Did the Fed Do What It Said? Average Inflation Targeting Post-2020*

Dario Cardamone
University of Notre Dame

Victoria Consolvo
University of Notre Dame

Irakli Shalikashvili
University of Georgia

Eric Sims
University of Notre Dame and NBER

October 22, 2025

Abstract

As part of its framework review in 2020, the Federal Reserve (Fed) announced its intent to switch to average inflation targeting (AIT) rather than inflation targeting (IT). We estimate interest rate reaction functions pre- and post-2020. Pre-2020, Fed policy is well characterized by a conventional Taylor-type rule that reacts to period inflation. Post-2020, in contrast, the Fed appears to have reacted strongly to average inflation and not to period inflation, in line with the stated goals of the 2020 framework review. In the context of a textbook New Keynesian model, we show that AIT is similar to interest rate smoothing. In the face of large demand shocks, AIT results in a delayed policy response and higher, more persistent inflation. This pattern is roughly consistent with macroeconomic performance in the US post-2020.

Keywords:

*We are grateful to Christiane Baumeister and Christian Matthes for helpful comments. Correspondence: dcardamo@nd.edu, vconsolv@nd.edu, irakli.shalikashvili@uga.edu, and esims1@nd.edu.

1 Introduction

As part of a decades-long shift towards more transparency and clearer communication, in 2012 the Federal Reserve (Fed) issued its first Statement on Longer-Run Goals and Monetary Policy Strategy. This statement formalized the Fed's then-implicit two-percent inflation target. Small tweaks to the statement have been made each year thereafter. In 2019-20, the Fed conducted a year-long, comprehensive, and public review of its policy framework and signaled its intent to periodically do the same in the future.

The 2020 framework culminated in two sharp and highly visible changes to the Statement on Longer-Run Goals and Monetary Policy.[1] Regarding the first aspect of its dual mandate, the Fed articulated a focus on average, rather than period-by-period, inflation. This has come to be known as flexible average inflation targeting (FAIT or AIT). Regarding the second aspect of its dual mandate, the Fed announced a focus on shortfalls from full employment, rather than deviations. Formally announced in August 2020, the new framework coincided with the early stages of recovery from the brief COVID-19 recession. The Fed recently completed another comprehensive review. Both of the principal changes from the 2020 review were dropped.[2]

With the benefit of a few years' worth of data and hindsight, in the paper we seek to evaluate whether the Fed actually implemented the changes highlighted in the 2020 review and, if so, whether those changes mattered for US macroeconomic performance. In particular, we focus on the first aspect of the change in the Fed's framework; namely, its switch to average inflation targeting.[3] In Section 2, we empirically estimate interest rate reaction functions that allow for interest rate smoothing, a reaction to the unemployment rate, and reactions to both period and average inflation (where average inflation is a backward moving average

[1] A summary of the 2020 framework review may be found here.

[2] The updated framework from August 2025 may be found here.

[3] As we discuss in Section 2, we have done some analysis regarding the focus on shortfalls, rather than deviations, from full employment. A focus on the change in reaction to unemployment is particularly challenging for a couple of reasons. First, there is a question as how to measure full employment. Second, in the short sample we have since the framework review, there is not much variation regarding whether employment was above or below what one would consider full employment.

of period inflation over some specified period). For the post-Great Moderation (e.g., Stock and Watson 2003) period (1984-2019), we find no evidence that the Fed reacted to average inflation. Rather, monetary policy over this period is well-characterized by a conventional Taylor-type rule that reacts to period inflation and unemployment. We refer to such a rule as an inflation targeting (IT) rule. In the period between the 2020 framework review and the most recent review (August 2020 to the middle of 2025), in contrast, policy is well-characterized by an interest rate reaction function that responds to average inflation. In contrast, there is no evidence of any significant response to period inflation. These results are robust to several modifications in our baseline specification and use of different data sources (see the variety of results presented in Appendix A).

To answer the question posed in the title, the Fed does seem to have conducted policy as it said it would in the 2020 framework. With the caveats that the sample period since the last framework review is short (fewer than 60 monthly observations) and this time period was extraordinary in many respects, to our knowledge, this is the first paper to document a noticeable shift to AIT in estimated interest rate reaction functions.

In Section 3, we offer informed discussion on whether the switch in policy after August 2020 might have contributed to the high inflation post-COVID. Taking observed values of inflation and unemployment as given, we construct a counterfactual path of the policy rate had the Fed stuck with its estimated pre-2020 policy rule that focused only on period inflation. While this counterfactual is imperfect because it assumes no feedback from the parameters of the policy rule to the target variables, we find that the policy rate would have fallen less, risen earlier, and peaked at a significantly lower value under the pre-2020 estimated parameters than it did in actuality. To allow for feedback between the parameters of the policy rule and the target variables, we consider a textbook, three-equation New Keynesian model. In a simple case, we show that an AIT reaction function implies a particular form of interest smoothing. In this sense, a switch from IT to AIT can be considered roughly equivalent to a more inertial policy rule. In response to a demand or potential output shock (i.e., a natural rate shock), we find that the pre-2020 IT rule produces lower and less persistent inflation than the estimated post-2020 AIT rule. An AIT rule performs better conditional on a shock that imparts a tradeoff between output and inflation (i.e., a cost-push shock).

Given the simplicity of the model, and the inherent imperfections in the model-free counterfactual regarding the path of the policy rate, we are wary of drawing firm conclusions. But our analysis clearly points to a change towards AIT in Fed policy post-2020, and is suggestive that this policy change might have contributed to the high inflation of this era to the extent to which that inflation was driven by demand shocks. While the relative importance of demand and supply shocks in driving post-pandemic inflation remains contested, a recent paper by Giannone and Primiceri (2025) argues that demand was the primary culprit.

Related Literature: Following Taylor (1993), there is a voluminous literature that empirically estimates interest rate reaction functions. Judd and Rudebusch (1998), Taylor (1999), Clarida, Galí, and Gertler (2000), and Orphanides (2004) are classic references. More recently, Nakamura, Venance, and Steinsson (2025) argue that the original version of the Taylor rule promulgated in Taylor (1993) fits poorly outside of his original sample. Taylor (2023) and Bullard (2025) both argue that the post-COVID behavior of the Federal Funds Rate differs substantially from what is proscribed in a traditional Taylor rule.

Although our focus is on an estimated interest rate reaction function and whether the nature of that policy rule changed with the 2020 framework, our work also relates to a number of recent papers that aim to assess the importance of shifts in monetary policy for the behavior of inflation post-COVID. As an example, Bocola, Dovis, Jorgensen, and Kirpalani (2024) argue that behavior in bond markets suggests that the Fed placed less weight on inflation post-2020, with this change accounting for about half of the post-pandemic rise in inflation. Relatedly, but using a different methodology, Duncan, Garcia, and Miller (2025) argue that the switch to AIT raised US inflation by about one percentage point. In contrast, based on narrative evidence, Romer and Romer (2024) argue that the shift to AIT did not play a significant role in the post-2020 inflation. Although they do not focus on AIT per se, Gonzales-Astudillo and Tanvir (2023) argue that monetary policy was significantly more persistent post-2020. Similarly, Eggertson and Kohn (2023) argue that the changes in the Fed's 2020 framework delayed its response to inflation in the immediate wake of the pandemic.

2 Estimation

A traditional Taylor-type rule for the Fed's reaction function (Taylor 1993) takes the following form:

$$i_t = i^* + \rho_i i_{t-1} + \phi_\pi \left(\pi_{t-1} - \pi^*\right) + \phi_u \left(u_{t-1} - u^*\right) + \varepsilon_t. \tag{1}$$

Here, i^*, π^*, and u^* are taken to be constants. The policy rate is measured by i_t. The specification allows for some interest smoothing, as measured by the parameter ρ_i. Inflation is measured as π_{t-1}. Policy reacts to deviations of inflation from target via the parameter ϕ_π. Policy reacts to deviations of the unemployment rate, u_{t-1}, from target via the parameter ϕ_u. ε_t is an error term, representing a policy shock. For the empirical part of our paper, as shown in (1), we assume that the Fed reacts to the two target variables (inflation and unemployment) with a one-period lag.[4] Allowing for a contemporaneous reaction does not affect the results that follow. There are many possible variations on (1). For example, one could assume that the Fed reacts to the output gap rather than unemployment, or one could assume that the Fed reacts to expected rather than realized inflation (as in, e.g., Clarida, Galí, and Gertler 2000).[5]

[4] We make this timing assumption for two reasons. First, in practice, the Fed cannot observe either of the targets in real time as it is setting the policy rate. Second, this assumption sidesteps an endogeneity concern. In a forward-looking model, policy shocks, ε_t, would have immediate effects on target variables. In principle, this would make regression estimates of the parameters on these targets biased. In practice, as long as policy shocks are not too important, the extent of bias seems to be small. See, e.g., Carvalho, Nechio, and Tristao (2021).

