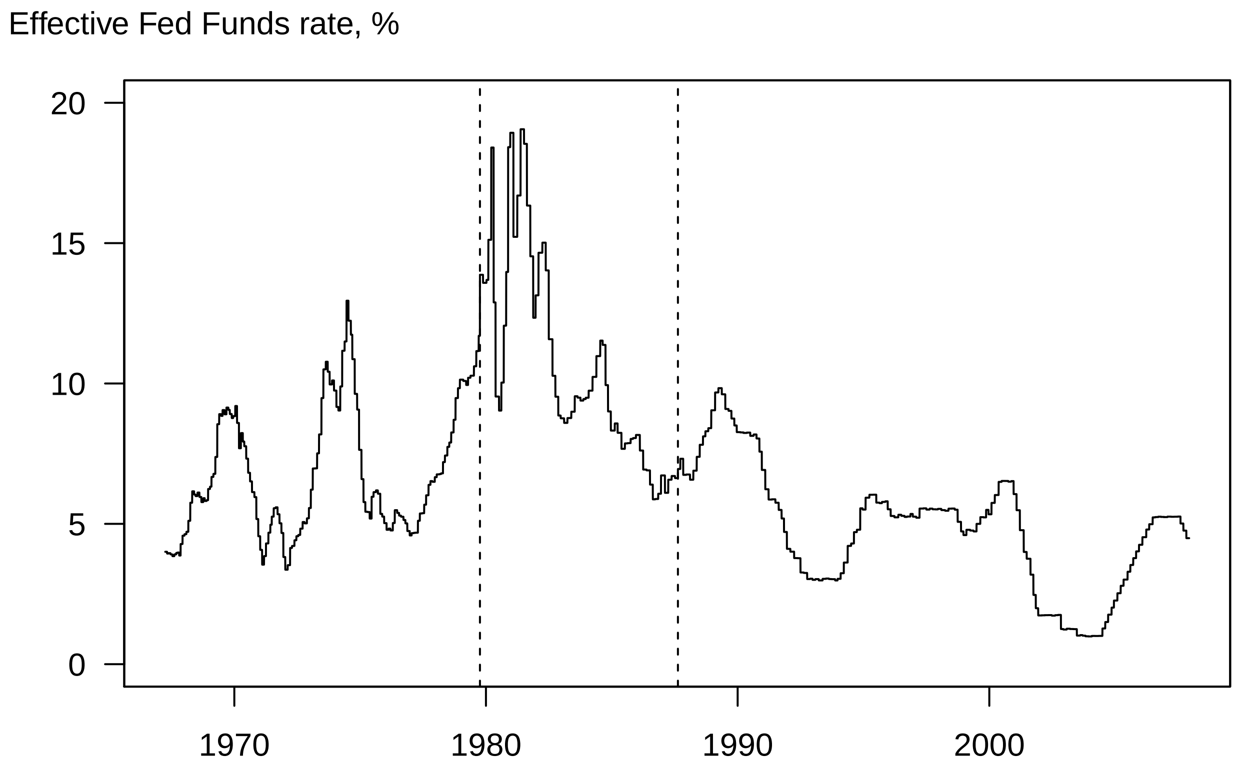

Figure A2: Between-meeting averages of the effective federal funds rate.

A2

In this appendix I present results from two interaction analyses. First I will test whether the effect of past projections depend on the eventual forecast errors, and after this I will test whether the role of the past projections varies over the business cycle. In both analyses I will use the baseline specification, i.e. real GDP growth and growth in GDP deflator as target variables and the sample starting from 1967.

The Staff doesn't always get their updates right - sometimes the previous forecast is actually closer to the final value than the more recent forecast. One explanation why the FOMC might use past projections is that it might be trying to outguess its staff, presumably thinking it has some private information on when its staff's revisions are correct and when they are not. To test this, I create a dummy variable which indicates that the previous forecast is actually closer to the final value than the current forecast.