[5] In both theoretical and empirical work, it is common to instead assume that the central bank reacts to deviations of output from potential. To the extent to which unemployment and the output gap are closely related (e.g., Okun 1962), this difference ought to be immaterial. As a baseline, we focus on the

We refer to a policy rule like (1) as an inflation-targeting (IT) rule. We posit that an average-inflation-targeting (AIT) rule simply replaces period inflation with average inflation:

$$i_t = i^* + \rho_i i_{t-1} + \phi_\pi \left(\pi^a_{t-1} - \pi^*\right) + \phi_u \left(u_{t-1} - u^*\right) + \varepsilon_t, \tag{2}$$

where π^a_{t-1} is the average of inflation over the previous $n \geq 1$ periods:

$$\pi^a_{t-1} = \frac{1}{n}\sum_{j=1}^{n} \pi_{t-j}. \tag{3}$$

In this section, we empirically estimate variants of these reaction functions. We estimate three types of regressions: one that includes just period inflation on the right-hand-side as in (1) (IT), one that includes average inflation over some specified time period as in (2) (AIT), and one that includes both period and average inflation as separate regressors (Combined). We conduct estimation over two sample periods: the post-Great Moderation period (1984-2019), and the shorter period from the release of the Fed's 2020 framework review up to its most recent changes to the Statement on Longer-Run Goals and Monetary Policy Strategy (August 2020 through May 2025). We omit the first seven months of 2020, which coincided with the COVID-19 recession.

As a baseline, all data are at the monthly frequency. We also consider estimations using quarterly data. The policy rate is measured as the effective Federal Funds rate (FFR), aggregated to a monthly frequency by averaging the daily rate within each month. For periods in which the FFR was 25 basis points or less, we use the Wu and Xia (2016) shadow rate series.[6] The measure of inflation is the Personal Consumption Expenditures (PCE) chain-type price index, excluding food and energy. This series is expressed at a compounded annual rate of change. When computing average inflation, we assume an 18-month window (six quarters) as a baseline. Unemployment is measured as the civilian unemployment rate. Inference is

unemployment rate because it is available at a higher frequency than a measure of the output gap. The results that follow are nevertheless robust to using the output gap in lieu of unemployment.

[6]Wu and Zhang (2019) estimate a version of the Taylor rule with the shadow rate series for periods where the zero lower bound (ZLB) was binding and argue that the empirical fit is strong.

conducted via Newey and West (1987) standard errors that are robust to heteroskedasticity and autocorrelation.

Results for the first sample are shown in Table 1. The first column estimates a traditional IT rule. There is a significant amount of interest rate smoothing. The coefficient on inflation is positive and statistically significant at 0.03. This implies a long-run reaction to inflation of 1.93.[7] The coefficient on the unemployment rate is negative and statistically significant. If one uses the gap version of Okun's Law (Okun 1962), which states that each percentage point movement in the unemployment rate corresponds to a two-percent reduction in output relative to potential, this would correspond to a long-run reaction to the output gap of 0.9. These are fairly conventional values of responses coefficients in Taylor-type rules. In particular, accounting for scale and the different frequency of observation, these estimates are quite similar to both the OLS and IV estimates presented in Carvalho, Nechio, and Tristao (2021) for a similar sample period.

The second column instead estimates an AIT rule where the Fed reacts to the 18-month (six-quarter) average of inflation. The signs and magnitudes of all estimated parameters are similar to the first column, albeit the coefficient on average inflation is a bit lower and statistically insignificant. The last column, labeled "Combined," regresses the FFR on its own lag, the unemployment rate, and both period inflation and average inflation. In this specification, the coefficient on period inflation is significant. Both it and the coefficient on unemployment are virtually identical to the estimates from the conventional IT estimation. In contrast, the estimated coefficient on average inflation is close to zero, albeit with a large standard error. These results suggest that, prior to 2020, the Fed was not targeting average inflation and is well-characterized as having followed a rather conventional Taylor-type rule.

Next, we repeat this exercise on a sample beginning in August 2020, the month the Fed announced its new operating framework. Results are shown in Table 2. For the IT

[7]It is common to see policy rules written as explicit partial-adjustment rules, i.e., $i_t = i^* + \rho_i i_{t-1} + (1-\rho_i)\left[\phi_\pi\left(\pi_{t-1} - \pi^*\right) + \phi_u\left(u_t - u^*\right)\right] + \varepsilon_t$. Written this way, ϕ_π measures the long-run response of the policy rate to inflation, and can be inferred by dividing our regression estimate on inflation by one minus the estimated coefficient on the lagged policy rate (and similarly for the response to unemployment).

Table 1: Interest Rate Reaction Function Estimates
1984-2019

	IT	**AIT**	**Combined**
Constant	0.133	0.135	0.133
	(0.081)	(0.084)	(0.082)
Lagged Rate	0.985***	0.985***	0.986***
	(0.007)	(0.008)	(0.008)
Inflation	0.029***		0.030***
	(0.010)		(0.011)
Avg. Inflation		0.025	-0.005
		(0.030)	(0.031)
Unemployment	-0.027**	-0.027**	-0.027**
	(0.011)	(0.011)	(0.011)
N	431	431	431
R-squared	0.996	0.995	0.996

Notes: this table presents results from regressions of the shadow FFR on its own lag and the once-lagged unemployment rate. Other regressors include the once-lagged period inflation rate (column labeled "IT"), the once-lagged average inflation rate over an 18-month window (column labeled "AIT"), or both of these variables (column labeled "Combined"). The frequency of observation is monthly. Standard errors are produced via Newey and West (1987).

Table 2: Interest Rate Reaction Function Estimates
2020-2025

	Inflation	**Avg. Inflation**	**Combined**
Constant	0.859**	-0.415	-0.449
	(0.353)	(0.474)	(0.460)
Lagged Rate	0.955***	0.966***	0.969***
	(0.021)	(0.020)	(0.019)
Inflation	0.027		0.008
	(0.018)		(0.019)
Avg. Inflation		0.176***	0.172***
		(0.043)	(0.045)
Unemployment	-0.176***	-0.014	-0.012
	(0.065)	(0.066)	(0.064)
N	57	57	57
R-squared	0.993	0.994	0.994

Notes: this table presents results from regressions of the shadow FFR on its own lag and the once-lagged unemployment rate. Other regressors include the once-lagged period inflation rate (column labeled "IT"), the once-lagged average inflation rate over an 18-month window (column labeled "AIT"), or both of these variables (column labeled "Combined"). The frequency of observation is monthly. Standard errors are produced via Newey and West (1987).

specification (left column), estimated coefficients are similar to the pre-2020 sample, albeit with large standard errors. In the middle column, which includes only average inflation as a regressor, the estimated coefficient on average inflation is large (0.18) and statistically significant. In the right-most column, we include both period and average inflation on the right-hand side. The results are the opposite of what appears in Table 1 for the earlier sample. In particular, the estimated coefficient on period inflation is close to zero, while the estimated coefficient on average inflation is large, positive, and statistically significant.

While the post-2020 sample size is admittedly small, our empirical results are nevertheless clear. Prior to 2020, the Fed is well-characterized as having followed a conventional Taylor-type rule. There is no evidence of a strong or significant response to average inflation. But post-2020, in contrast, the Fed appears to have reacted significantly to average inflation and not to period inflation. In other words, it seems that the Fed did do what it said it would in the August 2020 framework.

We conduct numerous robustness checks summarized in Appendix A, including alternative data frequencies, window lengths for averaging, and inflation measures. Across all of these, our main conclusion – that the Fed targeted period inflation pre-2020 and average inflation post-2020 – remains unchanged.[8]

As noted in Section 1, the 2020 framework review not only announced a switch away from IT to AIT, but also stated that the Fed would focus on shortfalls from full employment (as opposed to deviations). In Appendix Subsection A.9, we include the unemployment gap (relative to an estimate of the natural rate) and the unemployment gap interacted with a dummy variable equal to one when the gap is positive (these regressors appear in lieu of the unemployment rate). If the Fed were only focusing on deviations from full employment, we would expect the coefficient on the unemployment gap to be negative and the coefficient on the interaction term to be zero. In contrast, if the Fed were only focusing on employment shortfalls, we would expect the coefficient on the interaction term to be negative and the coefficient on the unemployment gap to be zero. Results are shown in Table A.12. Our results concerning reactions to period and average inflation across sub-samples are the same. The evidence on asymmetric responses to unemployment is inconclusive; the inclusion of the interaction term makes the standard errors significantly larger.

[8] In Appendix Subsection A.1, we repeat the above exercises but with quarterly data. In Appendix Subsection A.2, we drop the assumption that the Fed reacts to inflation (or average inflation) and the unemployment rate with a one-period lag, instead allowing for a contemporaneous reaction. In Subsection A.3, we consider alternative window lengths (where our baseline is $n = 18$). In particular, we consider three shorter windows: $n = 4$, $n = 8$, and $n = 12$ (one year, or four quarters). We consider one longer window: $n = 24$ (two years, or eight quarters). In Appendix Subsection A.4, we consider two alternative measures of inflation – the headline CPI and PCE (inclusive of food and energy). In Appendix Subsection A.5, we replace the unemployment rate on the right-hand-side of our regressions with different measures of real activity, including a measure of the output gap. In Appendix Subsection A.6, we consider additional lags of the interest rate on the right-hand-side of the regression specifications. In Subsection A.7, we use the actual FFR instead of the Wu-Xia shadow rate series for periods where the FFR was close to zero. In Subsection A.8, we conduct tests of equality of coefficients on many lags of inflation, instead of implicitly assuming in AIT specifications that these coefficients are identical.

3 The Framework Switch and Inflation Post-2020

Our empirical analysis points to a pivot in Fed policy aligning with the 2020 framework review. Pre-2020, the Fed is well-characterized as having followed a traditional IT reaction function. Post-2020, it appears that the Fed reacted to average inflation and not period inflation. Having established empirical evidence of this shift, we next assess whether it plausibly contributed to post-2020 inflation outcomes using both reduced-form counterfactuals and a stylized New Keynesian model.

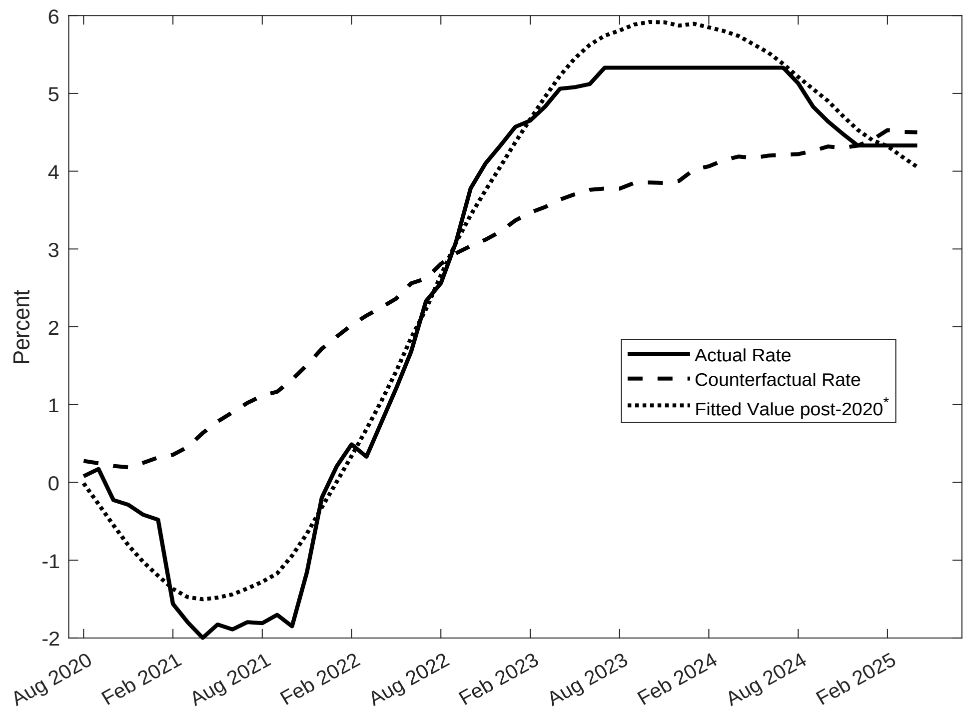
As a first pass, we simply take observed data on inflation and unemployment and compute (i) the implied path of the policy rate given the estimated AIT rule post-2020 and (ii) the counterfactual path of the FFR had the pre-2020 rule remained in place. We set policy parameters at the their estimated values from the "Combined" columns in Table 1 and Table 2. We take the observed FFR in July of 2020 and then simulate values of the policy rate from that starting point under either rule specification. We allow for the Fed to respond to both inflation and average inflation, but the estimated coefficients are such that the Fed approximately does not react to period inflation in the post-2020 sample and approximately does not react to average inflation in the counterfactual simulation using the pre-2020 estimates.

The results are shown in Figure 1. The solid line is the actual policy rate. The dotted line is the simulated value of the policy rate under the post-2020 estimation.[9] The dashed line is the counterfactual policy rate had the Fed stuck with its pre-2020 rule. To be clear, this counterfactual takes the actual paths of inflation and unemployment as given – it does not allow feedback from the parameters in the rule to the paths of inflation and output, which makes its interpretation potentially problematic.

In spite of this caveat, we nevertheless feel that this counterfactual is potentially instruc-

[9] This is similar, but not equivalent, to a fitted value. A fitted value would use the actual lagged policy rate each period to compute the fitted value in each period. Instead, we use only the initial value of the actual policy rate in the first period of the simulation. For subsequent periods, we use the simulated policy rate as the lagged rate each period to construct the counterfactual path (taking the paths of inflation and unemployment as given).

Figure 1: Actual and Counterfactual FFR Paths



Notes: this figure shows the actual time series of the shadow Federal Funds Rate (black, solid), the counterfactual path had the pre-2020 rule been used (dashed line), and the fitted value from the post-2020 estimation (dotted line).

tive. Had the Fed not switched to an AIT rule, the path of the policy rate would have been much smoother. It never would have gone negative and would have started rising much sooner than under the AIT rule.[10] In contrast, the policy rate would not have risen as significantly nor reached as high a level as the actual rate did in the high-inflation period of 2023-24. These results are similar to arguments put forth in Taylor (2023) and Bullard (2025).

To address the obvious concerns with this counterfactual, we compare and contrast the performances of an IT and an AIT rule in an otherwise textbook, three-equation New Keynesian model (e.g., Gali 2015). The demand and supply blocks of the economy are characterized by a forward-looking IS equation, (4), and a Phillips curve, (5).

$$x_t = \mathbb{E}_t x_{t+1} - \frac{1}{\sigma}\left(i_t - \mathbb{E}_t \pi_{t+1} - r_t^n\right). \tag{4}$$

$$\pi_t = \gamma x_t + \beta \mathbb{E}_t \pi_{t+1} + u_t. \tag{5}$$

In (4)-(5), x_t is the output gap (output relative to the flexible price level of output, y_t^f). The parameter σ^{-1} is the elasticity of intertemporal substitution, β is a discount factor, and γ is a function of the degree of price rigidity. The natural rate of interest, r_t^n, and a cost-push disturbance, u_t, both obey exogenous AR(1) processes:

$$r_t^n = \rho_r r_{t-1}^n + \varepsilon_{r,t}, \tag{6}$$

$$u_t = \rho_u u_{t-1} + \varepsilon_{u,t}. \tag{7}$$

For the model, we assume that the policy rate obeys the following reaction function:

$$i_t = \rho_i i_{t-1} + \phi_\pi \pi_t + \phi_{\pi^a} \pi_t^a + \phi_x x_t + \varepsilon_t. \tag{8}$$

[10] To be clear, the actual policy rate never went negative, either, but we use the Wu and Xia (2016) "shadow rate" for periods where the FFR was close to zero.