As Croushore (2012a) notes, the concept of a "final" value is somewhat difficult, as updates to price indices induce changes in very distant past. For example the benchmark revision of GDP in January 1996 changed real GDP growth rates in the 1950's. For this reason some researchers (e.g. Auerbach & Gorodnichenko 2012) use (also) measure of final data closer to the real-time projection. For robustness I will use both final-vintage data from FRED and an alternative measure which uses the final available data point from Greenbooks. For example the final Greenbook projection for real GDP growth in 1968:Q3 was presented in the June 1969 Greenbook.

Using the final-vintage data, previous forecast was closer to the current forecast 40 and 48 % of the time for real GDP growth and GDP deflator growth, respectively, and 31 and 33 % of the time using the Greenbooks for final values. Table A1 presents the results. D refers to the dummy variable indicating that the previous forecast was closer to the final value, with specification 1 defining final values from new-vintage data and specification 2 defining them from Greenbook data.

The only significant interaction is for inflation in the second specification. Looking at the coefficients, it would seem that the FOMC is raising rates *less* in response to past projections of inflation when that past projection is more correct than the current projection. One could interpret this as the FOMC trying to outguess its Staff and failing at it, but I would not pay too much attention to this result as the effect of past inflation projections was not very robust across different specifications in the first place (see **Table 4** in text).

	Baseline	Specification	Specification 2
$F_{m-1}(y_{\tilde{q}(m)})$	-0.14^{***}	-0.15^{***}	-0.15^{***}
$F_{m-1}(\pi_{\tilde{q}(m)})$	0.13^{**}	0.15^{***}	0.16^{***}
$F_{m-1}(y_{\tilde{q}(m)}) \times D$		-0.01	-0.01
$F_{m-1}(\pi_{\tilde{q}(m)}) \times D$		-0.04	-0.13^{***}

Table A1: Effect of past projections conditional on relative forecast. The interaction dummy D indicates that the previous forecast was in the end closer to the final value than the current forecast. Specification 1 defines final values using final-vintage data, and specification 2 defines final values from Greenbook data, taking the last available Greenbook projection. The first column presents the baseline results with no interactions. Stars (***/**/*) denote t-test p-values of (< 0.01/< 0.05/< 0.1).

Table A2 presents results for interacting past projections with a recession dummy. I use two alternative recession dummies, defined either by NBER business cycle dates or the 6.5 % unemployment rate threshold used by Ramey & Zubairy (2016). With the first measure the economy is in recession 17 % and with the second measure 32 % of the sample.

The interaction effects are negative and statistically significant except for the real GDP growth interaction using the unemployment threshold dummy. These are somewhat open to interpretation, but looking this through the lens of forecast smoothing, this is consistent with the FOMC believing projections are smoothed more strongly in recessions. The results of Messina et al. (2015), however, indicate that if anything, the Greenbook forecasts for the GDP deflator are smoothed less during recessions.

	Baseline	R =NBER Recession	R =RZ recession
$F_{m-1}(y_{\tilde{q}(m)})$	-0.14^{***}	-0.12^{***}	-0.15^{***}
$F_{m-1}(\pi_{\tilde{q}(m)})$	0.13^{**}	0.12^{**}	0.21^{***}
$F_{m-1}(y_{\tilde{q}(m)}) \times R$		-0.08^{**}	0.01
$F_{m-1}(\pi_{\tilde{q}(m)}) \times R$		-0.09^{**}	-0.07^{**}

Table A2: Effect of past projections by business cycle. Table gives coefficient values for past projections and the interactions of past projections with a recession indicator. The first column presents the baseline results with no interactions. The second column defines recessions using NBER dates for beginning and end of recession. The third column uses Ramey & Zubairy's (2016) 6.5 percent unemployment rate threshold. Stars (***/**/*) denote t-test p-values of (< 0.01/< 0.05/< 0.1).