Here, π_t^a is the six-quarter average inflation rate. This rule aligns with the "Combined" regression columns in Table 1 and Table 2 in that it allows for a response to both inflation and average inflation. It differs from our empirical regressions in two respects. First, we allow for contemporaneous feedback between targets on the right-hand-side and the policy rate.[11] Second, we replace the unemployment rate, which does not have a counterpart in the three-equation model, with the output gap, x_t.

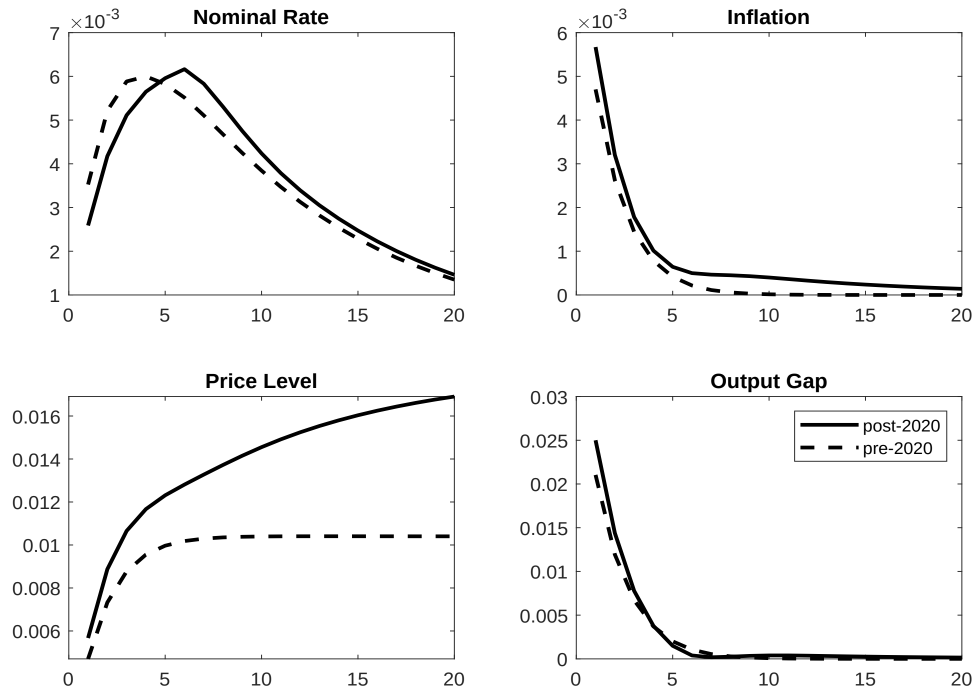
We parameterize the model as follows: $\gamma = 0.1$, $\beta = 0.99$ (i.e., the frequency of observation is quarterly), $\sigma = 1$, and $\rho_r = \rho_u = 0.9$. The natural rate and cost-push shocks are drawn from a normal distribution with standard deviations of 0.01 each. We assign policy parameters based on our empirical regressions. Because of the quarterly frequency in the model, and because there is no unemployment in the model, we estimate quarterly interest rate reaction functions with the output gap on the right-hand-side in lieu of unemployment. These regression results are shown in Table A.8 in the Appendix and are similar to our other analysis. One parameterization takes the estimated policy parameters from the pre-2020 sample (which features a strong reaction to period inflation and virtually no reaction to average inflation). The other uses estimates from post-2020 (a strong reaction to average inflation and virtually no reaction to period inflation).[12]

Figure 2 plots impulse responses to a natural rate shock. Solid lines are for the post-2020 parameterization; dashed lines are for the pre-2020 coefficients.

[11] As shown in Section 2, coefficient estimates are similar whether the right-hand-side target variables are lagged or not. With the exception of on impact, the model behaves similarly whether the right-hand-side variables in the reaction function are lagged or not. Things are quite different on impact, however, as there is no mechanism in the model for the interest rate to react immediately if it does not respond to contemporaneous values of targets on the right-hand-side.

[12] To be clear, the values of ρ_i, ϕ_π ϕ_{π^a}, and ϕ_x are taken from the "Combined" columns for the 1984-2019 and 2020-present samples in Table A.8.

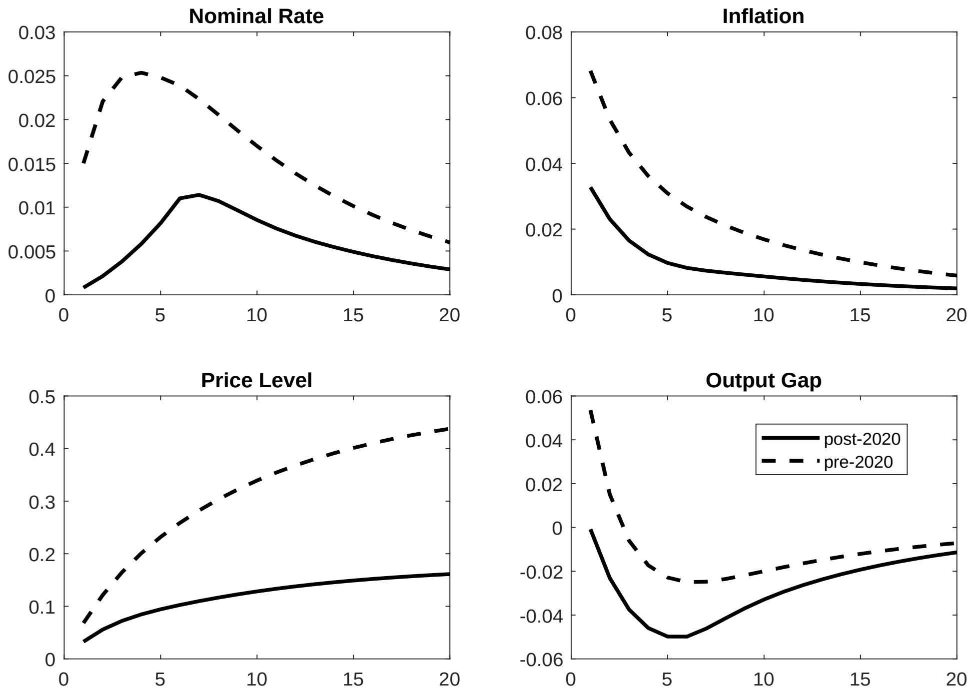
Figure 2: Pre- vs. Post-2020 Rule: Natural Rate Shock



Notes: this figure plots model-based impulse responses to a natural rate shock under the pre-2020 estimated policy rule (dashed line) and the post-2020 estimated rule (solid line).

For the post-2020 parameterization of the policy rule, there is a smaller initial response of the policy rate but a larger and more delayed medium-term response compared to the pre-2020 rule. There is little difference in the response of the output gap. Inflation responds more, and more persistently, with the post-2020 parameterization. The differences in the inflation responses translate into noticeable differences in the paths of the log price level. Under the pre-2020 rule, after 15 quarters, the price level is about 0.6 percentage points below where it would be using the post-2020 estimated rule..

Figure 3: Pre- vs. Post-2020 Rule: Cost-Push Shock



Notes: this figure plots model-based impulse responses to a cost-push under the pre-2020 estimated policy rule (dashed line) and the post-2020 estimated rule (solid line).

Figure 3 plots responses to a cost-push shock under both parameterizations. Relative to the pre-2020 parameterization, the post-2020 version of the policy rule results in significantly smaller swings in inflation, output, and the price level. The post-2020 parameterization results in a smaller, though more persistent, movement in the policy rate.

Of course, without knowing something about the relative importance of these two kinds of shocks, it is difficult to say much about how the change in policy parameters might have contributed to macroeconomic performance post-2020. To draw firm conclusions, we would also want to have a more quantitatively realistic model with additional frictions and rigidities. But there are, perhaps, some insights to be gleaned from the relatively simple model. After the immediate impact of COVID-19 in the first half of 2020, it seems reasonable to think that the US economy was hit by several large, positive, natural rate shocks (due, e.g., to large fiscal stimulus and/or pent-up demand from the first stages of the pandemic). With the estimated post-2020 parameterization, the Fed would have been slower to move rates in response to demand shocks, resulting in a larger response of inflation, a more persistent response of the price level, and a slower (and ultimately longer and larger) rise in the policy rate itself. Taken at face value, these responses are potentially roughly consistent with the simple, model-free counterfactual from Figure 1.

It is worth noting that the exercise of comparing the pre- and post-2020 parameterizations in Figure 2 with Figure 3 is not as straightforward as it might at first appear. As documented in our empirical analysis, not only did the Fed seem to switch from targeting period inflation (pre-2020) to average inflation (post-2020), the estimated coefficient on average inflation post-2020 is much larger than the estimated coefficient on period inflation in the earlier sample. Given that, it might appear odd that we find that inflation reacts more to the natural rate shock in the post-2020 parameterization compared to what would have happened with an IT reaction function. The key to understanding this particular result is that average inflation targeting is equivalent to a particular form of interest rate smoothing. To see this point clearly, suppose that the policy rate features no explicit interest smoothing:

$$i_t = \phi'_\pi \sum_{j=0}^{n-1} \pi_{t-j}. \tag{9}$$

Here, $\phi'_\pi = \phi_\pi / n$, where n is the number of periods over which average inflation is calculated. (9) may be written:

$$i_t = s_t + \phi'_\pi \pi_t, \tag{10}$$

where:

$$s_t = i_{t-1} - i_{t-n} + s_{t-n}. \tag{11}$$

When $n = 1$, (9) is a standard IT rule with no smoothing. When $n = 2$, for example, through recursive substitution, we get:

$$s_t = i_{t-1} - i_{t-2} + i_{t-3} - i_{t-4} + i_{t-5} - i_{t-6} + \dots \tag{12}$$

When $n = 3$, for example, we have:

$$s_t = i_{t-1} - i_{t-3} + i_{t-4} - i_{t-6} + i_{t-7} - i_{t-9} + \dots \tag{13}$$

One could continue beyond $n = 3$ and similar patterns would emerge. Average inflation targeting is equivalent to a particular form of interest rate smoothing. As the window over which average inflation is calculated increases, the responsiveness to current inflation decreases in importance relative to the dependence on lagged interest rates.

While certainly not dispositive, this exercise points to a potential role for the switch to AIT in understanding post-COVID inflation dynamics. AIT is roughly equivalent to more interest rate smoothing. In response to shocks driving an inflation-output tradeoff (such as a cost-push shock, see Figure 3), or in a situation where the effective lower bound (ELB) binds and inflation is below target, interest rate smoothing is desirable in that it ties future policy to the past, and in effect can be considered a form of forward guidance. But in the face of large, stimulative demand shocks, more interest rate smoothing can lead to a delayed policy response, resulting in high and persistent inflation. This is roughly consistent with macroeconomic performance of the last several years.

4 Concluding Thoughts

The Fed's 2020 framework review resulted in a noticeable shift in moving focus away from targeting inflation period-by-period to targeting average inflation over some unspecified period. Though average inflation targeting (AIT) was dropped subsequent to the Fed's 2025 review, the shift in 2020 represented the most dramatic and transparent change to the Fed's operating framework in decades.

This paper empirically estimates simple interest rate reaction functions for the Fed. Prior to 2020, the Fed is well characterized as having set policy according to a conventional inflation targeting (IT) rule. Post-2020, in contrast, the Fed seems to have reacted to average inflation instead of period-by-period inflation. To the best of our knowledge, ours is the first paper to empirically document this shift in an estimated interest rate reaction function. Because AIT effectively embeds additional interest-rate inertia, it may have contributed to the delayed policy adjustment and subsequent inflation persistence observed in recent years.

References

Bocola, L., A. Dovis, K. Jorgensen, and R. Kirpalani (2024): "Bond Market Views of the Fed," NBER working paper 32620.

Bullard, J. (2025): "Getting into the Zone," Remarks at Greater Louisville, Inc, November 17, 2022.

Carvalho, C., F. Nechio, and T. Tristao (2021): "Taylor rule estimation by OLS," *Journal of Monetary Economics*, 124(C), 140–154.

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

Duncan, R., E. M. Garcia, and L. Miller (2025): "Tempting FAIT: Flexible Average Inflation Targeting and the Post-COVID US Inflation Surge," Federal Reserve Bank of Dallas working paper 2511.

Eggertson, G., and D. Kohn (2023): "The Inflation Surge of the 2020s: The Role of Monetary Policy," Hutchins Center Working Paper #87.

Gali, J. (2015): *Monetary Policy, Inflation, and the Business Cycle: An Introduction to the New Keynesian Framework and Its Applications Second edition*, vol. None of *Economics Books*. Princeton University Press, 2 edn.

Giannone, D., and G. E. Primiceri (2025): "Demand-Driven Inflation," Working paper, Northwestern University.

Gonzales-Astudillo, M., and R. Tanvir (2023): "Hawkish or Dovish Fed? Estimating a Time-Varying Reaction Function of the Federal Open Market Committee's Median Participant," Federal Reserve Board of Governors, Finance and Economics Discussion Series.

Judd, J. P., and G. D. Rudebusch (1998): "Taylor's rule and the Fed, 1970-1997," *Economic Review*, None(None), 3–16.

Nakamura, E., R. Venance, and J. Steinsson (2025): "Beyond the Taylor Rule," Working paper, University of California, Berkeley.

Newey, W. K., and K. D. West (1987): "A Simple, Positive Semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix," *Econometrica*, 55(3), 703–708.

Okun, A. M. (1962): "Potential GNP: Its Measurement and Significance," Reprinted as Cowles Foundation Paper 190.

Orphanides, A. (2004): "Monetary Policy, Macroeconomic Stability, and Inflation: A View from the Trenches," *Journal of Money, Credit and Banking*, pp. 151–175.

Romer, C. D., and D. H. Romer (2024): "Did the Federal Reserve's 2020 Policy Framework Limit Its Response to Inflation? Evidence and Implications for the Framework Review," *Brookings Papers on Economic Activity*, 55(2 (Fall)), 59–87.

Stock, J. H., and M. W. Watson (2003): "Has the Business Cycle Changed and Why?,"
.

Taylor, J. B. (1993): "Discretion versus policy rules in practice," *Carnegie-Rochester Conference Series on Public Policy*, 39(1), 195–214.

——— (1999): "A Historical Analysis of Monetary Policy Rules," .

——— (2023): "There's Still Time to Get Back to Rules-Based Monetary Policy," Testimony before Subcommittee on Health Care and Financial Services, Committee on Oversight and Accountability, US House of Representatives, March 9, 2023.

Wu, J. C., and F. D. Xia (2016): "Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound," *Journal of Money, Credit and Banking*, 48(2-3), 253–291.

Wu, J. C., and J. Zhang (2019): "A shadow rate New Keynesian model," *Journal of Economic Dynamics and Control*, 107(C), 1–1.

A Appendix

The Appendix contains several sets of robustness checks. Subsection A.1 estimates interest rate reaction functions using quarterly, rather than monthly, data. Subsection A.2 drops our assumption that the Fed reacts to inflation and unemployment with a one-period delay and instead allows for contemporaneous feedback. Subsection A.3 allows variety of different windows over which average inflation is calculated. Subsection A.4 considers different measures of inflation and Subsection A.5 considers different economic activity targets in the reaction function specification. Subsection A.6 allows for more than one lag of the interest on the right-hand-side of the empirical specification. Subsection A.7 uses the actual Federal Funds Rate, instead of the Wu and Xia (2016) shadow rate, in the empirical regressions. Subsection A.8 estimates a reaction function with many lags of inflation on the right-hand-side and tests for equality of these coefficients. Subsection A.9 considers the possibility of an asymmetric policy response to deviations and shortfalls from full employment.

A.1 Quarterly Interest Rate Reaction Function Estimates

Here, we re-do our baseline regressions, but with quarterly, instead of annual data. Results are shown in Table A.1.

Table A.1: Interest Rate Reaction Function Estimates
Quarterly Data

	1984-2019			2020-2025		
	IT	AIT	Combined	IT	AIT	Combined
Constant	0.385	0.404	0.383	0.649	-1.639	-1.559
	(0.244)	(0.247)	(0.241)	(1.622)	(1.194)	(1.389)
Lagged Rate	0.945***	0.950***	0.950***	0.945***	0.881***	0.868***
	(0.020)	(0.020)	(0.025)	(0.097)	(0.045)	(0.083)
Inflation	0.107		0.128*	0.255*		-0.033
	(0.069)		(0.075)	(0.137)		(0.1114)
Avg. Inflation		0.080	-0.041		0.565***	0.589***
		(0.098)	(0.101)		(0.138)	(0.155)
Unemployment	-0.082***	-0.079**	-0.077**	-0.280	0.024	0.022
	(0.031)	(0.031)	(0.030)	(0.201)	(0.141)	(0.153)
N	143	143	143	18	18	18
R-squared	0.979	0.979	0.979	0.973	0.986	0.986

Notes: this table presents results from regressions of the shadow FFR on its own lag and the once-lagged unemployment rate. Other regressors include the once-lagged period inflation rate (column labeled "IT"), the once-lagged average inflation rate over an six-quarter window (column labeled "AIT"), or both of these variables (column labeled "Combined"). The frequency of observation is quarterly. Standard errors are produced via Newey and West (1987).

Note that care must be taken in interpreting the coefficient on the lagged interest rate when moving from a monthly to a quarterly frequency. In particular, to compare these coefficients to the monthly ones (Table 1 or Table 2) one must raise the estimated smoothing parameter here to the power 1/3. For the "Combined" specification, for example, the estimate of 0.950 in the pre-2020 sample at the quarterly frequency translates to 0.983 at a monthly frequency. The estimate of 0.868 at the quarterly frequency is equivalent to 0.954 at the monthly frequency. These estimates are very close to what is shown in the main text.

Care must also be taken when interpreting the coefficients on inflation, average inflation, and unemployment. One needs to multiply the monthly coefficients by $(1 + \rho + \rho^2)$ to get the quarterly equivalents, where ρ is the estimated persistence parameter at a monthly frequency. In the early sample in the "Combined" specification, the coefficient on inflation of 0.030 at a monthly frequency (see Table 1) would be equivalent to about 0.09 at the quarterly frequency, which is similar to what is shown above.

A.2 Contemporaneous Inflation and Unemployment in the Reaction Function

In this subsection, we re-estimate our baseline regressions, but allow for immediate reactions of the policy rate to inflation, average inflation, and the unemployment rate (as opposed to assuming that the Fed only reacts with a lag, as in the main text). Results are shown in Table A.2.

Table A.2: Interest Rate Reaction Function Estimates
Contemporaneous Target Variables

	1984-2019			2020-2025		
	IT	AIT	Combined	IT	AIT	Combined
Constant	0.148*	0.150*	0.148*	1.236***	-0.433	-0.321
	(0.079)	(0.083)	(0.081)	(0.364)	(0.480)	(0.476)
Lagged Rate	0.985***	0.983***	0.984***	0.941***	0.975***	0.967***
	(0.006)	(0.009)	(0.008)	(0.021)	(0.020)	(0.021)
Inflation	0.026**		0.024**	-0.008		-0.018
	(0.010)		(0.011)	(0.021)		(0.019)
Avg. Inflation		0.034	0.009		0.173***	0.179***
		(0.030)	(0.031)		(0.041)	(0.043)
Unemployment	-0.029***	-0.031***	-0.031***	-0.226***	-0.014	-0.024
	(0.010)	(0.011)	(0.011)	(0.065)	(0.071)	(0.071)
N	431	431	431	57	57	57
R-squared	0.996	0.995	0.996	0.993	0.994	0.994

Notes: this table presents results from regressions of the shadow FFR on its own lag and the contemporaneous unemployment rate. Other regressors include the contemporaneous period inflation rate (column labeled "IT"), the contemporaneous average inflation rate over an 18-month window (column labeled "AIT"), or both of these variables (column labeled "Combined"). The frequency of observation is monthly. Standard errors are produced via Newey and West (1987).

A.3 Alternative Windows for Average Inflation

In this subsection, we return to our baseline regression specifications but consider alternative window lengths when calculating average inflation. In particular, we assume window lengths of $n = 4$ (where the frequency is monthly), $n = 8$, $n = 12$, and $n = 24$. Results are shown in Table A.3.

Table A.3: Interest Rate Reaction Function Estimates
Alternative Window Lengths

	1984-2019				2020-2025			
	$n = 4$	$n = 8$	$n = 12$	$n = 24$	$n = 4$	$n = 8$	$n = 12$	$n = 24$
Constant	0.128	0.130	0.129	0.131	0.412	-0.249	-0.647	-0.142
	(0.083)	(0.083)	(0.082)	(0.529)	(0.615)	(0.680)	(0.612)	(0.519)
Lagged Rate	0.981***	0.983***	0.981***	0.988***	0.977***	1.001***	1.002***	0.942***
	(0.008)	(0.008)	(0.009)	(0.009)	(0.031)	(0.035)	(0.028)	(0.017)
Inflation	0.022*	0.026**	0.025**	0.031***	0.012	0.013	0.007	0.014
	(0.013)	(0.013)	(0.011)	(0.011)	(0.021)	(0.021)	(0.019)	(0.019)
Avg. Inflation	0.021	0.011	0.018	-0.012	0.066***	0.122**	0.172***	0.161***
	(0.025)	(0.028)	(0.031)	(0.031)	(0.050)	(0.059)	(0.060)	(0.059)
Unemployment	-0.030***	-0.029***	-0.030***	-0.025**	-0.131*	-0.043	0.013	-0.060
	(0.011)	(0.011)	(0.011)	(0.011)	(0.081)	(0.097)	(0.081)	(0.073)
N	431	431	431	431	57	57	57	57
R-squared	0.996	0.996	0.996	0.993	0.994	0.994	0.994	0.994

Notes: this table presents results from regressions of the shadow FFR on its own lag, the once-lagged unemployment rate, the once lagged inflation rate, and the once lagged average of inflation rates over different windows. We consider four different windows over which to calculate average inflation: $n = 4$, $n = 8$, and $n = 12$ (one year, or four quarters), and $n = 24$ (two years, or eight quarters). The frequency of observation is monthly. Standard errors are produced via Newey and West (1987).

A.4 Different Measures of Inflation

In this subsection, we consider different measures of inflation. In our baseline analysis, we measure inflation by the PCE less food and energy. Table A.4 replaces this with the headline CPI inflation rate. Table A.5 uses the headline PCE inflation rate (inclusive of food and energy).

Table A.4: Interest Rate Reaction Function Estimates
CPI Inflation

	1984-2019			2020-2025		
	IT	AIT	Combined	IT	AIT	Combined
Constant	0.135	0.190**	0.189***	1.160***	-0.097	-0.009
	(0.083)	(0.078)	(0.078)	(0.362)	(0.396)	(0.415)
Lagged Rate	0.991***	1.001***	1.000***	0.936***	0.977***	0.969***
	(0.006)	(0.008)	(0.008)	(0.023)	(0.021)	(0.022)
Inflation	0.002		0.004	-0.005		-0.008
	(0.003)		(0.003)	(0.009)		(0.009)
Avg. Inflation		-0.039**	-0.042***		0.091***	0.092***
		(0.020)	(0.020)		(0.021)	(0.021)
Unemployment	-0.022**	-0.018	-0.018	-0.205***	-0.040	-0.048
	(0.011)	(0.011)	(0.011)	(0.068)	(0.061)	(0.063)
N	431	431	431	57	57	57
R-squared	0.995	0.996	0.996	0.992	0.994	0.994

Notes: this table presents results from regressions of the shadow FFR on its own lag and the once-lagged unemployment rate. Other regressors include the one-lagged period inflation rate (column labeled "IT"), the once-lagged average inflation rate over an 18-month window (column labeled "AIT"), or both of these variables (column labeled "Combined"). Inflation is measured via the Consumer Price Index (CPI). The frequency of observation is monthly. Standard errors are produced via Newey and West (1987).

Table A.5: Interest Rate Reaction Function Estimates
PCE Inflation

	1984-2019			2020-2025		
	IT	AIT	Combined	IT	AIT	Combined
Constant	0.133	0.146*	0.145*	1.203***	-0.107	0.021
	(0.083)	(0.083)	(0.082)	(0.370)	(0.452)	(0.473)
Lagged Rate	0.989***	0.995***	0.994***	0.934***	0.977***	0.966***
	(0.006)	(0.008)	(0.008)	(0.023)	(0.023)	(0.023)
Inflation	0.010*		0.012**	-0.010		-0.014
	(0.005)		(0.005)	(0.014)		(0.012)
Avg. Inflation		-0.013	-0.022		0.109***	0.111***
		(0.023)	(0.023)		(0.029)	(0.030)
Unemployment	-0.023**	-0.020*	-0.020*	-0.210***	-0.040	-0.052
	(0.011)	(0.012)	(0.011)	(0.069)	(0.069)	(0.071)
N	431	431	431	57	57	57
R-squared	0.995	0.996	0.996	0.992	0.994	0.994

Notes: this table presents results from regressions of the shadow FFR on its own lag and the once-lagged unemployment rate. Other regressors include the one-lagged period inflation rate (column labeled "IT"), the once-lagged average inflation rate over an 18-month window (column labeled "AIT"), or both of these variables (column labeled "Combined"). Inflation is measured via the Personal Consumption Expenditures (PCE) price index (inclusive of food and energy). The frequency of observation is monthly. Standard errors are produced via Newey and West (1987).

A.5 Different Real Activity Measures

In this section, we replace the unemployment rate with different measures of real activity. Table A.6 shows results when we us the growth rate of Industrial Production (IP) in place of the unemployment rate.

Table A.6: Interest Rate Reaction Function Estimates
IP Growth

	1984-2019			2020-2025		
	IT	AIT	Combined	IT	AIT	Combined
Constant	-0.038	-0.005	-0.004	-0.269*	-0.553***	-0.561***
	(0.027)	(0.051)	(0.049)	(0.145)	(0.128)	(0.134)
Lagged Rate	0.989***	0.994***	0.994***	1.017***	0.973***	0.974***
	(0.006)	(0.007)	(0.007)	(0.024)	(0.014)	(0.013)
Inflation	0.019*		0.026**	0.077***		0.004
	(0.010)		(0.012)	(0.024)		(0.019)
Avg. Inflation		-0.003	-0.028		0.189***	0.186***
		(0.027)	(0.030)		(0.029)	(0.031)
IP Growth	0.007***	0.007***	0.007*	0.002	0.005	0.005
	(0.002)	(0.002)	(0.002)	(0.006)	(0.006)	(0.005)
N	431	431	431	57	57	57
R-squared	0.996	0.996	0.996	0.990	0.994	0.994

Notes: this table presents results from regressions of the shadow FFR on its own lag and the once-lagged growth rate of Industrial Production (IP). Other regressors include the once-lagged period inflation rate (column labeled "IT"), the once-lagged average inflation rate (column labeled "AIT"), or both of these variables (column labeled "Combined"). The frequency of observation is monthly. Standard errors are produced via Newey and West (1987).

Next, we consider using the output gap as a right-hand-side variable. We measure potential output using estimates of potential output from the Congressional Budget Office. We measure the gap as the log difference between real GDP and potential (multiplied by 100). This series is only available at a quarterly frequency. To convert it to monthly, we assume that the gap for the quarter is equal to the gap in each month of the quarter. Results are shown in Table A.7. Coefficients on the output gap are positive (and significant in the pre-2020 sample).

Table A.7: Interest Rate Reaction Function Estimates
Output Gap

	1984-2019			2020-2025		
	IT	AIT	Combined	IT	AIT	Combined
Constant	0.033	0.012	0.012	-0.206*	-0.503***	-0.520***
	(0.038)	(0.049)	(0.047)	(0.111)	(0.101)	(0.119)
Lagged Rate	0.974***	0.966***	0.968***	0.995***	0.965***	0.968***
	(0.009)	(0.012)	(0.012)	(0.019)	(0.018)	(0.018)
Inflation	0.032***		0.028**	0.064***		0.007
	(0.010)		(0.011)	(0.019)		(0.017)
Avg. Inflation		0.053*	0.024		0.180***	0.176***
		(0.031)	(0.032)		(0.024)	(0.026)
Output Gap	0.046***	0.053***	0.051***	0.068	0.018	0.016
	(0.014)	(0.017)	(0.016)	(0.041)	(0.046)	(0.004)
N	431	431	431	57	57	57
R-squared	0.996	0.996	0.996	0.990	0.990	0.994

Notes: this table presents results from regressions of the shadow FFR on its own lag and the once-lagged output gap. Other regressors include the once-lagged period inflation rate (column labeled "IT"), the once-lagged average inflation rate (column labeled "AIT"), or both of these variables (column labeled "Combined"). The frequency of observation is monthly. Standard errors are produced via Newey and West (1987).

Table A.8 estimates the gap-version of the policy rule, but on quarterly data.

Table A.8: Interest Rate Reaction Function Estimates
Output Gap, Quarterly Frequency

	1984-2019			2020-2025		
	IT	AIT	Combined	IT	AIT	Combined
Constant	0.065	0.046	0.037	-1.438**	-1.346***	-1.207***
	(0.130)	(0.148)	(0.145)	(0.566)	(0.294)	(0.392)
Lagged Rate	0.901***	0.898***	0.900***	1.024***	0.859***	0.833***
	(0.029)	(0.039)	(0.038)	(0.088)	(0.040)	(0.079)
Inflation	0.127*		0.098	0.397***		-0.066
	(0.071)		(0.069)	(0.122)		(0.124)
Avg. Inflation		0.154	0.058		0.514***	0.561***
		(0.102)	(0.097)		(0.070)	(0.114)
Output Gap	0.135***	0.149***	0.144***	0.141	0.085	0.097
	(0.047)	(0.055)	(0.052)	(0.160)	(0.119)	(0.133)
N	143	143	143	18	18	18
R-squared	0.980	0.980	0.981	0.968	0.987	0.987

Notes: this table presents results from regressions of the shadow FFR on its own lag and the once-lagged output gap. Other regressors include the once-lagged period inflation rate (column labeled "IT"), the once-lagged average inflation rate (column labeled "AIT"), or both of these variables (column labeled "Combined"). The frequency of observation is quarterly. Standard errors are produced via Newey and West (1987).

A.6 Multiple Lags of Interest Rate

In this subsection, we consider adding additional lags of the interest rate. Table A.11 shows results when we consider two or three lags of the interest rate on the right-hand-side of the regression specification.

Table A.9: Interest Rate Reaction Function Estimates
Multiple Interest Rate Lags

	1984-2019		2020-2025	
	Two Lags	Three Lags	One Lag	Two Lags
Constant	0.079*	0.071	-0.333	-0.345
	(0.047)	(0.066)	(0.484)	(0.478)
Lagged Rate	1.438***	1.386***	1.088***	1.091***
	(0.057)	(0.066)	(0.113)	(0.116)
Twice Lagged Rate	-0.452***	-0.289**	-0.118	-0.139
	(0.056)	(0.120)	(0.118)	(0.206)
Thrice Lagged Rate		-0.112		0.018
		(0.075)		(0.111)
Inflation	0.019*	0.018*	0.009	0.008
	(0.010)	(0.010)	(0.018)	(0.017)
Avg. Inflation	0.011	0.013	0.145**	0.149***
	(0.017)	(0.017)	(0.056)	(0.053)
Unemployment	-0.018**	-0.017**	-0.020	-0.019
	(0.007)	(0.008)	(0.063)	(0.063)
N	431	431	57	57
R-squared	0.996	0.997	0.994	0.994

Notes: this table presents results from regressions of the shadow FFR on its own first lag, its own second lag, and potential its own third lag. Other regressors include the once-lagged period inflation rate, the once-lagged average inflation rate, and the unemployment rate. The frequency of observation is monthly. Standard errors are produced via Newey and West (1987).

A.7 Using the Federal Funds Rate Instead of the Effective Funds Rate

In all of our analysis, we use the effective Federal Funds Rate (effective FFR) based on the Wu and Xia (2016) shadow rate series. The effective FFR can go below zero during periods in which the zero lower bound (ZLB) was binding.

In this subsection, we consider robustness exercises in which we use the actual FFR in the regressions. In one specification, we simply replace the effective FFR with the FFR; in the other, we replace the effective FFR with the FFR but also include a dummy variable equal to one in periods where the FFR was less than 25 basis points. We estimate both specifications on the pre- and post-2020 samples. Results are reported in Table A.10.

Table A.10: Interest Rate Reaction Function Estimates
Federal Funds Rate

	1984-2019		2020-2025	
Constant	0.067	0.079	-0.772**	-0.359
	(0.079)	(0.076)	(0.351)	(0.245)
Lagged Rate	0.991***	0.992***	0.978***	0.913***
	(0.009)	(0.010)	(0.019)	(0.016)
Inflation	0.036***	0.036***	-0.022*	-0.015*
	(0.012)	(0.012)	(0.012)	(0.008)
Avg. Inflation	-0.031	-0.026	0.185***	0.141***
	(0.031)	(0.032)	(0.046)	(0.028)
Unemployment	-0.011	-0.017	0.074*	0.086***
	(0.010)	(0.013)	(0.044)	(0.029)
ZLB Dummy		0.041		-0.426***
		(0.050)		(0.071)
N	431	431	57	57
R-squared	0.995	0.995	0.997	0.999

Notes: this table presents results from regressions of the actual FFR on its own lag, the once-lagged inflation rate, the once-lagged average inflation rate, the once-lagged unemployment rate gap, and the once-lagged unemployment rate. In some specifications, we include a dummy variable equal to one in months where the ZLB was binding. The frequency of observation is monthly. Standard errors are produced via Newey and West (1987).

A.8 Testing Equality of Coefficients on Multiple Lags of Inflation

Consider estimating a regression of the form:

$$i_t = \beta_0 + \beta_1 i_{t-1} + \sum_{j=1}^{n} \beta_{1+j}\pi_{t-j} + \beta_{n+2}u_{t-1} + e_t, \tag{A.1}$$

where $n \geq 1$ is the window length. When $n = 1$, this is a standard IT regression. When $n = 2$, for example, (A.1) amounts to regressing the Fed Funds Rate on its own lag, two lags of inflation, and one lag of unemployment. By instead including the two-period average of inflation as a regressor prior to estimation, we are effectively imposing, in this example, that $\beta_2 = \beta_3$. In principle, this is an assumption that can be tested.

Employing the same window length as before, we now estimate (A.1) where $n = 18$; i.e., we regress the Fed Funds rate on its own lag, the first 18 lags of inflation, and the first lag of the unemployment rate. Estimated coefficients, for both the 1984-2019 and the 2020-2025 samples, are shown in Table A.11. For the early sample, the estimated coefficients on the first two lags of inflation are statistically significant and similar in magnitude. With one exception, all the other coefficients are close to zero and statistically insignificant.[13] In the post-2020 sample, the coefficient on the first lag of inflation is close to zero. The only statistically significant coefficient is on the second lag of inflation. Admittedly, given the small sample size and the large number of parameters, it should not be too surprising that there are few significant coefficients on lags of inflation. It should be noted, however, that many of the coefficients on lags of inflation, particularly at relatively long horizons, are positive and close in magnitude to the coefficient on the second lag of inflation.

It is straightforward to conduct a chi-squared test of the equality of all the coefficients on lags of inflation. In the early sample, the p-value of such a test is 0.016, meaning that the hypothesis that all the coefficients are equal can easily be rejected. With the continued caveat of the small sample size, one cannot reject this hypothesis in the post-2020 sample (p-value of 0.324).

A.9 Different Response to Employment Shortfalls vs. Deviations

In this subection, we explore the second major change in the Fed's 2020 operating framework: responding to shortfalls, rather than deviations, from full employment. We estimate the following regression:

$$i_t = \beta_0 + \beta_1 i_{t-1} + \beta_2\pi_{t-1} + \beta_3\pi^a_{t-1} + \beta_4\left(u_{t-1} - u^*_{t-1}\right) + \beta_5\left(u_{t-1} - u^*_{t-1}\right) \times D_{t-1} + e_t \tag{A.2}$$

(A.2) is similar to our baseline specification ("Combined"), with two differences. First, we explicitly allow for the target unemployment rate to be time-varying (whereas in our baseline analysis we implicitly assume it to be constant). We measure the target unemployment rate as the non-cyclical rate of unemployment, as produced by the Congressional Budget Office.

[13] The exception is the coefficient on inflation lagged 13 periods, which is negative (not positive) and statistically significant.

Table A.11: Interest Rate Reaction Function Estimates
Individual Lags of Inflation

	1984-2019		2020-2025	
	Coefficient	S.E.	Coefficient	S.E.
Constant	0.120	(0.081)	0.267	(0.763)
Lagged Rate	0.987***	(0.008)	0.920***	(0.046)
π_{t-1}	0.029***	(0.009)	-0.014	(0.019)
π_{t-2}	0.025***	(0.010)	0.044**	(0.018)
π_{t-3}	0.000	(0.010)	-0.008	(0.019)
π_{t-4}	0.001	(0.010)	-0.023	(0.026)
π_{t-5}	-0.002	(0.007)	0.011	(0.018)
π_{t-6}	0.007	(0.008)	-0.019	(0.025)
π_{t-7}	0.000	(0.008)	0.011	(0.018)
π_{t-8}	-0.008	(0.013)	0.002	(0.018)
π_{t-9}	0.008	(0.007)	0.002	(0.017)
π_{t-10}	-0.006	(0.009)	-0.018	(0.014)
π_{t-11}	0.014	(0.010)	0.036	(0.037)
π_{t-12}	0.002	(0.013)	0.024	(0.018)
π_{t-13}	-0.023***	(0.008)	0.012	(0.015)
π_{t-14}	-0.012	(0.008)	0.016	(0.015)
π_{t-15}	-0.018	(0.011)	-0.016	(0.020)
π_{t-16}	0.002	(0.011)	0.028	(0.018)
π_{t-17}	0.001	(0.009)	0.016	(0.020)
π_{t-18}	0.005	(0.008)	0.026	(0.024)
Unemployment	-0.024**	(0.010)	-0.100	(0.097)
N	431		57	
R-squared	0.996		0.996	
chi-squared p-value	0.016		0.324	

Notes: this table presents results from regressions of the shadow FFR on its own lag, the once-lagged unemployment rate gap, and 18 separate lags of inflation. The frequency of observation is monthly. Standard errors are produced via Newey and West (1987). The p-values are from a chi-squared test of the equality of all coefficients on lags of inflation.

Table A.12: Interest Rate Reaction Function Estimates
Differential Response to Employment Shortfalls

	1984-2019	2020-2025
Constant	0.023	-0.520
	(0.066)	(0.408)
Lagged Rate	0.982***	0.971***
	(0.010)	(0.030)
Inflation	0.030***	0.008
	(0.011)	(0.019)
Avg. Inflation	-0.008	0.178
	(0.033)	(0.119)
Unemployment Gap	-0.023	0.010
	(0.011)	(0.384)
Unemployment Gap Positive	-0.011	-0.018
	(0.079)	(0.327)
N	431	57
R-squared	0.996	0.994

Notes: this table presents results from regressions of the shadow FFR on its own lag, the once-lagged inflation rate, the once-lagged average inflation rate, the once-lagged unemployment rate gap, and the once-lagged unemployment rate gap interacted with a dummy variable for periods when the unemployment gap is positive. The frequency of observation is monthly. Standard errors are produced via Newey and West (1987).

Second, we include an interaction term. $D_{t-1} = 1$ in periods where the unemployment gap is positive. The coefficient β_4 therefore measures the response to the unemployment rate, while $\beta_4 + \beta_5$ measures the response when the gap is positive. If the central bank were just targeting deviations from full employment, we would expect $\beta_5 = 0$. If the central bank were only reacting to shortfalls from full employment, we would expect $\beta_4 = 0$ and $\beta_5 < 0$.

Results are shown in Table A.12. The estimate coefficients on period and average inflation are very similar to our baseline: pre-2020, the Fed seems to have reacted to period and not average inflation, whereas the reverse is true post-2020. In the early sample, though the individual coefficients are statistically insignificant, the Fed seems to have responded to unemployment deviations (coefficient -0.023), with some weak evidence of a stronger response when the unemployment gap is positive (coefficient -0.011, or cumulative coefficient of -0.034). In the later sample, the estimated response to positive unemployment gaps is negative, whereas the response to unemployment deviations is small and close to zero. We consider this evidence to be inconclusive – the inclusion of the unemployment interaction term leads to much higher standard errors, particularly in the shorter sample.